SEEPZ-SEZ AUTHORITY

(Using E- Procurement mode on Central Public Procurement Portal)

REQUEST FOR PROPOSAL

FOR

DEMOLITION OF EXISTING STANDARD DESIGN FACTORY (SDF) – 1 AND CONSTRUCTION OF NEW ENTERPRISES & SERVICES TOWER (NEST) - 3

AT

SEEPZ-SEZ, MIDC CENTRAL ROAD, ANDHERI EAST, MUMBAI 400 096, INDIA.

Tender Ref. No: SEEPZM-IT/14/2025-PROC

Date of Issue: 08-10-2026

ISSUING AUTHORITY

Development Commissioner, SEEPZ- SEZ, Mumbai, India.

Postal Address: SEEPZ-SEZ, MIDC Central Road, Andheri East, Mumbai 400 096.

E-Mail: dcseepz-mah@nic.in || Helpline No.: 022-28290856 || Landline: 022-28294728/29

(From 9:30 A.M. to 6:00 P.M.)

KEY INFORMATION AT A GLANCE

Sr.	Item	Description
1.	Tender Ref. No.	SEEPZM-IT/14/2025-PROC
2.	Tender Title.	Demolition of Existing Standard Design Factory (SDF) – 1 and Construction of New Enterprises & Services Tower (NEST) - 3 at SEEPZ-SEZ, MIDC Central Road, Andheri East, Mumbai 400 096, India.
3.	Brief Description.	The entire scope of work will be executed in following 02 (two) stages: **Stage 1:** The Contractor shall carry out the "Demolition of the existing Ground + 03 RCC structure of SDF 01, Sub-station, and Canteen Building, including but not limited to: a) Safe dismantling of all structural components, fixtures, and associated utilities. b) Collection, loading, and transportation of all debris outside of site premises. c) Disposal of debris at the designated location as directed and approved by the statutory authority. d) Compliance with all applicable safety, environmental, and statutory regulations during execution. **Stage 2:** The Contractor shall execute and complete the Works for the "Construction of New Enterprises & Services Tower (NEST)-3", comprising a total of 03 (three) towers simultaneously, each consisting of 01 (one) Basement Level, 01 (one) Ground Floor, 01 (one) Podium Level, and 10 (ten) Upper Floors / Storeys, including all associated civil, structural, architectural, MEPF, infrastructure, external development, testing, commissioning, statutory approvals, and ancillary works, whether specifically mentioned herein or not, as required for the complete and functional delivery of the Project, including but not limited to the following: a) The Contractor shall execute site preparation, excavation, piling, PCC / RCC works, post-tensioned structures, interior and finishing works, and development of external infrastructure such as roads and land development, in accordance with approved drawings and specifications. b) Design, engineering, fabrication, supply, installation, testing, and commissioning of façade systems and BMU, including glazing, cladding, louvers, doors, and railings, along with structural analysis, BIM coordination, and performance validation. c) Execution of plumbing, drainage, firefighting, HVAC, electrical, lightning protection, and earthing systems, including installation, testing, and commissioning as per project specifications.

Sr.	Item	Description
		d) Preparation of coordinated shop drawings and BIM models (LOD 500), including stakeholder integration, clash detection, and submission of as-built documentation. e) Handling of procurement, logistics, QA/QC processes, testing, provision of temporary infrastructure, and coordination with nominated contractors. f) Securing all required statutory permissions for both the commencement and completion of the execution work. g) Execution of mock-ups, inspections, and testing; submission of as-built documentation, warranties, and guarantees; completion of final cleaning, snag rectification, and project handover; and maintenance during the Defect Liability Period. h) Provision of all materials, labour, plant, equipment, transportation, tools, and services required for complete execution in accordance with contract specifications. i) Provision and maintenance of temporary infrastructure, including access roads for equipment and vehicle movement, temporary drainage systems, and area lighting required for construction activities. j) Resolution of all snag items to the satisfaction of the Engineer-in-Charge prior to final handover. k) Preparation and submission of final as-built drawings in both soft and hard copy formats. l) Execution of material certification processes required to achieve the targeted Green Building rating. m) Completion of thorough deep cleaning across all areas prior to project handover. n) Submission of fire rating certifications, as applicable. o) Operation and comprehensive maintenance of all MEP systems within the Contractor's scope during the Defect Liability Period, in accordance with the Service Level Agreement. The Contractor shall ensure that the work is executed in a manner that minimizes disruption to surrounding operations and adheres strictly to the instructions issued by SEEPZ-SEZ Authority and other statutory bodies.
4.	NA	
5.	Type of Contract	Item Rate Contract.

Sr.	Item	Description
6.	Bid Security / EMD Amount	**Rs. 12,34,03,170/- (Rupees Twelve Crore Thirty-Four Lakh Three Thousand One Hundred Seventy Only.)** in the form of a Fixed Deposit Receipt or a Bank Guarantee from any scheduled bank or a Demand Draft raised in the name of SEEPZ-SEZ Authority Funds payable at Mumbai before last date of submission of bids.
7.	Link for Downloading Tender Documents.	Tender Document can be downloaded free of cost from the following websites: Link: https://eprocure.gov.in/epublish/app
8.	Date of Tender Publishing.	8th October 2026
9.	Date and Time of Pre-Bid Meeting.	Meeting Platform: WebEx Meeting number: 2515 709 1035 Password: PB@11 on 16th October 2026 at 11:00 AM.
10.	Last Date and Time for Submission of Technical + Financial Bids.	31st October 2026 up to 1200 hrs.
11.	Date and Time of Technical Bid Opening	3rd November 2026 at 15:00 Hrs. The opening of the Technical Bid shall take place at: SEEPZ-SEZ, MIDC Central Road, Andheri East, Mumbai 400096.
12.	Tentative Date and Time of Commercial Bid Opening	18th November 2026 at 15:00 Hrs. Financial Bids of only technically qualified Contractors shall be opened at a date which shall be pre-disclosed on the e-procurement portal
13.	Date of Commencement	**01 (one) Calendar Month** from the date of issue of work order or the date on which the contractor is instructed to take possession of the site whichever is later.
14.	Project Completion Period	**30 (thirty) Calendar Months** from date of commencement.
15.	Defect Liability Period	**24 (twenty-four) Calendar Months** from the date of work completion as certified by the consultants.
16.	Help Desk No. (For eProcurement)	eProcurement Helpdesk nos. (New Delhi): 0120-4200462, 0120-4001002, 0120-4001005.
17.	Authority to be Contacted in Case of any Clarification / Request for Entry Permission for Physical Visit	Name: Shri. Aman Kumar Sharma Designation: ADC, SEEPZ, SEZ Email: amank.g142101@gov.in Landline: 9407021577

Sr.	Item	Description
		Name: Shri. Soodershan Shindde Designation: ADC, SEEPZ, SEZ Email: soodershan.shindde@gov.in Landline: 9823422899
18.	Link for accessing training schedule regarding use of e-procurement portal by consultants may be found at:	Link: https://eprocure.gov.in/CPP/trainingdisp

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DISCLAIMER

The information contained in this Bidding Documents (hereinafter referred to as "RFB") document provided to the Contractors, by Development Commissioner, SEEPZ-SEZ, Mumbai referred to as Employer, or any of their employees or advisors, is provided to the Contractor(s) on the terms and conditions set out in this RFB document and all other terms and conditions subject to which such information is provided.

The purpose of this RFB document is to provide the Contractor(s) with information to assist in the formulation of Bids. This RFB document does not purport to contain all the information each Contractor may require.

This RFB document may not be appropriate for all people, and it is not possible for SEEPZ, their employees or advisors to consider the business/investment objectives, financial situation and particular needs of each Contractor who reads or uses this RFB document. Each Contractor should conduct its own investigations and analysis and should check the accuracy, reliability, and completeness of the information in this RFB document and where necessary obtain independent advice from appropriate sources.

SEEPZ, its employees, other stakeholders or/and advisors make no representation or warranty and shall incur no liability under any law, statute, rules, or regulations as to the accuracy, reliability, or completeness of the RFB document.

SEEPZ may, in its absolute discretion, but without being under any obligation to do so, update, amend or supplement the information in this RFB document.

The issue of this RFB does not imply that SEEPZ is bound to appoint a Contractor, as the case may be, for the Consultancy and SEEPZ reserves the right to reject all or any of the Applications without assigning any reasons whatsoever.

The Contractor shall bear all its costs associated with or relating to the preparation and submission of its Application including but not limited to preparation, copying, postage, delivery fees, expenses associated with any demonstrations or presentations which may be required by SEEPZ, or any other costs incurred in connection with or relating to its Application.

All such costs and expenses will remain with the Contractor and SEEPZ shall not be liable in any manner whatsoever for the same or for any other costs or other expenses incurred by an Applicant in preparation or submission of the Application, regardless of the conduct or outcome of the Evaluation Process.

Section 01

Notice Inviting Bid (NIB)

Section 01 - Notice Inviting Bid.

Bid Ref. No.: SEEPZM-IT/14/2025-PROC **Date:** 8th October 2026.

Tender Title: Demolition of Existing Standard Design Factory (SDF) – 1 and Construction of New Enterprises & Services Tower (NEST) - 3 at SEEPZ-SEZ, MIDC Central Road, Andheri East, Mumbai 400 096, India.

1. The SEEPZ-SEZ Authority invites online bids from eligible contractors for the work of "Demolishing the existing G+3 RCC structure of SDF-01, along with the substation and canteen building. The scope includes safe dismantling of all structural components and utilities, site clearance after demolition, and collection, transportation, and disposal of debris at locations approved by statutory authorities, in full compliance with safety, environmental, and regulatory requirements.

   Additionally, the project includes the complete construction of NEST-3 (Basement + Ground + Podium + 10 floors), covering civil works, façade systems, MEP installations, external development, design coordination, procurement, statutory approvals, testing and commissioning, documentation, finishing, and maintenance during the Defect Liability Period. The contractor shall provide all materials, manpower, equipment, temporary infrastructure, and complete all works, including green certification requirements and final handover, in accordance with contract specifications."

   All works shall be executed with minimal disruption to surrounding operations and in strict compliance with SEEPZ-SEZ Authority guidelines and applicable statutory regulations.

2. More details pertaining to the work may be seen under 'Section 5 - Scope of Work and Technical Specifications'.

3. The Bidding process shall be conducted in an online mode on the Central Public Procurement Portal (CPP) which is publicly accessible- using the following web address: https://eprocure.gov.in/eprocure/app. Contractors can download the Bidding Documents free of cost from this portal.

4. In order to be considered for technical evaluation, bids must be accompanied by a bid security (EMD) amounting to **Rs. 12,34,03,170/- (Rupees Twelve Crore Thirty-Four Lakh Three Thousand One Hundred Seventy Only.)** . Permissible bid security instruments, beneficiary details, exemption rules, and submission procedure are provided under 'Section I -Instructions to Bidders'.

5. Interested Contractors must register on the e-procurement portal and upload their technical and financial Bids separately within the stipulated date and time, i.e., 16th October 2026 up to 1200 Hrs. Bidders are required to upload scanned copy of bid security (EMD) as part of their technical bid. The original copy of the bid security must be submitted physically at the office of the Development Commissioner prior to the deadline for bid submission.

6. Detailed instructions regarding online submission of Bids may be seen under Annexure I. In case of any issues or queries related to the e-procurement portal, kindly send an email request to amank.g142101@gov.in or contact on 9407021577 (Name: Shri. Aman Kumar Sharma) or soodershan.shindde@gov.in contact on 9823422899 (Name: Shri. Soodershan Shindd)

7. The Contractor is solely responsible for timely uploading of Bids on the e-procurement portal. SEEPZ-SEZ Authority shall not be liable for resolving any queries / issues raised on the last day of bid submission.

8. Technical Bids shall be opened online on 5th December 2026 at 15:00 Hrs. Contractors can see the tender opening status by logging on to the e-procurement portal using their registered IDs.

9. Financial Bids of only technically qualified Contractors shall be opened at a date which shall be pre-disclosed on the e-procurement portal.

10. SEEPZ-SEZ Authority reserves the right to accept any or reject any or all of the Bids at any time during the Bidding process.

Sd/-

Development Commissioner

SEEPZ-SEZ Authority

Section 02

Instructions to Bidders (ITB)

Section 02 - Instructions to Bidders (ITB)

1. Introduction.

a) This Section provides the relevant information as well as instructions to assist prospective Bidders in preparation and submission of bids. It also includes the mode and procedure to be adopted by the Procuring Entity, being SEEPZ-SEZ Authority for receipt and opening as well as scrutiny and evaluation of bids and subsequent placement of award of contract.

b) Before preparing the bid and submitting the same to the Procuring Entity, SEEPZ-SEZ authority, the Bidder should read and examine all the terms & conditions, instructions etc. contained in the Bidding Documents. Failure to provide required information or to comply with the instructions incorporated in this Bidding Documents may result in rejection of bids submitted by Bidders.

c) The successful Bidder will be expected to complete the performance of Services by the Intended Completion Date as provided in the tender document.

d) SEEPZ-SEZ Authority Invites Open E-tender for "**Demolition of Existing Standard Design Factory (SDF) – 1 and Construction of New Enterprises & Services Tower (NEST) - 3 at SEEPZ-SEZ, MIDC Central Road, Andheri East, Mumbai 400 096, India.**" on "**Item Rate**" basis in 02 (two) cover system from experienced and competent bidders, meeting prescribed qualifying criteria.

e) The bidder shall be debarred if he has been convicted of an offence under the Prevention of Corruption Act, 1988, or the Indian Penal Code, or has been debarred/blacklisted by any Central Government Ministry / Department, CPSE, Statutory Authority including CPWD, or any court of law during the last 05 (five) years, as per CPWD Manual for Procurement of Works, 2025.

2. Language of Bids.

a) Bid submitted by the Bidder and all subsequent correspondences and documents relating to the bid exchanged between the Bidder and the Procuring Entity, shall be written in "English" language. However, the language of any printed literature furnished by the Bidder in connection with its bid may be written in any other language, provided the same is accompanied by a self-certified English translation and, for purposes of interpretation of the bid, the English translation shall prevail.

3. Currencies of Bid and Payment.

a) The unit rates and the prices shall be quoted by the Bidder entirely in INR.

4. Cost of Bidding.

a) The Bidder shall bear all costs associated with the preparation and submission of its Bid, and the Employer shall in no case be responsible or liable for those costs, regardless of the conduct or outcome of the bidding process.

5. Code of Integrity

a) The Procuring Entity and all officers or employees of the Procuring Entity being SEEPZ-SEZ authority, whether involved in the procurement process or otherwise, or Bidders and their representatives or Contractor participating in a procurement process or other persons involved, directly or indirectly in any way in a procurement process shall maintain an unimpeachable standard of integrity in accordance with Rule 175 of GFR-2017 read with relevant provisions of CPWD Manual for Procurement of Works, 2025.

b) In case of breach of the code of integrity by a Bidder or a prospective Bidder, the SEEPZ-SEZ Authority, after giving a reasonable opportunity of being heard, may respond appropriately including –

   i) exclusion of the Bidder from the procurement process.

   ii) calling off of pre-contract negotiations and forfeiture or encashment of bid security.

iii) forfeiture or encashment of any other security or bond relating to procurement.

iv) recovery of payments made by the Procuring Entity along with interest thereon at bank rate.

v) cancellation of the relevant contract and recovery of compensation for loss incurred by the Procuring Entity.

vi) Debarment of the Bidder from participation in any future procurement of any procuring entity for a period of up to 03 (three) years.

6. Eligibility.

a) This invitation to tender is open to all bidders eligible as described in the instructions to bidders. SEEPZ employees, Committee members, Board members, and their relatives (Spouse or Children) are not eligible to participate in the tender. Bidders involved in corrupt and fraudulent practices or debarred from participating in Public Procurement by any state government or any procuring entity of the central government shall not be eligible.

b) SEEPZ employees directly associated with procurement, members of the Tender Evaluation Committee, and officers having conflict of interest shall not participate.

General disqualification of relatives (spouse/children) is not mandated unless conflict of interest is established, in line with latest CPWD Manual.

c) The general eligibility conditions applicable to all bidders are as follows:

i) Bidder shall be a natural person, private entity, government-owned entity or, any combination of these having a formal intent and legal competency to enter into an agreement or contract and are registered under respective Act and Jurisdiction in India.

ii) Bidder shall have fulfilled his obligation to pay such of the tax payable to the Central Government or the State Government or any local authority.

iii) Bidder shall not be insolvent, in receivership, bankrupt or wound up, not have its affairs administered by a court or a judicial officer, not have its business activities suspended and must not be the subject of legal proceedings for any of the foregoing reasons.

iv) Bidder shall not have, and their directors and officers do not have, been convicted of any criminal offence related to their professional conduct within a period of 05 (five) years preceding the commencement of the procurement process preceding the commencement of the procurement process or not have been otherwise disqualified pursuant to debarment proceedings.

v) Bidder shall not be presently debarred by any Procuring Entity under the State Government, the Central Government, Autonomous body, Authority by whatever name is called under them.

d) The specific eligibility conditions, if there are any, shall be as prescribed under the Bid Data Sheet.

e) Bidders shall submit a declaration regarding its eligibility vis-à-vis all the criteria mentioned under the instructions to bidders and the bid data sheet.

7. Qualifications.

a) Bidders should meet the qualification criteria as stipulated in the “Section 3 – Qualification and Evaluation Criteria (EQC)”. Bidders should fill and submit the Forms provided in “Section 4 - Bid Data Sheet (BDS)” to provide relevant information and documents in support of fulfilment of Bidder’s qualification as part of its technical bid. Only technical qualified bidders shall be processed for valid financial bids (i.e., Two Envelope System).

8. e-Tendering Online Bid Submission Process.

a) The e-tender is available on CPP portal, https://eprocure.gov.in/eprocure/app as mentioned in the tender. The tenders duly filled in should be uploaded and submitted online or before the end date of submission. More details regarding the online bid submission process may be found under Annexure-I attached to this bidding document.

9. Contents of Bidding Documents.

a) The Bidding Documents include the following Sections, which should be read in conjunction with any amendment issued in accordance with ITB.

i) Section 1: Notice Inviting Bids (NIB),

ii) Section 2: Instructions to Bidders (ITB),

iii) Section 3: Qualification and Evaluation Criteria (EQC),

iv) Section 4: Bid Data Sheet (BDS),

v) Section 5: Scope of Work and Technical Specifications (SOW & TS),

vi) Section 6: General Conditions of Contract (GCC),

vii) Section 7: Special Conditions of Contract (SCC),

viii) Section 8: Contract Forms (COF),

ix) Section 9: Financial Bid: Bill of Quantity (BOQ).

b) Unless downloaded directly from the SEEPZ website (http://seepz.gov.in) or the e- procurement portal (https://eprocure.gov.in/eprocure/app) or from any other source as may be specified in the Bid Data Sheet, Procuring Entity shall not be responsible for the correctness of the Bidding Documents, responses to requests for clarification, the Minutes of the Pre-bid meeting, if any, or Amendment(s) to the Bidding Documents in accordance with ITB.

c) Bidders are expected to examine all instructions, forms, terms, and specifications in the Bidding Documents and to furnish with its Bid all information or documentation as is required by the Bidding Documents.

d) The Employer is not responsible for the completeness of the Bidding Document and their addenda, if they were not obtained directly from the source stated by the Employer in the Tender Document.

10. Clarification of Bidding Documents.

a) A Bidder requiring any clarification of the Bidding Documents shall contact the SEEPZ-SEZ authority by writing / email at the Procuring Entity's address specified in the Bid Data Sheet.

b) The Procuring Entity will respond in writing / email / through the e-procurement portal to any request for clarification, provided that such request is received prior to the deadline for submission of bids within a period specified in the Bid Data Sheet. The Procuring Entity shall also promptly publish brief description of the enquiry but without identifying its source and its response at its website or on the e-procurement portal.

c) Should the clarification result in changes to the essential elements of the Bidding Documents, the Procuring Entity shall amend the Bidding Documents following the procedure given under ITB.

11. Pre-bid Meeting.

a) In order to provide response to any doubt regarding Bidding Documents, or to clarify issues, a pre-bid meeting may be scheduled, as specified in the Bid Data Sheet.

b) During the pre-bid meeting, the clarification sought by representatives of prospective Bidders shall be responded appropriately. However, they shall be asked to submit their written request by close of office next day or by e-mail for electronic record thereof. The Procuring Entity shall publish written responses to such requests for clarifications, without identifying its source. In case required, amendment(s), in terms of ITB below shall be issued, which shall be binding on all prospective Bidders.

12. Amendments to Bidding Documents.

a) At any time prior to the deadline for submission of bids, the SEEPZ-SEZ authority may, for any reason deemed fit by it, amend or modify the Bidding Documents by issuing Amendment(s) / Corrigendum.

b) Such Amendment(s) / Corrigendum will be published on SEEPZ-SEZ authority's website or on the e-procurement portal and the same shall be binding on all prospective Bidders.

c) In order to give reasonable time to prospective Bidders to take necessary action in preparing their bids, the Procuring Entity may, at its discretion, extend the deadline for the submission of bids and other allied time frames which may be linked with that deadline.

d) Any Bidder who has downloaded the Bidding Documents should check the Amendment(s), if any, issued on the SEEPZ-SEZ authority website and on the e- procurement portal. The Procuring Entity shall not be responsible in any manner if prospective Bidders miss any Amendment(s) published on Procuring Entity's website or on the e-procurement portal.

13. Documents Comprising Bid.

a) The Bidder shall furnish a Technical Proposal including a statement of work methods, equipment, personnel, schedule, and any other information as stipulated in "Section 4-Bidding Data Sheets (BDS)", in sufficient detail to demonstrate the adequacy of the Bidders' proposal to meet the work requirements and the completion time.

Bidder's technical bid shall comprise the following:

i) Letter of Bid as per the form provided in Section 4 – Bidding Data Sheet (BDS).

ii) Bid Security / Earnest Money Deposit (EMD) or Bid Security Declaration, as applicable.

iii) Bidder Information Format as per Form provided in Section 4 – Bidding Data Sheet (BDS).

iv) Documents Establishing Bidders' Eligibility and Qualification.

v) Any other document as required in the ITB or Bid Data Sheet.

vi) An Undertaking duly signed on the letter head from the Bidders to the effect that they agree and abide by the clauses / conditions of Bidding Documents issued by the Procuring Entity and any amendment made thereafter.

b) Bidder's financial bid shall comprise the following:

i) Letter of Price Bid.

ii) the financial quote submitted in the excel template published along with these bidding documents.

14. Financial Bid.

a) The Financial Proposals shall be evaluated exclusive of Goods and Services Tax (GST). In accordance with Section 16 of the Integrated Goods and Services Tax Act, 2017, supplies of services made to a Special Economic Zone (SEZ) unit or developer qualify as zero-rated supplies. Accordingly, no GST shall be payable under this Contract, and bidders shall quote their rates taking into account the zero-rated status of the services.

b) Bidders shall submit their Financial Proposals in accordance with the provisions applicable to Item Rate Contracts under the latest CPWD Works Manual and relevant CPWD guidelines. Any Abnormally Low Bid (ALB) shall be examined and dealt with strictly in accordance with the provisions of the Manual for Procurement of Works, Second Edition, 2025, including, but not limited to, seeking detailed rate analysis, cost break up, supporting calculations, and written justification from the bidder to establish the reasonableness and sustainability of the quoted rates. The Employer reserves the right to reject any bid where the bidder fails to provide satisfactory justification for the quoted rates.

15. Period of Validity of Bids.

a) Bids shall remain valid for a period of **90 (ninety) days** from the deadline of submission of bids unless otherwise specified in the Bid Data Sheet.

b) In exceptional circumstances, prior to the expiration of the bid validity period, the Procuring Entity may request Bidders to extend the period of validity of their bids. The request and the responses shall be made in writing. A Bidder may refuse the request without forfeiting its Bid Security. A Bidder granting the request shall not be required or permitted to modify its bid.

c) The Bidder who agrees to the extension of the period of validity of bids so requested by the Procuring Entity shall also extend the period of validity of bid securities submitted by them or submit new bid security to cover the extended period of validity of their bids. A Bidder whose bid security is not extended or new bid securities not submitted shall be considered to have refused the request to extend the period of validity of its bids and rejected as non-responsive.

The decision of Procuring Entity will be final and binding in this regard.

16. Bid Security.

a) The Bidder shall furnish as part of its bid, a bid security worth the amount specified in the Bid Data Sheet in the form of a bank guarantee or a fixed deposit receipt or a demand draft issued in the name of the beneficiary named in the Bid Data Sheet. Scanned copy of the bid security must be uploaded as part of the qualification documents on the e-procurement portal and the hard copy of the bid security must reach the address of the procuring entity as specified in the Bid Data Sheet prior to the deadline for bid submission stipulated under ITB 19 a. Bids unaccompanied by a Bid Security in the required format shall be rejected by the Procuring Entity.

b) Micro & Small Enterprises (MSEs) registered with MSME / Udyam shall be exempted from Bid Security / EMD as per CPWD Procurement Manual, subject to submission of valid documentary proof.

17. Format and Signing of Bids.

a) The technical bids comprising all documents specified under ITB Clause 13 a may be compiled into a single PDF document. All pages in the document should be serially numbered and an index specifying contents of the bid should be populated at the beginning of the document.

b) Authorized signatory of the bidder shall sign, either physically or digitally, on each page of the bid. This signature should be accompanied by bidder's official seal.

c) The financial bid must be submitted in the MS excel template provided with the bidding documents.

18. Sealing, Marking and Submission of Bids.

a) Bidders shall digitally sign and upload their technical and financial bids in separate folders provided on the e-procurement portal.

b) The procedure for online submission of bids shall be in accordance with the instructions given under Annexure I.

19. Deadline for Submission of Bids.

a) Bids must be received by the Procuring Entity online on the e-procurement portal and the hard copy of the bid security, at the address specified in ITB 01 above, no later than the date and time specified in the Bid Data Sheet.

b) The date of submission and opening of bids shall not be extended except when:

i) sufficient number of bids have not been received within the given time and the Procuring Entity is of the opinion that further bids are likely to be submitted if time is extended; or

ii) The Bidding Documents are required to be substantially modified as a result of discussions in pre-bid meeting or otherwise and the time for preparations of bids by the prospective Bidders appears to be insufficient for which such extension is required.

c) In cases where the time and date of submission of bids is extended, an amendment to the Bidding Documents shall be issued in accordance with ITB 09.

20. Late Bids.

a) The Employer shall not consider any EMD that arrives after the deadline for submission of bids, Any EMD received by the Employer after the deadline for submission of Bids shall be declared late, rejected, and returned unopened to the Bidder.

21. Opening of Bids.

a) The technical bids shall be opened online on the date and time stipulated in the Bid Data Sheet.

b) After due evaluation of the technical bids, the procuring entity shall notify the technically qualified bidders regarding the date of financial bid opening by giving at least 03 (three) days advance notice on the e-procurement portal.

c) The financial bids of only technically qualified bidders shall be opened.

22. Confidentiality.

a) Information relating to the evaluation of bids and recommendation of contract award, shall not be disclosed to Bidders or any other persons not officially concerned with the bidding process until the same is published officially on the e- procurement portal for information of all Bidders.

b) Any effort by a Bidder to influence the Procuring Entity in the evaluation or contract award decisions may result in the rejection of its Bid.

23. Preliminary Examination of Bids.

a) The Bid Evaluation Committee constituted by the Procuring Entity shall conduct a preliminary scrutiny of the opened bids at the beginning to assess the prima-facie responsiveness and record its findings thereof particularly in respect of the following:

   i) that the bid is complete and duly signed by authorized signatory.

   ii) that the bid is valid for the period specified in the Bidding Documents.

   iii) that the bid is accompanied by Bid Security / EMD or Bid Security Declaration, as applicable.

   iv) that the bid is unconditional and that the Bidder has agreed to give their enquired performance Guarantee; and

   v) any other specific requirements put forth in the bidding documents.

b) Bids failing to meet these preliminary requirements shall be treated as non-responsive and shall not be considered further for evaluation.

c) Any attempt by a Bidder to influence the Employer in the evaluation of the Bids or Contract award decisions may result in the rejection of its Bid.

d) Notwithstanding from the time of bid opening to the time of Contract award, if any Bidder wishes to contact the Employer on any matter related to the bidding process, it may do so in writing.

24. Immaterial Non-conformities.

a) The Bid Evaluation Committee may waive non-conformities in the bid that do not constitute a material deviation, reservation or omission and deem the bid to be responsive.

b) Provided that a Technical Bid is substantially responsive, the Employer may request that the Bidder submit the necessary information or documentation, within a reasonable period of time, to rectify nonmaterial nonconformities in the Technical Bid related to documentation requirements. Requesting information or documentation on such nonconformities shall not be related to any

aspect of the Price Bid. Failure of the Bidder to comply with the request may result in the rejection of its Bid.

c) Provided that a Technical Bid is substantially responsive, the Employer shall rectify quantifiable nonmaterial nonconformities related to the Bid Price. To this effect, the Bid Price shall be adjusted, for comparison purposes only, to reflect the price of a missing or non-conforming item or component. The adjustment shall be made using the method indicated in Section 3: Qualification and Evaluation Criteria (EQC).

25. Determination of Responsiveness.

a) The Bid Evaluation Committee constituted by the Procuring Entity shall determine the responsiveness of a bid to the Bidding Documents based on the contents of the bid submitted by the Bidder.

b) A substantially responsive Technical Bid is one that meets the requirements of the Bidding Document without material deviation, reservation, or omission. A material deviation, reservation, or omission is one that, if accepted, would:

   i) affect in any substantial way the scope, quality, or performance of the Works specified in the Contract; or

   ii) limit in any substantial way, inconsistent with the Bidding Document, the Employer's rights or the Bidder's obligations under the proposed Contract; or

   if rectified, would unfairly affect the competitive position of other Bidders presenting substantially responsive Bids.

c) The Employer shall examine the technical aspects of the Bid submitted in accordance with requirements of Section 5: Scope of Work and Technical Specifications (SOW & TS) have been met without any material deviation, reservation.

d) If a Bid is not substantially responsive to the requirements of the Bidding Document, it shall be rejected by the Employer and may not subsequently be made responsive by correction of the material deviation, reservation, or omission.

26. Non-conformities, Errors, and Omissions.

a) Provided that a Bid is substantially responsive, the Bid Evaluation Committee may waive any nonconformity in the Bid.

b) Provided that a bid is substantially responsive, the Procuring Entity, being SEEPZ-SEZ authority or authorized representative, may request that the Bidder submit the necessary information or documentation, within a reasonable period of time, to rectify non-material non-conformities or omissions in the bid related to documentation requirements. Such omission shall not be related to any aspect of the price of the Bid. Failure of the Bidder to comply with the request may result in the rejection of its Bid.

c) Provided that a bid is substantially responsive, The Bid Evaluation Committee may correct only arithmetical errors in accordance with CPWD Manual. No post-bid adjustment of quoted rates shall be permitted under the guise of non-material nonconformities.

d) During the evaluation of Bids, the following definitions apply:

   i) "Deviation" is a departure from the requirements specified in the Bidding Document.

   ii) "Reservation" is the setting of limiting conditions or withholding from complete acceptance of the requirements specified in the Bidding Document; and

   iii) "Omission" is the failure to submit part or all of the information or documentation required in the Bidding Document.

27. Evaluation of Bids.

a) Technical evaluation of bids shall be carried out based on the criteria stipulated under “Section 3 – Qualification and Evaluation Criteria (EQC)”. The evaluation committee shall not adopt any other criteria other than the ones already stipulated in the bidding documents.

b) The evaluation of financial Proposal shall exclude GST. Section 16 of the IGST Act categorizes services provided to SEZs as zero-rated. Hence, there shall be no instance of GST.

c) The Procuring Entity’s evaluation of a bid may require the consideration of other factors, in addition to the bidder’s financial offer. These factors may be related to the characteristics, performance, and terms and conditions of purchase of Non- Consultancy Services. The effect of the factors selected, if any, shall be expressed in monetary terms to facilitate comparison of bids, shall be specified in “Section 3 - Qualification and Evaluation Criteria (EQC)”.

28. Right to Accept Any Bid and to Reject Any or All Bids.

a) The Employer reserves the right to accept or reject any bid, and to cancel / annul the bidding process and reject all bids at any time prior to contract award, without thereby incurring any liability to the Bidders for which the Procuring Entity shall keep record of clear and logical reasons properly for any such action / recall of bidding process. In case of cancellation / annulment, all bids submitted and specifically, bid securities, shall be promptly returned to the Bidders.

b) In case the quoted bid price is found to be abnormally low or exceptionally high with respect to the estimated cost of the work, the Employer may seek detailed justification and rate analysis from the bidder. If the bidder fails to satisfactorily demonstrate the capability to execute the work at the quoted rates, the bid shall be liable for rejection. The Employer reserves the right to reject any unreasonably high bid or cancel the tender without assigning any reason thereof.

29. Award Criteria.

a) Subject to the bid being substantially responsive, technically qualified, and meeting all eligibility and qualification criteria, the bid achieving the highest combined technical and commercial score, ranked as **H1 under the QCBS system**, shall be deemed the successful bid and shall be considered for award of contract.

30. Notification of Award.

a) Prior to the expiration of the period of bid validity, the Procuring Entity shall notify the successful Bidder, in writing, that its Bid has been accepted.

At the same time, the Employer shall also notify all other Bidders of the results of the bidding.

b) Until a formal Contract is prepared and executed, the Letter of Acceptance shall constitute a binding Contract.

31. Performance Guarantee.

a) Within **15 (fifteen) days** of the receipt of Letter of Acceptance from the Procuring Entity, the successful Bidder shall furnish the Performance Security in the form of a bank guarantee or a fixed deposit receipt, or a demand draft issued in the name and amount stipulated in this tender document.

b) Failure of the successful Bidder to submit the above-mentioned Performance Security or to sign the Contract shall constitute sufficient grounds for the annulment of the award and forfeiture of the Bid Security. In that event the Procuring Entity may award the Contract to the next highest evaluated Bidder, whose bid is substantially responsive and is determined by the Procuring Entity to be qualified to perform the Contract satisfactorily.

c) The Performance Guarantee shall be submitted by the contractor on format as per GCC and shall be initially valid up to the stipulated date of completion plus minimum 06 (six) months beyond that. In case the time for completion of work gets enlarged, the contractor shall get the validity of Performance Guarantee extended to cover such enlarged time for completion of work. After

recording the completion certificate for the work by the competent authority, the performance guarantee shall be returned to the contractor, without any interest.

32. Retention Money.

a) From every payment for Works due to the Contractor in accordance with the provisions of Clause (“Retention Money") subject the condition that the maximum amount of Retention Money amount stipulated in this tender documents.

b) Retention Money / Security deposited shall be released upon successful completion of Defect liability period months from the date of completion record of project.

c) SEEPZ-SEZ reserves the right of part or full forfeiture of Retention Money / Security Deposit in addition to other claims in the event of contractor's failure to fulfil any of the contractual obligations or in the event of termination of contract as per terms and conditions of contract.

33. Other Statutory Compliances.

a) Successful bidder shall fulfil insurance and other statutory requirements including submission of signed undertakings assuring compliance with the various standards stipulated in the conditions of contract, failing which the course of action stipulated under ITB clause 31 b) shall be applicable.

34. Signing of Contract.

a) Promptly after notification of Award, the Procuring Entity shall send the successful Bidder the Contract Agreement. Within **15 (fifteen) days** of receipt of the Contract Agreement, the successful Bidder shall sign, date, and return it to the Procuring Entity.

Section 03

Qualification and Evaluation Criteria (EQC)

Section 03 - Qualification and Evaluation Criteria

This Section contains all the criteria that the SEEPZ-SEZ Authority shall use to evaluate bids and qualify the Bidders in accordance with ITB 27. No other factors, methods or criteria shall be used for the purpose of evaluation.

Only those intending bidders who meet the eligibility and qualification criteria stipulated below shall be eligible to submit their Technical Bids. Participation through Joint Venture (JV) or Consortium arrangements is not permitted under this tender. Any bid submitted by a bidder not meeting the prescribed criteria shall be liable for rejection.

Technical Evaluation Process.

1. Preliminary Examination of Bids and Determination of Responsiveness.

The evaluation committee shall carry out the preliminary examination of bids and shall determine the responsiveness of bids based as per the procedure stipulated under ITB 24, 25, 26 and 27.

2. Qualification Requirements.

The SEEPZ-SEZ Authority shall assess qualifications of participating in bidders according to the following criteria, based on the corresponding documentary evidence to be submitted by the bidders:

a) Eligibility & Qualification Criteria.

Sr.	Qualification Criteria	Supporting Documents /Format
1.	Proof of Payment for EMD.	Hard copy to be submitted before deadline. Bid will be rejected if hard copy is not submitted before deadline. Scan copy of submitted EMD to be uploaded online.
2.	The bidder should have a Solvency not less than the amount equal to 40% (forty percent) of the estimated cost; The solvency certificate should be from a Nationalized / Scheduled bank. The certificate should be submitted on attached format	**(Form- 1)** Bid will be rejected if scan copy is not uploaded online with technical proposal before deadline.
3.	Power of Attorney to sign the Tender / Agreement.	A Power of Attorney authorizing the signatory to sign the Bid documents shall be submitted in the name of only the Company's Owner, Director, Chief Executive Officer (CEO), Managing Director (MD), or President level officer.
4.	Must be Indian Registered Company under Companies Act 1956 / Public or Corporation, registered with the appropriate government authority as Proprietorship / Limited Company / Private Limited Company / LLP / Partnership / and shall be in the Construction Business for at least last **15 (fifteen) years**.	Copy of the Incorporation / Registration Certificate clearly indicating the nature of business.
5.	Must possess a valid GST, PAN, ESIC, EPFO number	Copies GST, PAN, ESIC, EPFO registration.
6.	Letter of Transmittal on bidder letter Head to submit Technical Bid	**(Form-2)**

Sr.	Qualification Criteria	Supporting Documents /Format
7.	Name, Address, details of the Organization, Name(s) of the Owner / Partners/Promoters and Directors of the firm/company. The bidder shall have a functional office in India. Documentary proof such as office address details, utility bill, or lease / ownership documents shall be submitted along with the bid.	**(Form-3)**
8.	Bidder should not be blacklisted / debarked by any government/ semi government department / PSU as on last date of submission of tender. Bidder should submit the declaration of not being ineligible for corrupt or fraudulent practices as on last date of submission of tender on non-judicial stamp paper of minimum ₹ 100 (Hundred).	**(Form-4A)**
9.	Pending Litigation and Arbitration.	**(Form-4B)**
10.	Letter of understanding the project site on bidder letter Head.	**(Form-5)**
11.	Consent Letter to execute the Integrity Pact.	**(Form-6)**
12.	The average annual financial turnover of the bidders during the last 02 (two) years, ending on 31st March of the previous financial year, should be at least **Rs. 1000 Cr. (Rupees One Thousand Crore Only)**. The turnover, profit, and net worth certificates must be certified by the Statutory Auditor of the firm or company. Furthermore, the contractor should not have incurred losses in more than 02 (two) years out of the last 03 (three) financial years, and this requirement must be duly verified and audited by a Chartered Accountant. Any such certificate issued must carry a Unique Document Identification Number (UDIN) to ensure authenticity and compliance with professional standards.	**(Form- 7)**
13.	The contractor should have satisfactorily completed the work as mentioned below during the last **10 (ten) years** ending previous day of last date of submission of tender. One similar nature completed work costing not less than the amount equal to 80% (eighty percent) of the estimated cost. Or Two similar natures completed works costing not less than the amount equal to 50% (fifty percent) of the estimated cost.	**(Form- 8)**

Sr.	Qualification Criteria	Supporting Documents /Format
	Or Three similar natures completed works costing not less than the amount equal to 40% (forty percent) of the estimated cost;	
	"**Similar Works**" for the purpose of eligibility shall mean works executed in accordance with CPWD specifications, relevant IS Codes, and statutory regulations, and shall comprise the following: **Building Construction Works**: Construction of Multi-Storied Industrial and Commercial Building, meeting the following criteria: i) **Height Criteria**: The bidder shall have successfully completed at least one high-rise building of RCC frame Structure of minimum 12 (twelve) stories or 48 (forty-eight) meters in height within the stipulated completion period (i.e., agreement period plus justified extension, if any). The scope shall include Civil Works, Finishing Works, Internal Water Supply & Sanitary installations, Internal Electrical Installation, Firefighting System, etc. all executed under 01 (one) agreement / contract. **Notes**: ▪ Stilt and basement, where provided, shall be counted as a story for height calculation. ▪ Mumty / Machine Room slab shall not be considered as a floor. ▪ For evaluation purposes, 01 (one floor shall be considered equivalent to 03 (three) meters in height. ii) **Green Building Certification**: The bidder shall have successfully completed at least 01 (one) project achieving a minimum GRIHA 5-Star or IGBC Platinum rating for industrial, commercial, Institutional Building. iii) **Demolition Works**: The bidder shall have executed at least 01 (one) project having Controlled demolition of multistorey buildings executed using manual, mechanical, or advanced techniques (such as hydraulic breakers, excavators, diamond cutting, etc.), including dismantling of superstructure and complete removal of foundations comprising RCC, steel, masonry, or composite structures. The work shall include safe disposal of debris and compliance with all applicable environmental, safety, municipal, and statutory requirements, demonstrating the bidder's technical capability and experience in demolition projects. iv) **Updating of Cost of Work**: The value of executed works shall be brought to current cost level by enhancing the actual value of work done at a simple rate of 07% (seven percent) per annum, calculated from the date of completion to the previous day of the last date of submission of tenders. This definition shall be strictly applied for determining technical eligibility and qualification of bidders in accordance with CPWD guidelines.	
14.	Construction method statement, Mobilization schedule, construction schedule / work plan, Quality assurance Programme.	**(Form – 09)**
15.	Equipment & Machinery required The Bidder should self-certify owned or have assured access (through hire, lease, purchase agreement, other commercial means) to the specified key items of equipment, in full working order, and satisfy that, based on known commitments.	Bidder shall submit a self-certified certificate on company Letter head confirming the listed equipment is either owned or the bidder has assured access through hire, lease, purchase agreement, other commercial means, in full working order. **(Form – 10)**

Sr.	Qualification Criteria	Supporting Documents /Format
16.	Key Personnel.	**(Form 11 & 12)**
a)	Project Manager – 01 (one) No.	Graduate Civil Engineer with minimum 20 (twenty) years of similar work experience.
b)	Deputy Project Manager - 01 (one) Nos.	Graduate Civil Engineer with minimum 12 (twelve) years of similar work experience.
c)	Deputy Project Manager - 02 (two) Nos.	Graduate Electrical & Mechanical Engineer with minimum 12 (twelve) years of similar work experience.
d)	Project / Site Engineer: 04 (four)	Graduate Civil Engineer with minimum 05 (five) years or Diploma Engineer with minimum 10 (ten) years of similar work experience. **Note**: Trade-wise manpower deployment may vary in accordance with the Employer's requirements during actual execution.
e)	Project / Site Engineer: 02 (two)	Graduate Electrical & Mechanical Engineer with minimum 05 (five) years or Diploma Engineer with minimum 10 (ten) years of similar work experience. **Note**: Trade-wise manpower deployment may vary in accordance with the Employer's requirements during actual execution.
f)	Quality Control / Lab in Charge – 02 (two) Nos.	Graduate Engineer with minimum 08 (eight) years of similar work experience.
g)	Project Planning and Billing – 02 (two) Nos.	Graduate Engineer with minimum 06 (six) years of similar work experience.
h)	Site Surveyor – 01 (one) No.	Diploma Engineer with minimum 08 (eight) years of similar work experience.
i)	Site Supervisor– 10 (ten) Nos.	Diploma Civil Engineer with minimum 08 (eight) years of similar work experience. **Note**: Trade-wise manpower deployment may vary in accordance with the Employer's requirements during actual execution.
j)	Site Supervisor– 06 (six) Nos.	Diploma Electrical & Mechanical Engineer with minimum 08 (eight) years of similar work experience. **Note**: Trade-wise manpower deployment may vary in accordance with the Employer's requirements during actual execution.
k)	Safety Engineer– 5 (five) Nos.	Diploma Engineer with minimum 08 (eight) years of similar work experience.
17.	Proforma of Letter of Bid.	**(Form – 13)**

Sr.	Qualification Criteria	Supporting Documents /Format
18.	Site Visit and Submission of Geotagged Site Inspection Report.	**(Form – 14)**
19.	a) Certification for International Standard for Environmental Management Systems (EMS): ISO 14001 Certification. b) International Standard for Occupational Health and Safety Management Systems (OHSMS): ISO 45000/ OHSAS 18001 Certification. c) International Standard for Quality Management Systems (QMS): ISO 9001 Certification.	The bidder shall submit valid supporting document evidence needed to submit along with the technical bid. Also, all the submitted certifications must be valid at tender date.
20.	**Green Building Certification**: The bidder shall have successfully completed at least 01 (one) project achieving a minimum GRIHA 5-Star or IGBC Platinum rating for industrial, commercial, Institutional Building.	The bidder shall submit valid supporting document evidence needed to submit along with the technical bid.

The personnel listed above constitute the minimum requirement at site. The bidder shall, at his own discretion and cost, deploy any additional qualified staff as may be required to ensure proper execution and completion of the work.

Note *All documents shall be submitted in the sequence specified in the checklist, with each page duly numbered.

Bidders must ensure that the documentary evidence submitted by them as proof of their qualification must provide the necessary information in adequate detail to establish the facts without a scope for doubt. Any scanned documents being submitted must possess adequate resolution to ensure their legibility without confusion. In case any information necessary for establishing bidder's qualifications is not clear from the documents submitted, the evaluation committee's interpretation in that regard shall be final. Incomplete or unclear documents may lead to disqualification of the bidder.

After the opening and scrutiny of the eligibility documents, any deficiencies, discrepancies, or shortcomings identified in a bidder's submission with reference to the requirements stipulated in the Notice Inviting Tender (NIT) shall be communicated to the respective bidder through email. The bidder shall submit the requisite documents, information, or clarifications within **03 (three) working days** from the date of receipt of such communication. Failure to furnish the required documents, information, or clarifications within the stipulated period shall be deemed to indicate that the bidder has no further documents or submissions to provide. In such event, the Employer/Purchaser shall proceed with the evaluation of the bid and take an appropriate decision based on the documents and information available on record, and the bidder shall have no claim arising from such decision.

b) QCBS Scoring Criteria.

The bidders qualifying the initial criteria as set out in Clause no. 2a of this section 3.0 above will be evaluated for following criteria by scoring method on the basis of details furnished by them.

Sr.	Particulars	Maximum Marks
A.	Past Experience in Similar Nature of Work: Last 10 (ten) Years.	25 Marks
B.	Experience in Green Buildings (GRIHA 5-Star / IGBC Platinum).	15 Marks
C.	Technology considered for saving overall Project Timeline.	10 Marks

Sr.	Particulars	Maximum Marks
D.	Presence in Project State and Company Establishment Year.	15 Marks
E.	Presentation for Understanding Scope of Work.: To be submitted in Technical Proposal and shall be called for presentation during evaluation process.	35 Marks
	Gross Marks	**100 Marks**

The above criteria will be evaluated for the following criteria by scoring method on the basis of details furnished by the Bidder.

Sr.	Criteria	Evaluation Marks Within Category	Maximum Marks	Remark
A.	**Past Experience in Similar Nature of Work.:** Only data pertaining to the last 10 (ten) years of completed and ongoing projects of minimum 80% physical and financial completion as certified by the client shall be considered valid for evaluation.			
1	Past Experience in the construction of Similar Nature of Work under following category: a) **Any 03 (three)** Building of Similar Nature of Work and of Cumulative Build-up Area more than 15.00 (fifteen) Lakh Sqft**.: 09 Marks** b) **Any 02 (two)** Building of Similar Nature of Work and of Cumulative Build-up Area more than 15.00 Lakh Sqft**.: 12 Marks** c) **Any 01 (one)** Building of Similar Nature of Work and of Cumulative Build-up Area more than 15.00 Lakh Sqft.**: 15 Marks.**	15 Marks	25 Marks	The bidder shall submit Valid supporting document evidence needed to submit along with the technical bid. Also, necessary certifications must be valid at tender date. Summary of relevant experiences. Completion certificates issued by the clients clearly mentioning the name of the assignment, scope of work, value of the contract, etc. Satisfactory Performance Certificate from the previous Employer Or CA Certificate certifying the same as per available invoices.
2	Experience in the construction of multi-storied buildings of a similar nature of work under the following categories: a) Commercial Building of Cumulative Build-up Area more than 15.00 Lakh Sqft. **: 08 Marks.** b) Industrial Building of Cumulative Build-up Area more than 15.00 Lakh Sqft.: **10 Marks.**	10 Marks		

Sr.	Criteria	Evaluation Marks Within Category	Maximum Marks	Remark
B.	**Experience in Green Building GRIHA 5-Star or IGBC Platinum Rating Only.: Only completed projects will be considered for evaluation.**			
1	**Any 01 (one)** Project with IGBC Platinum rating or / GRIHA 5-star rating.**: 05 Marks.**	05 Marks.	15 Marks	a) **GRIHA / IGBC Certification Letters**: Official certificate issued by GRIHA Council or IGBC confirming the building's rating (e.g., Platinum, Gold, etc.). b) **Client Completion Certificates**: Certificates from the client stating that the project was completed and achieved GRIHA/IGBC compliance. c) **Work Orders / Contract Agreements**: Copies of signed agreements showing scope of work included sustainability compliance.
2	**Any 02 (two)** Project with IGBC Platinum rating or / GRIHA 5-star rating. **: 10 Marks.**	10 Marks.		
3	**Any 03 (three)** Project with IGBC Platinum rating or / GRIHA 5-star rating. **: 15 Marks.**	15 Marks		
C.	**Technology Considered for Saving Overall Project Timeline.**			
1	Past experience in utilization of following type of Formwork considered for their projects to save overall project timelines a) Aluminium Formwork (Mivan): **10 Marks.** b) Climbing Formwork & Jump Formwork: **08 Marks.** c) Table Formwork: **06 Marks**.	10 Marks	10 Marks	The bidder shall submit Valid supporting document evidence needed to submit along with the technical bid. Also, necessary certifications must be valid at tender date. Project considered in Section "B" from this table will be considered for this evaluation.
D.	**Presence in Project State and Company Establishment Year.**			
1	a) If Head Office / Regional Office at Project State.	05 Marks	15 Marks	The bidder shall submit Valid supporting document evidence needed to submit along with the technical bid. Also, necessary certifications must be valid at tender date.
	b) Availability of Manpower On-role and Project Basis across PAN India. i) Between 250 Nos to 500 Nos: **03 Marks** ii) Between 501 Nos to 750 Nos: **04 Marks** iii) More than 751 Nos: **05 Marks**	05 Marks		

Sr.	Criteria	Evaluation Marks Within Category	Maximum Marks	Remark
2	Company establishment tenure from the date of incorporation: a) Between **10 (ten) years to 15 (fifteen) years**: **03 Marks.** b) More than **15 (twenty-five) years**: **05 Marks.**	05 Marks		
E.	**Presentation for Understanding Scope of Work.:** To be submitted in Technical Proposal and shall be called for presentation during evaluation process.			
1	a) Understanding the Scope of Project.: **05 Marks** b) Technical approach & methodology i. Typology, structure, Finishing, sustainability, Energy Efficiency: **10 Marks** ii. Deployment Plan for Machinery & Equipment.: **03 Marks** iii. Organization Structure with Key Personnel Profiles. .: **03 Marks** iv. Innovation in Implementation / Technology / Shuttering Systems. .: **03 Marks** v. Site-specific Quality Plan and Safety Plan. .: **03 Marks** vi. Site Logistics, Housekeeping, and Debris Disposal Plan. .: **03 Marks** vii. Current Claims and Litigation records statement. .: **02 Marks** viii. Market Feedback from Completed / Ongoing Projects, as evidenced by Client Appreciation Letters and Performance Certificates, highlighting timely project completion, quality of execution, adherence to safety standards, and a strong claims-free or low-claims track record. .: **03 Marks**	35 Marks	35 Marks	The bidder shall submit a project-specific presentation along with the technical bid, which must be presented before the committee for evaluation. Based upon the presentation evaluation will be done. Furthermore, the bidder shall be called for presentation during evaluation process.

Sr.	Criteria	Evaluation Marks Within Category	Maximum Marks	Remark
	Total Score		**100 Marks**	

To become eligible for short listing the bidder must secure at least 75% (seventy-five percent) marks in aggregate.

The department, however, reserves the right to restrict the list of qualified contractors to any number deemed suitable by it.

Note: The average value of performance of work for time over run and quality shall be taken on the basis of performance report and eligible similar works.

c) Financial Evaluation and Ranking of Bid.

The financial evaluation of the bids shall be carried out in accordance with the Quality-cum-Cost Based Selection (QCBS) method, wherein predefined weightages are assigned to both the technical and financial components. The final selection shall be based on the combined score derived from these components.

The financial bids shall be opened only in respect of those bidders who qualify in the technical evaluation.

Weightages: Under QCBS selection, the technical proposals will be allotted weightage of not more than 30% (thirty percent) while the financial proposals will be allotted weightages of 70% (seventy percent) or more as declared in the Tender.

Evaluation of Quality Score: Proposal with the highest technical marks (as allotted by the evaluation committee) shall be given a score of 100 (Hundred) and other proposals be given technical scores that are proportional to their marks w.r.t the highest technical marks.

Evaluation of Financial Score: Similarly, proposals with the lowest evaluated cost may be given a financial score of 100 (Hundred) and other proposals given financial scores that are inversely proportional to their prices w.r.t the lowest offer.

Weighted QCBS Score: The total score, both technical and financial, shall be obtained by weighing the quality and cost scores and adding them up. On the basis of the combined weighted score for quality and cost, the contractor shall be ranked in terms of the total score obtained. The proposal obtaining the highest total combined score in evaluation of quality and cost will be ranked as H-1 followed by the proposals securing lesser marks as H-2, H-3 etc. The proposal securing the highest combined marks and ranked H-1 shall be recommended for award of contract. In the event two or more bids have the same score in final ranking, the bid with higher technical score will be considered as H-1.

QCBS Formula: An Evaluated QCBS Score will be calculated for each responsive Bid using the following formula, which permits a comprehensive assessment of the Bid price and the technical merits of each Bid (rounded up to two decimal points):

- Normalized Technical Score $T_s = (T * 100) / T_{high}$
- Normalized Financial Score $F_s = (C_{low} * 100) / C$
- Evaluated Combined Bid Score $B = F_s * (1 - W) + T_s * W$

Whereas,

C : Evaluated Bid Price.

C_{low} : Lowest of all Evaluated Bid Prices among responsive Bids.

T : Total Technical Marks awarded to the Bid.

T_{high} : Technical Marks Achieved by Bid that was Scored Best Among all Responsive Bids.

T : Normalized Technical Score.

F_s : Normalized Financial Score.

W : Weightage for the Technical as specified in the AITB/BDS.

B : Evaluated Combined Bid Score.

Calculation of Technical Score (for e.g.)

Following example illustrates the evaluation of QCBS:

i) In a particular case of selection of contractor, it was decided to have minimum qualifying marks for technical qualifications as 75 (seventy-five) and the weightage of the technical bids and financial bids was kept as 30:70 (Thirty: Seventy). In response to the Tender Document, three proposals, A, B & C, were received. The technical evaluation committee awarded the following marks as under:

Bid A: 80 Marks

Bid B: 75 Marks

Bid C: 90 Marks

ii) The minimum qualifying marks were 75 (seventy-five) thus, all the three proposals were found technically suitable. The following normalized technical scores are awarded by the evaluation committee:

Bid A: 80*100/90 = 89.00 points

Bid B: 75*100/90 = 83.00 points

Bid C: 90*100/90 = 100.00 points

iii) The financial proposals of each technically qualified contractor were opened after notifying the date and time of bid opening to the successful participants. The price evaluation committee examined the financial bids and evaluated the quoted prices as under:

Bid A: Rs.120 (one hundred and twenty).

Bid B: Rs.100 (one hundred).

Bid C: Rs.105 (one hundred and five).

iv) The committee gave them the following normalized financial score to the Bids:

Bid A: 100*100/120 = 83.00 points

Bid B: 100*100/100 = 100.00 points

Bid C: 100*100/105 = 95.00 points

v) In the combined evaluation, thereafter, the evaluation committee calculated the combined technical and financial score as under:

Bid A: 89.00x0.30 + 83.00x0.70 = 85.00 points.

Bid B: 83.00x0.30 + 100.00x0.70 = 95.00 points

Bid C: 100.00x0.30 + 95.00x0.70 = 97.00 points.

vi) The three proposals in the combined technical and financial evaluation were ranked as under:

Bid A: 85.00 points: H-3

Bid B: 95.00 points: H-2

Bid C: 97.00 points: H-1

vii) Bid C at the evaluated cost of Rs.105 (Rupees One hundred and five, second lowest bid) was, therefore, declared as winner and recommended for approval, to the competent authority.

The Bidder obtaining the Highest Combined Score “H1” shall be recommended for award of contract by the evaluation committee.

For whatever reason If the Price Schedule is submitted as part of the Techno Commercial Bid, the Bidder shall be disqualified, and the submitted bid shall not be evaluated further.

Section 04

Bid Data Sheet (BDS)

Section 04 - Bid Data Sheet (BDS)

Form 01: Solvency Certificate

[on Bank letter head]

Ref No: _____

Date: _____

To,

The Development Commissioner SEEPZ,

SEZ Authority Andheri (East),

Mumbai-400 096

Name of Work: Submission of bids for "[Tender Name] for SEEPZ-SEZ Authority, Andheri (E), Mumbai, Maharashtra"

This is to certify that M/s _____ (Name of the Firm / Company), having its registered office at _____, is a valued constituent of this bank.

Based on the financial records, transactions, and dealings of the firm with this bank, we are satisfied with their financial standing and reputation.

We further certify that the said firm is solvent to the extent of ₹ _____ (Rupees _____ only) as on the date of this certificate.

This certificate is issued at the specific request of the customer without any risk or responsibility on the part of the bank or any of its officials.

This certificate is issued at the specific request of the customer.

For (Name of the Bank)

(Signature with Seal)

Authorized Signatory

Name: _____

Designation: _____

Contact No.: _____

Date: _____

Form 02: Letter of Technical Proposal

To,

The Development Commissioner

SEEPZ-SEZ Authority Andheri (East),

Mumbai-400096

Subject: Submission of bids for the work of "[Tender Name] for SEEPZ-SEZ Authority, Andheri (E), Mumbai, Maharashtra."

We, the undersigned, declare that:

We have examined and have no reservations to the Bidding Documents, including Addendum/Corrigendum issued in accordance with Instructions to Bidders (ITB).

Our Bid consisting of the Technical Bid and the Price Bid shall be valid for a period of 90 (ninety) days from the date fixed for the bid submission deadline in accordance with the Bidding Documents, and it shall remain binding upon us and may be accepted at any time before the expiration of that period.

We, including any Sub-vendors or Suppliers for any part of the contract, do not have any conflict of interest in accordance with ITB.

If our Bid is accepted, we commit to mobilizing key equipment and personnel in accordance with the requirements set forth in Section 2 and our technical proposal, or as otherwise agreed with the Employer.

Name .....

In the capacity of .....

Signed.....

Duly authorized to sign the Bid for and on behalf of .....

Date ……

Form 03: Bidder's Information Sheet

Sr.	Item	Details
1.	Name of Company / Firm	
2.	Nature of the Company/Firm whether Proprietary / Partnership / Limited / Private Limited/LLP (Provide full details)	
3.	Names of the partners/full time directors with their bio data	
4.	Postal Address	
5.	Telephone, Mobile and Fax Numbers	
6.	Name, Designation, Telephone, Mobile, email of the Contractor:	
7.	Year of commencement of Business	
8.	Turnover during past three financial years	
9.	Description of the work done in the last three years.	
10.	Details of manpower availability (managerial and technical)	
11.	Details of tools, machinery, and equipment availability	
12.	Point of Contact in case of clarifications	
13.	Details of litigations (both as a petitioner and as respondent) and debarment.	

Attached are copies of the following documents.

a) In case of a single entity, articles of incorporation or constitution of the legal entity named above, in accordance with eligibility criteria

Form 04(A): Format for No-Conviction Certificate

[non-judicial stamp paper of minimum ₹ 100 (Hundred)]

This is to certify that _____ (Name of the organization), having registered office at _____ (Address of the registered office) has not blacklisted or restricted to apply for any such activities by any Central / State Government Department or Court of law anywhere in the country as on last date of submission of tender.

Yours Faithfully,

Date: (Signature, name, and designation of the Authorized signatory)

Place: Name and seal of Bidder

Form 04(B): Pending Litigation and Arbitration

[on Bidder Letter Head]

Each Bidder must fill out this form if so, required under Section 04 (Evaluation and Qualification Criteria) to describe any pending litigation or arbitration formally commenced against bidder.

Pending Litigation and Arbitration			
Choose one of the following: a) No pending litigation and Arbitration against bidder. b) Below is a description of all pending litigation and Arbitration against bidder.			
Year	**Matter in Dispute**	**Value of Pending Claim in Rs.**	**Value of Pending Claim as a Percentage of Net Worth**

Form 05: Format for Understanding the Project Site

[on Bidder Letter Head]

To,

The Development Commissioner SEEPZ,

SEZ Authority Andheri (East),

Mumbai-400 096

Subject: Undertaking of the Site Visit for "[Tender Name] for SEEPZ-SEZ Authority, Andheri (E), Mumbai, Maharashtra."

Dear Sir,

I/we hereby certify that I/we have examined & inspected the site & available space & it is surrounding satisfactorily, where the project is to be executed as per the scope of works. I/ We are well aware about the Location of the Building and existing utilities to connect to the system, conditions prevailing at site, availability of materials, availability of land and transport facilities, weather condition at site, the extent of leads and lifts involved in execution of work etc.

I / We hereby submit our BID considering above all facts gathered during site visit and each & every aspect has been considered in the Quoted cost of the project as per BOQ.

Yours faithfully,

Date: (Signature, Name and Designation of the Authorized Signatory)

Place: Name and seal of Bidder

Form 06: Consent Letter to Execute the Integrity Pact

[on Bidder Letter Head]

To,

The Development Commissioner SEEPZ,

SEZ Authority Andheri (East),

Mumbai-400 096

Subject: Consent to Execute Integrity Pact "[Tender Name] for SEEPZ-SEZ Authority, Andheri (E), Mumbai, Maharashtra."

Dear Sir,

With reference to the Tender No. _____ dated _____ for [Name of Work / Project], we hereby confirm that we have read and understood the terms and conditions of the Integrity Pact as prescribed in the tender document.

We agree to execute the Integrity Pact in the prescribed format and to abide by its terms and conditions throughout the tendering process and execution of the contract, if awarded to us.

We further confirm that we will not engage in any corrupt, fraudulent, coercive, or collusive practices and will maintain the highest standards of ethics and transparency in all dealings with your organization.

This letter of consent is submitted in compliance with the tender requirement for participation in the bidding process.

Yours faithfully,

Date: (Signature, Name and Designation of the Authorized Signatory)

Place: Name and Seal of Bidder

Form 07: Historical Financial Performance

[Each Bidder must fill out this form.]

Particulars	Year 1	Year 2	Year 3
	FY-	FY-	FY-
Information from Balance Sheet			
Total Assets (TA)			
Total Liabilities (TL)			
Net Worth = TA – TL			
Current Assets (CA)			
Current Liabilities (CL)			
Working Capital = CA - CL			
Information from Income Statement			
Total Revenues			
Profits Before Taxes			
Profits After Taxes			

Attached are copies of financial statements (balance sheets including all related notes and income statements) for the last 05 (five) years, as indicated above, complying with the following conditions:

a) Unless otherwise required by Section 03 of the Bidding Document, all such documents reflect the financial situation of the legal entity or entities comprising the Bidder and not the Bidder's parent companies, subsidiaries, or affiliates.

b) Historical financial statements must be audited by a certified accountant.

c) Historical financial statements must be complete, including all notes to the financial statements.

d) Historical financial statements must correspond to accounting periods already completed and audited (no statements for partial periods shall be requested or accepted).

Form 08: Contracts of Similar Size and Nature

[Fill out one (1) form per contract.]

Contract of Similar Size and Nature	
Contract No.:	
Contract Identification:	
Award Date:	
Completion Date:	
Total Contract Amount:	
Employer's Name:	
Address:	
Telephone Number:	
E-mail:	
Description of the Similarity in Accordance with (Evaluation and Qualification Criteria)	

Form 09: Technical Submissions

The following documents shall be submitted by the bidder as part of the Technical Bid. Each document shall be prepared in the bidder's own format, providing sufficient details to demonstrate capability, planning, and methodology for completing the project within the stipulated time frame.

Sr.	Particulars	Description / Requirements
1.	Construction Method Statement	The bidder shall provide a detailed description of the proposed methodology for execution of all major components of the work, including Pre-Demolition Stage, Demolition Stage, Post Demolition Stage, Safety Precautions, Post completion of Contract Closure Report and allied works, highlighting safety, sequencing, and resource management.
2.	Mobilization Schedule	A schedule indicating the timeline and sequence of mobilization of manpower, plant, and machinery from the date of award of work, ensuring readiness to commence construction activities without delay.
3.	Construction Schedule / Work Plan	A comprehensive work plan or project schedule (in CPM / Bar Chart format) showing major milestones, activity sequencing, and completion strategy to achieve the stipulated completion period of 30 (thirty) months from the date of award.
4.	Quality Assurance Programme	A detailed Quality Assurance and Control Plan conforming to latest CPWD Specifications, SOPs, and Quality Manuals, including testing protocols, inspection procedures, documentation formats, and responsibilities of QA/QC personnel.
5.	Presentation for Understanding Scope of Work a) Understanding the Scope of Project. b) Technical approach & methodology (typology, structure, finishing, sustainability, energy efficiency, safety, innovation, faster construction techniques) c) Client appreciation for timely completion, quality, and safety practices d) Deployment plan for machinery & equipment e) Organization structure with key personnel profiles f) Innovation in implementation / technology / shuttering systems g) Site-specific Quality Plan and Safety Plan.	To be submitted in Technical Proposal and shall be called for presentation during evaluation process.

Sr.	Particulars	Description / Requirements
	h) Site logistics, housekeeping, and debris disposal plan	

Note:

a) The above items are to be prepared by the bidder in their own format and submitted along with the Technical Bid.

b) The bidder shall ensure that all details provided are comprehensive and consistent with the project scope and specifications to facilitate evaluation of technical capability.

c) The total project completion period shall be as mentioned in the Section 07- Special Conditions of Contract from the date of award of work.

Form 10: Equipment & Machinery

[List of Equipment and Machinery Required]

The bidder shall ensure deployment of adequate and appropriate construction equipment, plant, and machinery for timely and quality execution of the project. The following list represents the minimum indicative requirement; however, the contractor may deploy additional equipment as necessary to meet the project schedule and specifications.

Sr.	Equipment / Machinery	Minimum Quantity	Own / Rent / Lease
1.	Air Compressor	1 No.	
2.	Bar Bending & Cutting Machines	3 Sets	
3.	Combi Crusher	4 Nos. (of Appropriate Capacity)	
4.	Concrete Batching Plant	1 No. (of 20–30 m^3/hr. capacity)	
5.	Concrete Cube Testing Machine	1 No.	
6.	Concrete Pumps with Pipeline	2 Nos.	
7.	Curing Pumps with Pipes	10 Sets	
8.	Dewatering Pumps	2 Nos. (of Appropriate Capacity)	
9.	Dumpers / Tippers	6 Nos.	
10.	Gas Cutting and Welding Machines	2 Nos.	
11.	Jaw Cutter	2 Nos.	
12.	JCB	2 No. (With all Necessary Accessories)	
13.	Passenger-cum-Material Hoist	3 Nos.	
14.	Poclain / Excavator	2 Nos. (of Appropriate Capacity and All Necessary Accessories)	
15.	Rebar Threading / Coupler Machine	2 Set	
16.	Safety Equipment (i.e. Nets, Harness, PPE, Fire Extinguishers)	As required	
17.	Shuttering System / Scaffolding System (Cup lock or Equivalent)	18400 Sqm.	
18.	Total Station / Auto Level	3 Set	
19.	Tower Crane	2 Nos. (with adequate reach & height)	
20.	Tower Light / Lighting System	As required	
21.	Trackers with Trolly	4 Nos.	

Sr.	Equipment / Machinery	Minimum Quantity	Own / Rent / Lease
22.	Transit Mixers	4 Nos. (6 m^3 capacity)	
23.	Vibrators (Needle / Surface / Plate)	8 Nos. (of Appropriate Capacity)	
24.	Water Sprayer	As required	
25.	Water Tanker / Pump Set	1 No.	
26.	Water Testing and Concrete Lab Setup	1 Set	
27.	Welding Machines	2 Nos.	

Notes:

a) The above list is indicative and minimum; bidders may propose additional or alternative equipment depending on methodology and project schedule.

b) All machinery and equipment shall be in good working condition and shall conform to relevant IS codes and safety standards.

c) The deployment schedule and adequacy of equipment shall be reviewed and approved by the Engineer-in-Charge before commencement of work.

Form 11: Proposed Personnel

Bidder should provide the details of the proposed personnel and their experience record in the relevant Information Forms below for each candidate:

1.	Title of Position	
	Name	
2.	Title of Position	
	Name	
3.	Title of Position	
	Name	
4.	Title of Position	
	Name	
5.	Title of Position	
	Name	

Form 12: Resume of Proposed Personnel

Position:		
Personnel Information:	Name:	Date of Birth:
Professional Qualifications:		
Present Employment:	Name of Employer:	
Address of Employer:		
Telephone:	Contact (Manager / Personnel Officer):	
Fax:	E-Mail:	
Job Title:	Years with Present Employer:	

Summarize professional experience in reverse chronological order. Indicate particular technical and managerial experience relevant to the project.

From	To	Company / Project / Position / Relevant Technical and Management Experience

Form 13: Proforma of Letter of Bid.

The Contractor must prepare the Letter of Bid on its letterhead clearly showing the Contractors complete name and address.

Note: All italicized text is for use in preparing these forms and shall be deleted from the final products.

Date: Bid Ref. No.:

To,

The Development Commissioner

SEEPZ-SEZ Authority, Andheri (East), Mumbai-400 096

1. We have examined and have no reservations to the Bidding Documents, including Addenda issued in accordance with Instructions to Contractor and the Terms and Conditions of Contract.
2. We meet the eligibility requirements in accordance with ITC 4 and have no Conflict of Interest in accordance with GFR 175.
3. We offer to complete, in conformity with the Bidding Documents, the following works: "[Tender Name]" at SEEPZ-SEZ Premises, Andheri East, Mumbai 400 096. Our final price offer is as submitted in our financial Bid.
4. Our Bid shall remain valid for 90 (ninety) days from the last date of submission of the Bid and it shall remain binding upon us and may be accepted at any time before the expiration of that period.
5. We are not participating, as a Contractor or as a sub-Contractor, in more than one Bid in this bidding process.
6. We are not debarred by any procuring entity of the Central Government or any State Government or any Public Undertaking, Autonomous body, Authority by whatever name is called.
7. We hereby certify that we have taken steps to ensure that no person acting for us or on our behalf will engage in any activities which are in contravention of the Code of Integrity proscribed in GFR 175.
8. We hereby certify that we are neither associated nor have we been associated directly or indirectly with the officials / consultants or any other individual or entity that has prepared the design, specifications, and other documents for the subject matter of procurement or is being proposed as Project Manager for the contract from the SEEPZ-SEZ Authority.
9. We hereby certify that we have fulfilled our obligations to pay all such taxes as payable to the Central Government or the State Government or any local Authority.
10. We hereby certify that we are not insolvent, in receivership, bankrupt or being wound up, not have its affairs administered by a court or a judicial officer, not have its business activities suspended and must not be the subject of legal proceedings for any of the foregoing reasons.
11. We hereby certify that our directors and officers have not been convicted of any criminal offence related to their professional conduct or the making of false statements or misrepresentations as to their qualifications to enter into a procurement contract within a period of three years preceding the commencement of the procurement process or not have been otherwise disqualified pursuant to debarment proceedings.
12. We understand that this Bid, together with your written acceptance thereof included in your notification of award, shall constitute a binding contract between us, until a formal contract is prepared and executed; and
13. We understand that SEEPZ-SEZ Authority is not bound to accept the H1 Bid or any other Bid that SEEPZ-SEZ Authority may receive and that the decision of the SEEPZ-SEZ Authority shall be final & binding.

Name of the Contractor:

Designation of the person signing the Bid:

Signature of the person named above Date signed.

Form 14: Proforma of Site Visit Report with Geotagged Photographs

(Pre-Tender / Tendering Stage)

(This Document should be submitted along with technical bid at the time of online submission of the Tender with Geo Tagged Photocopies.)

To,

The Development Commissioner,

SEEPZ Special Economic Zone,

2*nd* Floor, Service Centre Building,

SEEPZ SEZ Authority, MIDC Central Road,

Andheri East, Mumbai-400096.

A. Basic Project Information

Particulars	Details
Name of Work	
Tender No.	
Estimated Cost	
Client Department	
Location of Work	
Type of Work	New Construction / Renovation / Repair / Maintenance / Infrastructure
Date of Site Visit	
Time of Site Visit	
Weather Conditions	
Name of Visiting Officer / Representative	
Organization / Company	
Contact Number	
Email ID	

B. Site Location Details

Particulars	Details
Site Address	
Village/City	
Taluka/District	

Particulars	Details
State	
Latitude	
Longitude	
Elevation (if available)	
Google Map Link	
Nearest Landmark	

C. Attendance Record

Department Representatives

Name	Designation	Contact No.	Signature

Bidder/Consultant Representatives

Name	Designation	Contact No.	Signature

D. Existing Site Conditions Assessment

1. Land Information

Particulars	Observation
Site Area (Approx.)	
Boundary Defined	Yes / No
Fencing Available	Yes / No
Encroachments Observed	Yes / No
Site Ownership Confirmed	Yes / No
Site Topography	Flat / Sloping / Undulating
Existing Structures on Site	

Particulars	Observation
Demolition Required	Yes / No
Debris Clearance Required	Yes / No

2. Accessibility Assessment

Particulars	Observation
Approach Road Available	Yes / No
Road Width	
Heavy Vehicle Access Possible	Yes / No
Traffic Restrictions	
Distance from Main Road	
Site Entry Constraints	
Parking Availability	

3. Utilities & Services Availability

Service	Available	Remarks
Electricity	Yes / No	
Water Supply	Yes / No	
Sewer Connection	Yes / No	
Drainage Network	Yes / No	
Internet/Communication	Yes / No	
Street Lighting	Yes / No	
Fire Water Source	Yes / No	

4. Existing Underground / Overhead Services

Service	Present	Remarks
Water Pipeline	Yes / No	
Sewer Line	Yes / No	
Storm Water Drain	Yes / No	
Electrical Cables	Yes / No	
Optical Fiber Cable	Yes / No	
Gas Line	Yes / No	

Service	Present	Remarks
Overhead HT/LT Lines	Yes / No	

E. Tender Planning Assessment

Material Availability

Material	Distance from Site	Remarks
Cement		
Steel		
Sand		
Aggregate		
Ready Mix Concrete		
Bricks/Blocks		
Other Major Materials		

Labour Availability

Category	Availability	Remarks
Skilled Labour	Adequate / Limited	
Semi-Skilled Labour	Adequate / Limited	
Unskilled Labour	Adequate / Limited	
Specialized Labour	Adequate / Limited	

Construction Facilities

Particulars	Observation
Space for Site Office	
Space for Material Storage	
Space for Labour Camp	
Space for Equipment Parking	
Temporary Utilities Available	
Nearby Disposal Area	

F. Risk Identification

Risk Factor	Observation	Impact
Water Logging		Low/Medium/High
Flood Risk		Low/Medium/High
Restricted Access		Low/Medium/High
Utility Relocation Required		Low/Medium/High
Environmental Restrictions		Low/Medium/High
Security Issues		Low/Medium/High
Working Space Constraints		Low/Medium/High
Local Authority Permissions		Low/Medium/High

G. Technical Clarifications Required

Sr. No.	Query Raised During Site Visit	Response by Department
1.		
2.		
3.		
4.		

H. Geotagged Photographs

Photograph Register

Photo No.	Description	Latitude	Longitude	Date & Time	Remarks
1	Main Entrance				
2	Overall Site View				
3	Existing Structures				
4	Utilities Location				
5	Access Road				
6	Storage Area				
7	Constraint Area				
8	Additional View				

I. Site Sketch / Layout Verification

Verify Availability of:

- Approved Site Layout

- Tender Drawings
- Topographical Survey
- Utility Drawings
- Soil Investigation Report
- Structural Drawings
- Architectural Drawings
- Existing Service Drawings

J. Bidder's Assessment

Key Observations

_____
_____
_____

Construction Challenges Identified

_____
_____
_____

Instructions Issued During Visit.

_____
_____
_____

Summary of Visit.

_____
_____
_____

K. Declaration

We hereby confirm that the project site has been physically inspected and evaluated by the undersigned. The observations, findings, and site conditions recorded in this report shall be duly considered while preparing the bid proposal. Furthermore, we acknowledge that no claim arising from conditions that were reasonably observable during the site visit shall be entertained at any subsequent stage.

Certification

I/We hereby certify that:

1. The project site has been physically inspected by the undersigned representative(s).
2. The attached photographs were captured at the project location using a GPS-enabled device.
3. The geographic coordinates, date, and time information embedded in the photographs are accurate and authentic to the best of our knowledge.
4. The photographs fairly and accurately represent the site conditions prevailing on the date of inspection.
5. No photograph, geolocation data, date stamp, time stamp, or any related information has been modified, altered, manipulated, or misrepresented.
6. I/We have thoroughly familiarized ourselves with the site conditions, accessibility, constraints, utilities, and all other relevant factors that may influence the execution of the work.
7. I/We acknowledge that the bid has been prepared after due consideration of the prevailing site conditions, and no claim on account of inadequate knowledge, misunderstanding, or failure to inspect the site shall be admissible at a later stage.

8. The information provided in this site visit and geotagging report is true, complete, and correct to the best of our knowledge and belief.

Sign and Stamp

Signature of Bidder's Authorized Representative: _____ Name: _____ Designation: _____ Organization: _____ Date: _____ Place: _____	Signature of Bidder's Authorized Representative: _____ Name: _____ Designation: _____ Organization: _____ Date: _____ Place: _____

Mandatory Geo-Tagged Photo Checklist

- Main entry gate
- Complete site panorama
- Existing structures/buildings
- Utility connections
- Approach roads
- Material storage area
- Drainage conditions
- Nearby structures affecting work.
- Any major constraints/risk areas
- Google Maps location screenshot

Annexure I - Instructions for Online Bid Submission

Bidders are required to submit soft copies of their bids electronically on the CPP Portal, using valid Digital Signature Certificates. The instructions given below are meant to assist the bidders in registering on the CPP Portal, prepare their bids in accordance with the requirements and submitting their bids online on the CPP Portal.

Registration.

1. Bidders are required to enrol on the e-Procurement module of the Central Public Procurement Portal (URL: https://eprocure.gov.in/eprocure/app) by clicking on the link “Online bidder Enrolment” on the CPP Portal which is free of charge.
2. As part of the enrolment process, the bidders will be required to choose a unique username and assign a password for their accounts.
3. Bidders are advised to register their valid email address and mobile numbers as part of the registration process. These would be used for any communication from the CPP Portal.
4. Upon enrolment, the bidders will be required to register their valid Digital Signature Certificate (Class III Certificates with signing key usage) issued by any Certifying Authority recognized by CCA India (e.g., Sify / n-Code / e-Mudra etc.), with their profile.
5. Only one valid DSC should be registered by a bidder. Please note that the bidders are responsible for ensuring that they do not lend their DSCs to others, which may lead to misuse.
6. Bidder then logs in to the site through the secured log-in by entering their user ID / password and the password of the DSC / e-Token.

Searching for Tender Documents.

1. There is various search options built in the CPP Portal, to facilitate bidders to search for active tenders by several parameters. These parameters could include Tender ID, Organization Name, Location, Date, Value, etc. There is also an option of advanced search for tenders, wherein the bidders may combine a number of search parameters such as Organization Name, Form of Contract, Location, Date, Other keywords etc. to search for a tender published on the CPP Portal.
2. Once the bidders have selected the tenders they are interested in, they may download the required documents / tender schedules. These tenders can be moved to the respective ‘My Tenders’ folder. This would enable the CPP Portal to intimate the bidders through SMS / e-mail in case there is any corrigendum issued to the tender document.
3. The bidder should make a note of the unique Tender ID assigned to each tender; in case they want to obtain any clarification / help from the Helpdesk.

Preparation of Bids.

1. Bidder should consider any corrigendum published on the tender document before submitting their bids.
2. Please go through the tender advertisement and the tender document carefully to understand the documents required to be submitted as part of the bid. Please note the number of covers in which the bid documents have to be submitted, the number of documents - including the names and content of each of the documents that need to be submitted. Any deviations from these may lead to rejection of the bid.
3. Bidder, in advance, should get ready the bid documents to be submitted as indicated in the tender document / schedule and generally, they can be in PDF / XLS / RAR / DWF/JPG formats. Bid documents may be scanned with 100 (Hundred) dpi with black and white options which help in reducing size of the scanned document.
4. To avoid the time and effort required in uploading the same set of standard documents which are required to be submitted as a part of every bid, a provision for uploading such standard documents (e.g., PAN card copy, annual reports, auditor certificates etc.) has been provided to the bidders. Bidders can use “My Space” or ‘’Other Important Documents’’ area available to them to upload

such documents. These documents may be directly submitted from the “My Space” area while submitting a bid and need not be uploaded again and again. This will lead to a reduction in the time required for bid submission process.

Note: My Documents space is only a repository given to the Bidders to ease the uploading process. If Bidder has uploaded his Documents in My Documents space, this does not automatically ensure these Documents being part of Technical Bid.

Submission of Bids.

1. Bidder should log into the site well in advance for bid submission so that they can upload the bid in time i.e., on or before the bid submission time. Bidder will be responsible for any delay due to other issues.
2. The bidder has to digitally sign and upload the required bid documents one by one as indicated in the tender document.
3. Bidder has to select the payment option as “offline” to pay the tender fee / EMD as applicable and enter details of the instrument.
4. Bidder should prepare the EMD as per the instructions specified in the tender document. The original should be posted/couriered/given in person to the concerned official, latest by the last date of bid submission or as specified in the tender documents. The details of the DD/any other accepted instrument, physically sent, should tally with the details available in the scanned copy and the data entered during bid submission time.
5. Bidders are requested to note that they should necessarily submit their financial bids in the format provided and no other format is acceptable. If the price bid has been given as a standard BoQ format with the tender document, then the same is to be downloaded and to be filled by all the bidders. Bidders are required to download the BoQ file, open it and complete the white coloured (unprotected) cells with their respective financial quotes and other details (such as name of the bidder). No other cells should be changed. Once the details have been completed, the bidder should save it and submit it online, without changing the filename. If the BoQ file is found to be modified by the bidder, the bid will be rejected.
6. The server time (which is displayed on the bidders’ dashboard) will be considered as the standard time for referencing the deadlines for submission of the bids by the bidders, opening of bids etc. The bidders should follow this during bid submission.
7. All the documents being submitted by the bidders would be encrypted using PKI encryption techniques to ensure the secrecy of the data. The data entered cannot be viewed by unauthorized people until the time of bid opening. The confidentiality of the bids is maintained using the secured Socket Layer 128-bit encryption technology. Data storage encryption of sensitive fields is done. Any bid document that is uploaded to the server is subjected to symmetric encryption using a system generated symmetric key. Further this key is subjected to asymmetric encryption using buyers/bid opener’s public keys. Overall, the uploaded tender documents become readable only after the tender opening by the authorized bid openers.
8. The uploaded tender documents become readable only after the tender opening by the authorized bid openers.
9. Upon the successful and timely submission of bids (i.e., after Clicking “Freeze Bid Submission” in the portal), the portal will give a successful bid submission message & a bid summary will be displayed with the bid no. and the date & time of submission of the bid with all other relevant details.
10. The bid summary has to be printed and kept as an acknowledgement of the submission of the bid. This acknowledgement may be used as an entry pass for any bid opening meetings.

Assistance to Bidders.

1. Any queries relating to the tender document and the terms and conditions contained therein should be addressed to the Tender Inviting Authority for a tender or the relevant contact person indicated in the tender.

2. Any queries relating to the process of online bid submission or queries relating to CPP Portal in general may be directed at the 24x7 CPP Portal Helpdesk.

   More information useful for submitting online bids on the CPP Portal may be obtained at: https://eprocure.gov.in/eprocure/app. Bidders are requested to note that CPP has been built and maintained by the National Informatics Centre and that the Procuring Entity is not responsible for any technical issues related to the CPP Portal. All information contained in this annexure is taken directly from the CPP Portal.

Section 05

Scope of Work and Technical Specifications (SOW & TS)

SCOPE OF WORK

STAGE 1: DEMOLITION OF THE EXISTING GROUND + 03 RCC STRUCTURE OF SDF 01, SUB-STATION, AND CANTEEN BUILDING AND ASSOCIATED ALLIED WORKS

Section 05 - Scope of Work and Technical Specifications.

A. Scope of Work

Stage 1: "Demolition of the Existing Ground + 03 RCC Structure of SDF 01, Sub-station, and Canteen Building and Associated Allied Works."

This Section including but not limited to following Scope of Work.

1. Introduction

The Santacruz Electronic Export Processing Zone (SEEPZ–SEZ), established in 1973, is one of India's oldest export-oriented industrial enclaves. Initially conceived as a uni-product export processing zone for electronics manufacturing and exports, SEEPZ aimed to promote technological advancement, earn foreign exchange, and generate employment.

Over the years, SEEPZ evolved into a multi-sector export hub, accommodating electronics, IT (hardware and software), and gems & jewellery industries, thereby strengthening India's global competitiveness and employment base. In January 2002, an additional 11-acre parcel (SEEPZ++) was merged with the original campus through a government notification, enabling expansion of industrial and support infrastructure.

Today, SEEPZ-SEZ spans approximately 110 acres (44.51 ha) in Mumbai, offering strong logistical advantages with proximity to the international airport (6 km) and JNPT port (30 km), along with excellent road, rail, and air connectivity. Supported by comprehensive urban amenities and services, the zone functions as a self-sustaining business ecosystem.

In response to evolving global trade dynamics, technological advancements, sustainability goals, and urban constraints, the Client has initiated SEEPZ Vision 2.0, reimagining the campus as the "Golden Gateway to Global Markets.

2. Brief of the Project

Demolition of Standard Design Factory–1 (SDF-1), Canteen & Substation building:

The Standard Design Factory–1 (SDF-1), constructed in the year 1975 within the SEEPZ Special Economic Zone, Mumbai, has become structurally dilapidated and is no longer fit for continued occupation or operation.

All existing occupants of SDF-1 have been successfully relocated to in the existing premises, thereby enabling the proposed demolition of the SDF-1 structure. Upon completion of the demolition activities, the SEEPZ–SEZ Authority proposes to undertake the development of NEST-3 on the vacated SDF-1 site as the next phase of redevelopment.

a) Location: Standard Design Factory - 1 (SDF-01) at SEEPZ-SEZ, MIDC Central Road, Andheri East, Mumbai 400 096, India.

b) Proximity to Key Facilities:

- Airport - 3.8 km
- Train - 4.1km
- Metro - 0.1 km
- NH48 - 2.5 km

c) Site & Building Locations

1. Site Location Coordinates: 19.12516448659387, 72.87443627750069

2. Building Location

Demolition Built-up Area:

Area Statement for Demolition of Existing Structures				
Sr. No	**Buildings**	**Floors**	**Built-Up Area (In Sqm)**	**Built-Up Area (In Sqft)**
1.	Main Building- Standard Design Factory-1 (SDF-1)	Ground Floor	7962.15	85704.56
		First Floor	7082.45	76235.49
		Second Floor	6238.41	67150.27
		Third Floor	5394.37	58065.04
2.	Canteen	Ground Floor	653.88	7038.32
3.	Substation	Ground Floor	135.24	1455.76
	Total		**27466.50**	**295649.44**

Building Coordinates of Existing Structures				
Sr. No	**Buildings**	**Points#**	**Coordinates**	
			Latitude	**Longitude**
1.	Main Building (SDF-1)	1A	19.12595937	72.87391678
		1B	19.12535075	72.87486027
		1C	19.12520089	72.87475299
		1D	19.12492175	72.87493248
		1E	19.12476634	72.87482431
		1F	19.12458239	72.87487113
		1G	19.12443516	72.87478004
		1H	19.12504403	72.87383338
		1J	19.12519207	72.87394606
		1K	19.12547199	72.87374485
		1L	19.12561754	72.87385696
		1M	19.12580889	72.87379284
2.	Canteen	2A	19.12530662	72.8749462
		2B	19.12511654	72.87520914

Building Coordinates of Existing Structures				
Sr. No	**Buildings**	**Points#**	**Coordinates**	
			Latitude	**Longitude**
		2C	19.12497951	72.87500352
		2D	19.12520487	72.87487373
3.	Substation	3A	19.12567351	72.87375524
		3B	19.12564645	72.87380317
		3C	19.12552733	72.87371655
		3D	19.12555172	72.87366336

Please Note:

a) The area of demolition of existing structures indicated in the above table is tentative and indicative only. The actual demolition area may vary based on final site measurements, drawings, and prevailing site conditions. No additional claim or adjustment shall be entertained on account of such variation.

b) "#": The bidder shall refer to the coordinate points indicated in the respective Tender drawing.

3. Scope of Work

The Scope of Work shall include the safe and controlled demolition of the existing Standard Design Factory–1 (SDF-1) building, including the canteen and substation buildings, complete with dismantling, segregation, handling, transportation, lawful disposal of debris, and full site clearance.

The scope shall further include complete lifecycle management of the proposed NEST-3 development, covering pre-construction planning, construction execution, and post-construction completion and handover.

All works shall be executed in strict compliance with SEEPZ-SEZ Authority regulations, applicable statutory requirements, safety standards, environmental norms, and relevant codes. The Contractor shall ensure minimal disruption to adjoining operational facilities within the SEZ during execution of the works.

3.1 Pre Demolition Stage

3.2 Demolition Stage

3.3 Post Demolition Stage

3.4 Horticulture & Irrigation – Tree Transplantation Works

3.5 Site Safety and Precautionary Measures

3.6 Inspection and Closure Report

3.7 Reference

3.1 Pre Demolition Stage

General Note.

- This section defines the complete scope of activities to be undertaken by the Contractor during the pre-demolition stage, prior to commencement of physical demolition works, to ensure statutory compliance safety, environmental protection, and orderly execution of the Works.
- No demolition activity shall commence until all requirements under this section are fully complied with and approved in writing by the Engineer-in-Charge.

- The Contractor shall be deemed to have fully considered and included in its Bid Price all costs, expenses, risks, liabilities, and obligations associated with the implementation of the arrangements specified in this Section. All such costs shall be deemed to be included in the Contractor's quoted rates and shall form part of the Contractor's overheads and incidental expenses. No separate or additional payment, compensation, reimbursement, claim, or any other monetary consideration shall be admissible or payable by the Client on this account.

Statutory Approvals and Regulatory Compliance

- The Contractor shall obtain all required statutory approvals and shall initially pay all applicable statutory fees, charges, and levies, excluding those related to MIDC Demolition NOC and Tree Cutting/Transplantation Permission. Such fees paid by the Contractor shall be reimbursed by the Client upon submission of valid documentary evidence, or the Client may, at its discretion, make payment directly to the concerned authority.
- The Contractor shall be solely responsible for compliance with all applicable Central, State, and Local laws, rules, regulations, and guidelines, including but not limited to the following:
- Labour laws and welfare legislations such as the Building and Other Construction Workers (BOCW) Act, Employees' State Insurance (ESIC), Provident Fund (PF), Workmen's Compensation Act, and other applicable labour statutes.
- Environmental protection laws, Pollution Control Board norms, and applicable environmental regulations.
- Safety standards, relevant IS codes, SEZ guidelines, and directives issued by concerned authorities.
- The Contractor shall follow all demolition-related norms and guidelines issued by the Central and State Pollution Control Boards and other environmental authorities.
- Where mandated by applicable laws, the Contractor shall carry out the Environmental Impact Assessment (EIA) and incorporate its findings and recommendations into the demolition methodology, design, and execution plans as applicable.
- The Contractor shall maintain complete and up-to-date records of all statutory approvals, permissions, licenses, and NOCs and shall produce the same for inspection or verification by the Engineer-in-Charge as and when required.

Royalties and Charges

- All royalties, cess, local body taxes, PUC charges, transportation expenses, and any other charges or imposts whatsoever in connection with or arising out of the execution of the Works shall be fully borne and paid by the Contractor and shall be deemed to be included in the Contract Price.
- No reimbursement, claim, or additional payment shall be admissible to the Contractor on account of the above under any circumstances.
- Contractor ensured that payments shall be certified strictly in accordance with the approved contractual terms, conditions, and obligations as specified in the Contract Documents.
- The Contractor shall adhere to the agreed Billing and Payment Cycle, and any deviation therefrom shall not be entertained without prior written approval of the Client.
- All serviceable materials on which custom duty is applicable need to be quantified and necessary custom duty is to be paid by the contractor.

Mobilization of Resources

- The Contractor shall deploy competent and adequately experienced personnel, including demolition supervisors, safety engineers, certified equipment operators, and required skilled and unskilled workforce.
- The Contractor shall arrange and mobilize appropriate demolition plant and equipment, comprising, but not limited to, excavators fitted with breakers/shears, cranes, loaders, dumpers, water tankers, jet pumps, and necessary hand tools.

- All mobilization activities shall be carried out strictly in compliance with the approved execution methodology and shall take due consideration of prevailing site conditions and constraints.

Demolition Methodology and Planning

- The Contractor shall develop and submit a detailed Demolition Execution Methodology, which shall include, but not be limited to, the following:
- Proposed sequence and phasing of demolition activities.
- Safety provisions and risk mitigation measures.
- Deployment plan for plant, machinery, and equipment.
- Environmental management and pollution control measures.
- Procedures for debris handling, segregation, transportation, and final disposal.
- The above methodology shall be submitted along with an MS Project–based construction schedule clearly indicating the targeted completion timelines.
- No demolition or related work shall be initiated without obtaining prior written approval of the Demolition Methodology from the Engineer-in-Charge.

Pre-Demolition Surveys and Site Preparation

- The Contractor shall also carry out a Dilapidation Survey of all adjacent and nearby structures. The survey shall include photographic records, detailed condition reports, and an assessment of potential risks arising from demolition activities.
- A comprehensive Tree Survey shall be conducted by the Contractor, and recommendations for tree retention, removal, or transplantation shall be submitted for approval to the concerned authority.
- Prior to commencement of demolition works, the Contractor shall complete all site preparation activities, including site demarcation, identification and marking of demolition zones, and any other preparatory measures necessary to ensure safe and orderly execution of demolition operations.

Site Logistics and Access Planning

- The Contractor shall prepare and submit a comprehensive Site Logistics Plan defining the organization, movement, and control of all activities within the site. The plan shall include, but not be limited to, the following:
- Clearly identified routes for the movement of demolition equipment and debris transportation vehicles
- Designated and approved entry and exit points for personnel, machinery, and vehicles.
- Identified areas for storage, stacking, and temporary holding of materials and debris.
- Dedicated emergency access routes, which shall:
  a) Remain unobstructed and operational at all times.
  b) Be clearly marked with appropriate signage and lighting.
  c) Provide direct access for emergency services such as fire tenders, ambulances, and rescue teams.
  d) Be coordinated with local fire and emergency authorities, where applicable.
  e) Include provisions for emergency assembly points and evacuation pathways.
- The Contractor shall ensure that safe, clear, and uninterrupted access is maintained at all times for manpower, equipment, debris removal vehicles, and emergency response services throughout the duration of the works.

Site Barricading and Safety Installations

- The Contractor shall erect and maintain robust site barricading to clearly demarcate and secure all demolition zones. Barricading shall be constructed using rigid metal sheets, steel frames, or approved prefabricated panels of adequate height and strength to prevent unauthorized entry and protect adjoining properties, pedestrians, and vehicular traffic.
- The Contractor shall provide and maintain all necessary warning signs, caution boards, safety notices, reflective tapes, blinkers, and directional signage in accordance with applicable statutory requirements and the instructions of the Engineer-in-Charge. All signage shall be clearly visible during both daytime and night-time operations.
- Wherever directed by the Engineer-in-Charge, the Contractor shall install sound barriers, noise-control screens/ acoustic enclosures, Wave barrier trenches, to limit the transmission of noise and dust arising from demolition activities, ensuring compliance with local environmental and pollution control norms.

Additional Provisions for Demolition Works

- Barricading shall be continuous, stable, and properly anchored to withstand wind loads, vibrations from demolition equipment, and external impacts.
- Access and egress points for personnel, machinery, and emergency services shall be clearly identified, controlled, and secured at all times.
- Temporary overhead protection (such as covered walkways, debris nets, or crash decks) shall be provided where demolition activities pose a risk to adjacent roads, buildings, or public areas.
- Adequate night illumination, including hazard lights and reflective markers, shall be installed along barricades and entry points to ensure visibility and safety after sunset.
- Barricading, signage, and safety installations shall be inspected regularly and immediately repaired, reinforced, or replaced if damaged or displaced.
- The Contractor shall ensure that all barricading and safety measures remain in place for the entire duration of demolition and are removed only after completion of works and clearance from the Engineer-in-Charge.
- All arrangements shall comply with relevant local authority requirements, safety regulations, and industry best practices, at no additional cost to the Employer.

Temporary Utilities and Site Facilities

- The Contractor shall, at his own cost, arrange, install, operate, and maintain all temporary utilities required for execution of the Works, including temporary electricity supply, water supply, sanitary facilities, site drainage arrangements, and provision of potable drinking water.

  The Client will provide space for Site office as per approved site logistics plan to the contractor on chargeable basis as per mutually agreed.

Safety Documentation and Compliance

- The Contractor shall submit all requisite safety-related documents for demolition plant, machinery, and equipment prior to commencement of work. The documentation shall include, but not be limited to:
  a) Valid third-party inspection and testing certificates
  b) Applicable insurance policies
  c) Equipment fitness certificates
  d) Valid operator licences and competency certificates for all personnel engaged in demolition activities.
- The Contractor shall deploy qualified and experienced safety staff, including a Safety Engineer, Safety Supervisor, and certified Signalman, for continuous monitoring and enforcement of safety measures throughout the demolition period.
- The Contractor shall conduct regular safety induction programmes, toolbox talks, and hazard identification and awareness sessions for all site personnel to ensure adherence to approved safety

practices and procedures.

Labour Welfare and Statutory Compliance

- The Contractor shall ensure that all workmen deployed at site are provided, at his own expense, with appropriate personal protective equipment (PPE), including safety helmets, safety footwear, protective gloves, and high-visibility jackets, as per applicable safety standards.
- The Contractor shall strictly comply with all statutory labour laws and regulations, including but not limited to provisions relating to Employees' State Insurance (ESIC), Provident Fund (PF), and any other applicable central or state labour enactments.
- All arrangements for labour accommodation shall be made outside the project site by the Contractor at his own cost, in accordance with applicable statutory and local authority requirements.
- Engagement or employment of child labour at site is strictly prohibited, and the Contractor shall ensure compliance with all laws governing the prohibition of child labour.

Utility Identification and Disconnection

- Prior to commencement of demolition activities, the Contractor shall carry out detailed identification, verification, and mapping of all existing above-ground and underground utilities, including but not limited to electrical, water, sewer, gas, and communication services within and adjacent to the site.
- The Contractor shall ensure that all identified utilities are completely disconnected, safely isolated, and duly certified by the concerned authorities before initiation of any demolition works. Demolition shall not commence until written clearance for utility disconnection is obtained.
- The Contractor shall be solely responsible and liable for any damage to existing utilities arising out of demolition operations and shall make good such damage at his own cost without any liability to the Employer.

Environmental Control Measures

- The Contractor shall adopt and continuously implement effective dust control measures during execution of the Works, including but not limited to regular water sprinkling, mist spraying, or fogging arrangements to minimise airborne dust.
- The Contractor shall ensure that noise levels, ground vibrations, and air emissions arising from the works are strictly controlled and maintained within the limits prescribed under applicable statutory and environmental regulations.
- Demolition or construction activities during night hours shall not be carried out unless prior written approval is obtained from the competent statutory authorities and the Engineer-in-Charge.

Protection of Adjacent Structures

- The Contractor shall, prior to and during execution of demolition works, carry out necessary assessment and continuous monitoring of the condition of all adjoining and neighbouring structures so as to ensure their safety and stability.
- Any damage, settlement, cracking, or adverse effect caused to adjacent structures or properties as a result of demolition activities shall be made good by the Contractor at his own cost to the satisfaction of the Engineer-in-Charge, without any extra claim or compensation.

Debris Management and Disposal

- The Contractor shall prepare, submit and obtain approval of a comprehensive Construction and Demolition (C&D) Waste Management Plan from the Engineer-in-Charge/competent authority, in accordance with the prevailing rules, regulations, and guidelines issued by local bodies and statutory authorities. The Contractor shall implement the approved plan in its entirety during the execution of the work. All necessary permissions/clearances from the concerned government authorities shall be

obtained by the Contractor at his own cost, and no extra payment shall be made on this account. All demolition debris shall be properly segregated at source and shall be transported and disposed of only at designated and authorized disposal sites approved by the competent authorities.

- The Contractor shall maintain complete records of debris handling and disposal, including quantity details and valid disposal receipts or acknowledgements, and shall produce the same to the Engineer-in-Charge as and when required.

Scrap, Salvage, and Reusable Materials.

- All scrap, salvaged, and reusable materials arising from dismantling or demolition works shall be identified, segregated, and handled strictly in accordance with the written instructions of the Engineer-in-Charge.
- Ownership, valuation, disposal, or handover of all such materials shall be governed solely by the directions issued by the Engineer-in-Charge.
- No scrap, salvaged, or reusable material shall be removed from the site without prior written approval of the Engineer-in-Charge.
- All materials recovered from demolition or dismantling activities, whether serviceable or non-serviceable, shall remain the property of the Client.
- The Contractor shall pass the full salvage value of all recovered materials to the Client in the form of rebate through the quoted demolition rates, and no separate payment or claim shall be admissible.
- The Contractor shall remove all debris, waste, and unwanted material and shall clean and restore the site completely to the satisfaction of the Engineer-in-Charge.
- Scrap or salvaged materials shall not be permitted to be shifted from the site unless the debris of the concerned building has been fully removed and the site has been thoroughly cleaned.
- During the demolition, dismantling, excavation, cutting, drilling, cleaning, or any allied operation, any fossils, antiquities, archaeological remains, precious metals and materials (including but not limited to gold, silver, platinum, diamonds, gemstones, copper, aluminium and other non-ferrous metals), semi-processed or processed materials, bullion, coins, tools, dies, Molds, residues, scrap, artefacts, historical objects, heritage items, or any other article of commercial, historical, scientific, metallurgical, or proprietary value, whether known or unknown at the time of tender, shall vest absolutely in and be the sole property of the Engineer-in-Charge.
- The Contractor shall have no right, title, interest, lien, royalty, or claim of any nature whatsoever over such articles, except as expressly provided under this Contract.

Inventory, Illumination, Security, and Site Familiarization

- The Contractor shall jointly carry out and prepare a pre-demolition inventory with the Client / PMC, wherever required, prior to commencement of the Works.
- The Contractor shall provide, operate, and maintain adequate site illumination and security arrangements throughout the entire contract period at no additional cost to the Employer.
- The Contractor shall be deemed to have visited, inspected, and familiarized himself fully with the site conditions prior to submission of the tender, and no claim whatsoever on account of site conditions or constraints shall be entertained subsequently.
- The Works shall be executed strictly in accordance with the approved execution methodology, construction sequence, and the accepted MS Project work programme/schedule, unless otherwise authorized in writing by the Engineer-in-Charge.

Reporting & Documentation

- The Contractor shall submit a comprehensive Demolition Completion Report detailing the scope of demolition carried out, salvage particulars, cost analysis and overall statutory and contractual compliance.
- The Contractor shall furnish weekly progress reports highlighting the status of works and shall maintain

systematic photographic records documenting various stages of demolition.

- Upon completion of the Works, the Contractor shall issue a Final Certificate confirming safe and complete demolition, full clearance of debris from the site, and compliance with all applicable statutory requirements.
- The Contractor shall execute all other incidental and associated works necessary for the successful, safe, and timely completion of the project, even if not expressly specified elsewhere in the contract documents.

3.2 Demolition Stage.

General Note.

- The Contractor shall carry out the complete demolition, dismantling, removal, and safe disposal of existing buildings, civil structures, services, utilities, and related components within the project site. The works shall be executed in accordance with applicable statutory regulations, approved drawings, safety standards, environmental requirements, and the directions of the Engineer-in-Charge.

  The scope includes, but is not limited to, the following clauses.
- The Contractor shall be deemed to have fully considered and included in its Bid Price all costs, expenses, risks, liabilities, and obligations associated with the implementation of the arrangements specified in this Section. All such costs shall be deemed to be included in the Contractor's quoted rates and shall form part of the Contractor's overheads and incidental expenses. No separate or additional payment, compensation, reimbursement, claim, or any other monetary consideration shall be admissible or payable by the Client on this account.

Site Preparation and Safety Compliance.

- The Contractor shall carry out a comprehensive pre-demolition site inspection to identify existing utilities, structural conditions, access and egress routes, and potential hazard areas.
- All existing utility services, including electricity, water supply, gas lines, sewerage, telecommunications, and data services, shall be safely isolated and temporarily disconnected prior to the commencement of demolition activities.
- Wherever required, the Contractor shall obtain written confirmation from the concerned statutory and service authorities confirming the shutdown or isolation of utilities.
- Adequate safety signage, warning notices, barricades, and restricted access zones shall be installed, operated, and maintained in accordance with statutory safety regulations and National Safety Council guidelines.
- The Contractor shall deploy qualified and certified safety personnel, ensure the use of appropriate personal protective equipment (PPE) by all workers, and conduct regular toolbox talks and safety briefings during the demolition works.
- Fire-fighting equipment, first-aid facilities, and emergency response and evacuation arrangements shall be provided, maintained, and kept readily accessible at all times throughout the duration of the works.

Existing MEPF Services Dismantling and Associated Utilities.

- The Contractor shall submit formal intimation and obtain the requisite permissions for temporary shutdown of electrical services prior to the commencement of dismantling works.
- All live electrical systems, including circuits, feeders, and supply lines, shall be completely isolated, de-energized, and made safe before removal of any electrical installations.
- The Contractor shall dismantle all surface-mounted and concealed electrical wiring, conduits, trunking, raceways, and cable trays in a safe, systematic, and controlled manner.
- Switchgear panels, HT and LT panels, MCBs, distribution boards (DBs), junction boxes, control panels, and all associated electrical equipment shall be carefully dismantled and removed.

- All electrical fixtures, luminaires, fans, fittings, accessories, and allied installations shall be removed without causing damage to adjacent structures or services.
- Electrical distribution systems, including utility lines from the nearest power source up to the site comprising transformers, VCBs, ACBs, OCBs, DG sets, and associated infrastructure shall be dismantled or disconnected as specified in the scope of work.
- The Contractor shall coordinate with concerned statutory and utility authorities for disconnection, diversion, relocation, or safeguarding of electrical, gas, and other utility services. All applicable statutory fees, levies, and charges shall be borne by the Contractor.
- Gas supply lines and other utilities, including ventilation systems such as HVAC installations and compressed air lines, shall be safely isolated, dismantled, or removed as per approved procedures and relevant codes.
- The Contractor shall ensure uninterrupted operation of services in non-demolished or occupied areas by suitably restoring, diverting, or re-routing essential electrical and utility connections wherever required, to the satisfaction of the Engineer-in-Charge.

Dismantling of Water Supply, Plumbing and Sanitation, Irrigation, Fire Alarm & Fire-Fighting, STP / ETP and Water Treatment Systems.

- The Contractor shall provide prior notice and obtain all requisite approvals and service-shutdown permissions before commencement of dismantling works related to water supply, plumbing and sanitation, irrigation systems, fire-fighting, and fire alarm installations.
- All operational and pressurized connections shall be properly isolated, drained, and rendered safe prior to dismantling or removal of any pipelines, fixtures, fire-fighting equipment, or associated systems.
- All surface-mounted and concealed pipelines, including domestic water supply lines, irrigation networks, sprinkler and hydrant piping, valves, and accessories, shall be dismantled and removed in an orderly, controlled, and systematic manner.
- Pumps, pump rooms, sumps, tanks, valves, motors, control panels, MCBs, distribution boards (DBs), instruments, and all related electrical, mechanical, and control equipment forming part of water supply systems, fire-fighting installations, sewage treatment plants (STP), effluent treatment plants (ETP), and water treatment systems shall be dismantled as directed.
- Fire detection and alarm systems, including detectors, control panels, cabling, conduits, piping, and terminal devices, along with fire-fighting works, shall be dismantled carefully and in coordination with concerned statutory or local authorities wherever applicable.
- The Contractor shall make necessary arrangements for provision, diversion, or restoration of temporary or alternate service connections, wherever required, to ensure uninterrupted functioning of water supply, sanitation, fire-fighting services and STP / ETP, and Water Treatment Systems in non-demolished or occupied portions of the premises, to the satisfaction of the Engineer-in-Charge.

RCC and Civil Structure Demolition.

- The Contractor shall undertake demolition of all reinforced cement concrete (RCC) elements, including but not limited to slabs, beams, columns, shear walls, footings, pedestals, grade beams, foundations, and other associated structural components.
- Brick masonry works comprising load-bearing and non-load-bearing walls, internal partitions, façade elements, and ancillary masonry structures shall be carefully dismantled and removed.
- All doors, windows, ventilators, shutters, rolling shutters, gates, railings, grills, fencing, and associated fixtures and hardware shall be dismantled and cleared from the site.
- Fabricated structural steel works such as trusses, frames, staircases, sheds, platforms, and similar steel components shall be dismantled in a safe and controlled manner.
- Demolition shall be carried out using Jaw Crushing Technology or any other approved low-carbon and environmentally sustainable demolition techniques to minimize dust generation and support green building compliance.
- Demolition debris shall be segregated systematically into material categories such as concrete,

masonry, metals, timber, glass, and other materials to facilitate recycling and lawful disposal.

- All debris and waste shall be transported only to dumping yards authorized by the competent municipal authority, supported by valid challans, and complete documentary records of disposal shall be maintained.
- Hazardous waste and non-recyclable materials shall be disposed of strictly in accordance with applicable environmental, pollution control, and safety regulations.
- The Contractor shall maintain comprehensive records of waste generation, segregation, transportation, recycling, and disposal, and shall submit periodic reports to the Engineer-in-Charge.
- Demolition works shall be executed in planned phases to minimize disruption to nearby occupants, adjoining properties, and ongoing operations.
- The Contractor shall be entirely responsible for preventing damage to retained structures, equipment, utilities, or services and for ensuring safety of personnel; any damage or loss shall be made good or compensated as decided by the Engineer-in-Charge.
- All demolition activities shall be carried out strictly in accordance with the approved execution methodology, and progress reports shall be submitted as and when required.
- All underground structures and elements, including foundations, plinth beams, grade slabs, rafts, trenches, sumps, underground tanks, utility services, PCC, DPC, waterproofing systems, and pedestals, shall be demolished and removed by carrying out excavation to the required depth.
- Upon completion of demolition and removal of debris, all excavated areas shall be backfilled with approved quality murrum or equivalent material, compacted adequately to the required level, line, and density, as directed by the Engineer-in-Charge.

Salvage & Scrap Management.

- The Contractor shall implement an approved Scrap Buyback / Salvage Management system for all materials arising from demolition activities.
- The Contractor shall prepare and submit a detailed inventory of all salvageable materials, including structural steel, electrical fixtures, plumbing components, mechanical items, and other recoverable materials.
- The Contractor shall assess and estimate the potential value and cost recovery from reuse, recycling, or sale of salvaged materials and submit the same to the Client / Engineer-in-Charge.
- The Contractor shall coordinate with the Client to determine the method of disposal of salvaged materials, including buyback, auction, reuse in upcoming works, or other modes as directed.
- Handling, storage, transportation, and disposal of scrap and salvaged materials shall be carried out in compliance with all applicable environmental, municipal, and statutory regulations.
- The Contractor shall submit a detailed Salvage and Scrap Report indicating quantities, condition, valuation, financial recovery, and mode of disposal or reuse of all salvaged materials.
- All financial benefits arising from salvage shall be transparently accounted for and reflected in overall project cost optimisation, and the same shall be passed on to the Client in accordance with the contract provisions.
- The Contractor shall prepare and implement a Waste Segregation Plan for hazardous and non-hazardous materials and shall ensure safe handling, transportation, and disposal of hazardous waste such as asbestos, chemicals, or contaminated materials strictly as per statutory norms.

3.3 Post- Demolition Stage.

General Note.

- This section stipulates the responsibilities and obligations of the Contractor upon completion of demolition, chipping, surface preparation, and all related construction activities. The intent of these provisions is to ensure that the project site is handed over in a clean, safe, fully compliant, and fit-for-use condition, strictly in accordance with all applicable statutory provisions, safety regulations, and the directions of the Engineer-in-Charge.

- All works and actions described herein shall be deemed to form an integral part of the Scope of Work under the Contract. No separate or additional payment shall be admissible for carrying out these obligations, unless expressly provided for elsewhere in the Contract documents.
- The Contractor shall be deemed to have fully considered and included in its Bid Price all costs, expenses, risks, liabilities, and obligations associated with the implementation of the arrangements specified in this Section. All such costs shall be deemed to be included in the Contractor's quoted rates and shall form part of the Contractor's overheads and incidental expenses. No separate or additional payment, compensation, reimbursement, claim, or any other monetary consideration shall be admissible or payable by the Client on this account.

Site Clearance and Housekeeping.

- Upon completion of demolition and all associated works, the Contractor shall be responsible for the following:
  a) Removal from the site of all serviceable and unserviceable materials, surplus items, dismantled components, debris, dust, and waste generated during execution of the works.
  b) Thorough cleaning of the entire site to ensure it is free from construction residues, loose soil, sharp or hazardous objects, and any obstructions, leaving the area in a clean, safe, and orderly condition, to the satisfaction of the Engineer-in-Charge.

Scrap and Salvage Materials.

- Salvageable and scrap materials generated from demolition and dismantling works shall not be removed from the site until all debris, rubble, and waste arising from the concerned building or structure have been completely cleared and the site has been thoroughly cleaned.
- Removal of any salvage or scrap shall be permitted only after the site has been inspected and formally certified as clean and cleared by the Engineer-in-Charge.
- Ownership, custody, handling, and final disposal of all salvageable materials shall be strictly governed by the tender provisions and the directions issued by the Engineer-in-Charge from time to time.

Removal of Temporary Facilities and Equipment.

- Upon completion of the Works, the Contractor shall dismantle, remove, and clear from the site all temporary installations and facilities, including but not limited to:
  a) Temporary structures, site offices, sheds, barricades, scaffolding, ramps, access platforms, walkways, and similar installations
  b) Construction plants, machinery, tools, temporary electrical cables, pipelines, hoses, and utilities provided for execution of the Works.
- All dismantling and removal activities shall be carried out in a careful and controlled manner so as to prevent any damage to:
  a) Adjacent or retained buildings and structures.
  b) Existing services and utilities
  c) Roads, pavements, hardstanding, and other site infrastructure intended to remain in place.
- Any damage caused during such removal shall be made good by the Contractor at no additional cost to the Employer, to the satisfaction of the Engineer-in-Charge.

Site Levelling and Stabilization.

- Upon completion of site clearance activities, the Contractor shall carry out site levelling and stabilization works, including the following:
  a) Uniform levelling off the ground to the required lines, levels, and gradients as directed by the Engineer-in-Charge.

b) Filling of all depressions, excavated pits, voids, and low-lying areas arising from demolition or removal works, using approved and suitable fill material.

- The finished ground surface shall be:
  a) Properly compacted and adequately stabilized to achieve the required bearing capacity and surface integrity.
  b) Rendered safe and suitable for the movement of personnel, vehicles, and construction equipment.
  c) Prepared and handed over in a condition suitable either for safe site possession or for commencement of subsequent construction activities, as directed by the Engineer-in-Charge.

Disposal of Hazardous and Residual Materials.

- The Contractor shall identify, handle, and remove any hazardous or residual materials encountered during the execution of the Works, including but not limited to the following:
  a) Contaminated debris or waste materials.
  b) Oils, chemicals, paints, insulation materials, or similar substances.
  c) Any materials classified as hazardous in accordance with applicable environmental, safety, and pollution control regulations.
- The collection, handling, transportation, and disposal of such hazardous and residual materials shall be carried out:
  a) In strict conformity with all applicable statutory requirements, environmental laws, and local regulatory norms.
  b) Exclusively through authorized and licensed agencies approved by the competent statutory authorities.
- All documentation, manifests, permits, and disposal certificates related to hazardous waste management shall be maintained by the Contractor and submitted to the Engineer-in-Charge for verification as and when required.

Chipping / Demolition / Breaking Works (RCC / Plaster / Brick / Others).

- During the execution of chipping, breaking, and demolition activities, the Contractor shall ensure the following safety measures are strictly implemented:
  a) Provision of adequate guard rails, barricades, warning signage, and protective coverings to prevent accidental access and falling hazards.
  b) Continuous safeguarding of pedestrians, occupants, workmen, and adjoining properties, ensuring that all operations are carried out in a safe and controlled manner at all times.
- Debris Management
  a) All debris generated from chipping, breaking, and demolition works shall be stacked in an orderly manner within designated areas approved by the Engineer-in-Charge.
  b) Debris shall be removed without delay and transported to municipal or statutory-authority-approved dumping grounds in accordance with applicable regulations.
  c) Accumulation of debris shall not be permitted if it results in obstruction to movement, dust pollution, safety risks, or nuisance to surrounding areas.

Completion Certificate and No-Dues Submission

- Upon completion of the entire Scope of Work to the satisfaction of the Engineer-in-Charge, the Contractor shall furnish the following documents for record and final certification:
- A Completion Certificate confirming that all works have been executed satisfactorily in accordance with the Contract provisions, specifications, and approved drawings.
- A No-Claim Certificate affirming that the Contractor has no further financial or other claims whatsoever

against the Employer in respect of the executed works.

- A No-Dues Certificate obtained from all concerned statutory authorities, service providers, and agencies, as applicable.
- All relevant supporting records and compliance documentation, including but not limited to:
  a) Weighbridge slips for transportation and disposal of debris and waste.
  b) Construction and Demolition (C&D) waste disposal receipts from authorized facilities
  c) Air quality and noise level monitoring and compliance logs
  d) CCTV recordings of site activities, wherever stipulated in the Contract.
  e) Ambient Air Quality Index (AQI) monitoring reports
- Submission and acceptance of the above documents shall be a prerequisite for issuance of the final completion certificate and settlement of the final bill, in accordance with the terms of the Contract.

Final Payment

- The release of the final payment shall be subject to the following conditions:
  a) Final payment shall be processed only after the submission and acceptance of all required documents as specified under the relevant clauses of the Tender.
  b) The payment shall be made only upon due verification and certification of the completed works by the Engineer-in-Charge.
  c) Final settlement shall be contingent upon full compliance with all statutory requirements, contractual obligations, and clearance of any outstanding non-conformities, if any, to the satisfaction of the Engineer-in-Charge.
  d) No claim for additional payment, variation, or extension of time shall be admissible on account of any interpretation, misunderstanding, or deviation arising out of the above classification of Works.

3.4 Horticulture & Irrigation – Tree Transplantation Works.

General Note.

- All works and actions described herein shall be deemed to form an integral part of the Scope of Work under the Contract. No separate or additional payment shall be admissible for carrying out these obligations, unless expressly provided for elsewhere in the Contract documents.
- The Contractor shall be deemed to have fully considered and included in its Bid Price all costs, expenses, risks, liabilities, and obligations associated with the implementation of the arrangements specified in this Section. All such costs shall be deemed to be included in the Contractor's quoted rates and shall form part of the Contractor's overheads and incidental expenses. No separate or additional payment, compensation, reimbursement, claim, or any other monetary consideration shall be admissible or payable by the Client on this account.

Scope of Work Under the Purview of the Contractor

- Tree transplantation is a modern technique adopted to promote tree conservation while facilitating the execution of large-scale construction projects without resorting to tree felling. Accordingly, tree transplantation is proposed to minimize the loss of existing trees within the project area. The contractor/developer shall scientifically transplant all trees affected by the project that cannot be preserved on site, strictly in accordance with approved methodologies, best horticultural practices, and the permissions and approvals granted by Maharashtra Industrial Development Corporation (MIDC), and the respective statutory authority, as applicable.
- The contractor shall scientifically transplant a minimum of 80% of all trees affected as per project requirement that cannot be preserved on-site, as approved by the respective statutory Authority of the area. The Contractor shall execute complete tree transplantation works within the approved Master Plan area, on a lump-sum or item-rate basis, strictly in accordance with the BOQ, approved drawings, Technical Specifications, and the directions of the Engineer-in-Charge. All activities shall be carried

out under the supervision of qualified and experienced experts deployed by the Contractor.

- The scope of work includes detailed tree survey and assessment; selection of suitable trees based on health, size, species, and feasibility for transplantation; treatment of weak or infected trees; and treatment of all cut surfaces using approved pesticides and fungicides as per tree typology and age. The process shall follow a gradual methodology and typically require an adequate period to prepare a tree for relocation into a new living system. The scope also includes soil sampling and testing; preparation of transplant pits with necessary soil improvement, drainage, and root zone pH (alkaline/acidic) management; phased root pruning; and removal of underground obstructions, if encountered.
- The work further includes formation and packing of the root ball; crown and canopy pruning; scaffolding, lifting, transportation, replantation, alignment, and backfilling; and provision of temporary mechanical supports for stabilization. Post-transplant activities shall include application of fertilizers, watering, pest control, continuous monitoring during the adaptation period, periodic health assessment, post-transplant maintenance (minimum one year), and final removal of supports after successful establishment, ensuring complete and satisfactory execution of the tree transplantation works.

Contractor's Responsibility

- The Contractor shall be solely responsible for ensuring the safety and stability of trees during and after transplantation, protecting existing utilities and surrounding properties, and repairing any damage caused during execution at no extra cost to the Employer. If the survival rate of transplanted trees falls below 80% (eighty percent) during the minimum one-year maintenance period due to poor workmanship or non-compliance with specifications, the Contractor shall, at no additional cost, replace all failed or dead transplanted trees. Each such failure shall be made good through compensatory planting, carried out strictly in accordance with the guidelines, norms, and recommendations prescribed by the respective statutory authorities, as applicable.

Deviation Control

- The Contractor shall not deviate from the approved methodology, specifications, or execution procedures without prior written approval of the Engineer-in-Charge.

Payment Provisions & BOQ Linkage

- The quoted amount for Tree Transplantation Works shall be all-inclusive, covering all materials, labour, horticulture expert services, equipment, supervision, and coordination required for execution, with no entitlement to additional payment for any work implied under the Scope of Work, Technical Specifications, or the Contract unless expressly stated otherwise.

Contractor's Eligibility & Technical Capability

- Use proven and updated tree transplantation technologies capable of achieving a minimum 80% (eighty percent) survival rate, supported by one year of post-transplant maintenance.
- Demonstrate proven experience in executing large-scale tree transplantation works.
- Share and Submit details of the team, including names, roles, relevant experience, and qualifications of key experts such as arborists, horticulture specialists (holding a bachelor's degree (B.Sc.) in Horticulture), site supervisors, and equipment operators, for review and approval.
- Deploy trained and experienced personnel with adequate technical expertise and suitable tools, machinery, cranes, lifting systems, and transportation equipment for safe and professional execution.
- Execute all works in strict accordance with the approved Technical Specifications and the directions of the Engineer-in-Charge.
- Submit a detailed, project-specific Method Statement for approval prior to commencement, covering all stages from survey to post-transplant care.
- Remain fully responsible for the survival, health, and maintenance of all transplanted trees throughout

the minimum one-year maintenance period.

Completion Criteria & Survival Requirement

- Completion of tree transplantation works shall be deemed satisfactory only upon successful establishment, healthy growth, and survival of the transplanted trees. Minimum 80% (eighty percent) survival rate of transplanted trees, subject to one (01) year of post-transplantation maintenance.

Irrigation System for Transplanted Trees

- The Contractor shall be solely responsible for the planning, design, supply, installation, operation, and maintenance of a temporary and/or permanent irrigation system catering to all trees transplanted under the scope of the Project.
- The irrigation system shall be appropriately designed to suit site conditions and botanical requirements and shall comprise, but not be limited to, the following:
  a) Drip irrigation, ring irrigation, basin irrigation, or micro-sprinkler systems, as found suitable for the specific species and location of the transplanted trees.
  b) All necessary control valves, pipelines, fittings, emitters, and allied accessories.
  c) Water storage facilities, pumping arrangements, or connections to available water sources, wherever required.
- The frequency and quantity of irrigation shall be determined and regulated based on:
  a) Species-specific water requirements.
  b) Seasonal variations, including summer, monsoon, and winter conditions.
  c) Recommendations of qualified horticulture or arboriculture experts.
- The Contractor shall ensure effective operation and upkeep of the irrigation system to achieve the following:
  a) Prevention of water stress, moisture deficiency, or waterlogging of the root zones.
  b) Uniform and adequate distribution of water to the entire effective root spread.
  c) Periodic inspection, timely detection, and rectification of leakages, blockages, or system malfunctions.
- The entire cost towards design, materials, installation, water supply, operation, monitoring, and maintenance of the irrigation system for transplanted trees shall be deemed to be included in the Contractor's quoted rates, and no separate payment shall be made on this account.

Post-plantation / Post-Transplantation Maintenance

- The Contractor shall be responsible for carrying out comprehensive post-plantation and post-transplantation maintenance of all transplanted trees for a minimum period of one (01) year from the date of transplantation or for such extended period as may be specified in the Contract.
- The scope of maintenance shall include, but not be limited to, the following activities:
  a) Regular irrigation, watering schedules, and continuous monitoring of soil moisture levels
  b) Application of appropriate fertilizers, micronutrients, soil conditioners, and growth promoters as recommended by horticulture experts
  c) Mulching, soil loosening, and aeration to promote healthy root development.
  d) Preventive and corrective measures for pest infestation, diseases, and fungal infections.
  e) Periodic inspection of tree supports guy ropes, anchors, and stabilizing systems.
  f) Repair, replacement, or strengthening of damaged, loosened, or insufficient supports, stakes, or anchoring arrangements.
- The Contractor shall submit monthly tree health and maintenance reports to the Engineer-in-Charge,

detailing:

a) Overall visual condition and vitality of each tree

b) Leaf density, canopy development, and growth characteristics

c) Observed deficiencies, stress symptoms, or damages.

d) Corrective, preventive, and maintenance actions undertaken during the reporting period.

- In the event of poor health, decline, or mortality of any transplanted tree during the maintenance period, the Contractor shall immediately undertake remedial measures or replace the affected tree with a healthy specimen of equivalent size and species, entirely at the Contractor's own cost and risk.
- Final acceptance of the transplantation and maintenance works shall be accorded only upon successful completion of the stipulated maintenance period and achievement of the prescribed survival rate, to the full satisfaction of the Engineer-in-Charge.

3.5 Site Safety and Precautionary Measures

General Note.

- This section stipulates mandatory safety, health, environmental, and precautionary measures to be adhered to by the Contractor during execution of the works. The Contractor shall strictly comply with all safety codes, statutory regulations, tender provisions, instructions of the Engineer-in-Charge, and applicable local authority guidelines. The contractor has to make all the necessary provisions at site of all Safety measures described herein shall be deemed inclusive in the quoted rates, and no extra payment shall be admissible.
- The Contractor shall be deemed to have fully considered and included in its Bid Price all costs, expenses, risks, liabilities, and obligations associated with the implementation of the arrangements specified in this Section. All such costs shall be deemed to be included in the Contractor's quoted rates and shall form part of the Contractor's overheads and incidental expenses. No separate or additional payment, compensation, reimbursement, claim, or any other monetary consideration shall be admissible or payable by the Client on this account.

General Safety Obligations

- The Contractor shall comply with all safety provisions specified in the Tender documents and as directed by the Engineer-in-Charge.
- The Contractor shall provide, maintain, and enforce the use of adequate safety equipment including safety belts, helmets, shoes, gloves, goggles, and other Personal Protective Equipment (PPE) for all personnel at site.
- The Contractor shall take all necessary precautions against fire, electrical, mechanical, and environmental hazards.
- All safety arrangements shall be made at the Contractor's own cost, and the Contractor shall be solely responsible for any civil, criminal, or statutory liability arising out of unsafe practices.

Site Access, Housekeeping & Working Conditions

- Approaches to and exits from the premises shall be:

  a) Properly protected,

  b) Free from debris, materials, machinery, tools, and obstructions,

  c) Maintained clear at all times for unhindered movement.
- The site shall be maintained in a clean and orderly condition throughout execution.

Working at Heights & Falling Object Protection

- As work is involved at multiple heights and in all seasons, the Contractor shall:

a) Prevent falling of materials, tools, or debris from height,

b) Provide safety nets, toe boards, barricading, and intermediate platforms where required.

- No person shall be allowed to work or inspect any location at height without a properly secured safety harness or belt.

Personal Protective Equipment (PPE)

- All workers shall wear:

  a) Safety helmets and safety shoes bearing unique identification,

  b) Additional PPE as per activity risk.

- Visitors shall be provided safety helmets before entering the site.
- The Contractor shall always ensure strict enforcement and proper use of PPE.

First Aid & Emergency Preparedness

- A fully equipped First Aid Box shall be maintained at site and remain readily accessible at all times.
- Adequate measures for emergency response shall be maintained by the Contractor.

Scaffolding Safety

- Adequate, stable scaffolding shall be provided for all works that cannot be safely carried out from the ground or firm base.
- Scaffolding shall:

  a) Be independently supported and shall not rely on existing structures,

  b) Be properly braced, tied, and secured.

- Use of structural elements of the existing building for scaffolding support is strictly prohibited.

Electrical Safety

- All electrical installations and equipment shall be handled with due care.
- Rubber gloves, insulating mats, rubber footwear, and other protective equipment shall be used during live electrical works.
- Temporary electrical connections shall comply with safety norms and shall not pose hazard.

Demolition Safety Protocols

- The Contractor shall ensure the following prior to and during demolition works:

  a) Closure or protection of adjacent roads and open areas.

  b) De-energization of live electrical cables or equipment within work area.

  c) Measures to prevent fire, explosion, flooding, or overloading of structures.

  d) Provision and mandatory use of PPE as directed by Site Supervisor.

  e) Welders to be provided with protective eye shields.

  f) Stone breakers to be provided with goggles, protective clothing, and adequate working space.

  g) Sewers, manholes, and sumps to be ventilated for at least one hour prior to entry; such areas shall be barricaded and sign-posted.

Hoisting & Lifting Equipment Safety

- Hoisting machines and lifting gear shall:
  a) Be of sound construction, good quality, and well maintained,
  b) Have clearly marked safe working load (SWL).
- Ropes shall be free from defects and of adequate strength.
- Only certified operators above 21(twenty-one) years of age shall operate hoisting equipment.
- Machinery shall not be overloaded except during authorized testing.
- All moving and transmission parts shall be properly guarded to prevent accidents.

Responsibility for Completion

- Any item of work, material, service, or arrangement not specifically mentioned but necessary for safe and complete execution shall be deemed included in the scope of work and executed without extra cost within the stipulated time.

Coordination of Works

- The Contractor shall extend full coordination with all other agencies working on site, including electrical, firefighting, and interior contractors, to ensure safety and smooth execution.

Labour Safety & Welfare

- Employment of child labour below 18 years is strictly prohibited.
- Where female workers are employed, provision shall be made to safeguard accompanying children and keep them away from work zones.
- All labour shall wear helmets and safety shoes.
- All workmen shall be covered under Workmen's Compensation Act; any injury, accident, or fatality shall be the sole responsibility of the Contractor.

External Scaffolding & Hessian Covering

- External double scaffolding shall be properly braced, tied, and equipped with platforms, guard rails, safety nets, and PPE.
- No holes shall be made in external masonry.
- Stitched hessian cloth shall be tied to external faces of scaffolding to prevent flying debris.
- Ground-level fencing shall be provided to restrict third-party access.
- Any additional scaffolding arrangements required due to obstructions shall be included in quoted rates.

Window / Opening Protection

- All windows, doors, and openings shall be covered with securely fixed plywood or tin sheets.
- Adjacent equipment, furniture, fixtures, or fittings shall be removed or protected to prevent damage.

Propping & Shoring

- Propping and shoring shall follow approved sketches and consultant instructions.
- Steel adjustable props are preferred; timber props shall be of adequate section if used.
- Bracings, base plates, and wedges are mandatory and integral.
- Props shall remain in position until removal is permitted by consultant.

Defining Damaged Areas

- Doubtful areas shall be inspected and loose plaster/coatings removed.
- Sound concrete with deboned plaster shall be marked for replastering.
- Damaged concrete shall be demarcated for repairs as specified.

Mandatory Compliance with Air Pollution Mitigation Guidelines

- The Contractor shall strictly comply with all BMC, MPCB, CPCB, and Hon'ble Bombay High Court directives, including but not limited to:
  a) Mandatory barricade heights, tarpaulin/green-net coverage,
  b) Continuous water sprinkling and fogging,
  c) Ban on on-site crushing/hammering,
  d) Sensor-based AQI monitors and LED displays (if not available),
  e) Authorized C&D waste disposal only,
  f) CCTV installation (if not available),
  g) Vehicle controls including PUC, insurance, no overloading, tyre wash.
- Non-compliance shall result in stopping notices, sealing of site, and penalties at Contractor's cost.

Liability, non-Compliance & Termination

- The Contractor shall be solely liable for:
  a) Any environmental damage, safety breach, public nuisance, or third-party damage,
  b) Any penalties levied by statutory authorities.
- Repeated violations (more than two instances) may result in:
  a) Immediate termination of contract,
  b) Forfeiture of Performance Guarantee,
  c) Blacklisting / debarring.
- No claims or compensation shall be entertained.

Day & Night Work & Noise Control

- As the site is in a residential zone, the Contractor shall:
  a) Minimize noise, vibration, dust, light pollution,
  b) Obtain written statutory permissions for restricted-hour work.
- Contractors shall comply with CPCB, MPCB, and BMC noise regulations.
- Noise-generating activities shall be enclosed and controlled.

HSE Compliance

- Strict compliance with:
  a) IS 4130 (Demolition Safety),
  b) Relevant IS standards for scaffolding, PPE, lifting,
  c) BOCW Act & Maharashtra Rules,
  d) Workmen Compensation norms,

e) Client/PMC safety directives.

- Failure to comply shall result in immediate stoppage of work.

3.6 Inspection & Closure Report

- Upon completion of all demolition, dismantling, debris removal, and site clean-up activities, the Contractor shall arrange and conduct a final joint site inspection along with the Engineer-in-Charge. The purpose of this inspection shall be to verify and confirm that all works have been executed in full conformity with the approved drawings, scope of work, technical specifications, safety standards, and applicable statutory regulations. The inspection shall also ensure that the site has been cleared of all demolition debris and left in a safe, orderly, and acceptable condition.
- Subsequent to the joint inspection, the Contractor shall prepare and submit a Final Project Closure Report for review and approval by the Engineer-in-Charge. The closure report shall comprehensively document the completion of works and shall include, but not be limited to, the following:

  a) A detailed summary of demolition works executed, clearly outlining the scope, methodology adopted, and completion status.

  b) Complete waste management documentation, including C&D waste segregation details, transportation manifests, disposal logs, receipts, and certificates from authorized waste disposal or recycling facilities.

  c) Copies of all statutory approvals, permissions, NOCs, and clearances obtained from relevant authorities in connection with the demolition and site clearance works.

  d) Safety, health, and environmental compliance records, including compliance reports, air pollution monitoring data, dust and noise control measures, safety audits, and incident/accident reports (if any).
- In addition, the Contractor shall formally hand over all original statutory documents, approvals, test reports, compliance certificates, and relevant records to the Engineer-in-Charge as part of the project close-out process.
- The works shall be considered complete only after successful joint inspection, submission of the Final Project Closure Report, and written acceptance by the Engineer-in-Charge. Any observations or deficiencies identified during inspection shall be rectified by the Contractor promptly and at no additional cost to the Client, prior to issuance of final completion and closure certification.

3.7 References

a) Mumbai Air Pollution Mitigation Plan (MGC/A/1386 dated 13.03.2023),

b) BMC Circulars CHE/DP/214/GEN dated 15.09.2023,

c) MGC/F/1102 dated 25.10.2023,

d) CHE/DP/GEN/15831 dated 08.11.2024,

e) MGC/F/6526 dated 13.05.2025, and

f) the Hon’ble Bombay High Court’s Order dated 28.11.2025 in Suo Motu PIL No. 3 of 2023

g) BMC AIR Pollution Norms Add in SCC-26-03-2026 (1) - Sample BMC approval-

h) BMC Dy.Ch.E./B. P/8637/E. S 3Dec 2025.

i) BMC CHE/DP/214/GEN 15/09/2023

j) BMC MGC/F/6526 dated 13.05.2025.

k) BMC CH. e/dp/Gen/15831/dtd 8.11.2024

SCOPE OF WORK

STAGE 2: CONSTRUCTION OF NEW ENTERPRISES & SERVICES TOWER (NEST)-3

Stage 2: Construction of New Enterprises & Services Tower (NEST)-3.

Introduction

SEEPZ SEZ (Santacruz Electronics Export Processing Zone), Andheri MIDC, Mumbai is one of India's oldest and most prominent Special Economic Zones (SEZs). Located in Andheri East, Mumbai, within the MIDC (Maharashtra Industrial Development Corporation) area, it was established in 1973 to promote exports, attract investment, and generate employment.

Key highlights:

- Spread across approximately **110 acres** in Andheri East, Mumbai.
- Houses **IT/Software, Electronics, Engineering, and Gems & Jewellery** export-oriented companies.
- A major contributor to India's **gems and jewellery exports** and IT services exports.
- Offers excellent connectivity to **Chhatrapati Shivaji Maharaj International Airport**, Metro Rail, Western Express Highway, and other business districts of Mumbai.
- Provides world-class infrastructure and business-friendly facilities to support export-focused industries.

To expand the production and reach for more business opportunity, SEEPZ SEZ have introduced NEST 3 and Industrial Building Complex comprises of 3 Buildings have Ground Floor + 1 Basement + 2 Podiums + 10 Typical Floor, having all 3 buildings with height of approximately 65 meters. Project is located under SEEPZ premises near security Gate 1, Next to MEGA CFC Plot.

This Section comprising of 03 (three) towers simultaneously, each consisting of 01 (one) Basement Level, 01 (one) Ground Floor, 01 (one) Podium Level, and 10 (ten) Upper Floors / Storeys, including all associated civil, structural, architectural, MEPF, infrastructure, external development, testing, commissioning, statutory approvals, and ancillary works, whether specifically mentioned herein or not, as required for the complete and functional delivery of the Project, including but not limited to the following:

1.0 Scope of Works

- The Contractor shall carry out the following works, including all labour, materials, equipment, tools, consumables, supervision, testing, commissioning, scaffolding, transportation, quality control, and safety measures necessary and all ancillary activities required for the complete, satisfactory execution and operational in condition of the project.
- The Contractor shall be deemed to have fully considered and included in its Bid Price all costs, expenses, risks, liabilities, and obligations associated with the implementation of the arrangements specified in this Section. All such costs shall be deemed to be included in the Contractor’s quoted rates and shall form part of the Contractor’s overheads and incidental expenses. No separate or additional payment, compensation, reimbursement, claim, or any other monetary consideration shall be admissible or payable by the Client on this account.
- Since the project is targeted for IGBC Gold rating, appropriate proportion of recycled content wherever necessary needs to be considered in materials selection and green practices need to be integrated in execution methodology by the contractor. Documentary evidence should be submitted immediately as per instructions from Client/PMC.
- The Client / PMC shall be responsible for obtaining all required/applicable pre-construction statutory approvals such as Fire NOC (Provisional) -- MIDC / CFO / DFO, Fire NOC, MIDC Building Construction Approval – MIDC, Building Height Clearance -- DGCA / AAI, Environment Clearance – MOEF, Consent to Establish (CTE) -- Pollution Control Board, Power NOC – PWD, Flamingo Zone Approval (if applicable). The Contractor shall provide all necessary support during the approval process, including preparation and submission of required documents, attendance at meetings, coordination with concerned authorities, compliance-related assistance and coordination support to assist the Client throughout the approval process required for obtaining such approvals and clearances.

- The Contractor shall be solely responsible for obtaining and maintaining all statutory approvals, permissions, licenses, registrations, No Objection Certificates (NOCs), and clearances required for commencement of site operations from local bodies and other applicable authorities. This shall include, but not be limited to, royalties, compliance with labour laws and welfare legislations, Employees' State Insurance (ESIC), Provident Fund (PF), Workmen's Compensation, labour cess, local body taxes, pollution control (PUC) charges, transportation expenses, and all other statutory obligations applicable to the Works. All costs associated with the above shall be deemed to be included in the Contract Price, and no reimbursement, claim, compensation, or additional payment shall be payable to the Contractor under any circumstances.
- Consideration of all expenditures necessary for successful delivery of materials to site, including but not limited to shipping, customs clearance, insurance, inland transportation, loading, unloading, and compliance with package milestones as specified in the tender documents.
- The Contractor shall prepare and submit coordinated shop drawings as per the tender drawings and specification requirements. All engineering calculations associated with these components shall be provided to the satisfaction of the approving authority.
- Deployment of all required machinery and equipment for installation works, including gondolas, floor cranes, scaffolding, hoisting and staging systems, loading/unloading equipment, metal scaffolding, safety doors, barricades, and other necessary tools for his as well as scope of Nominated Contractors work.
- Application for and procurement of all statutory permissions and clearances from relevant government authorities required for execution of works at site.
- Submission of detailed installation procedures, QA/QC protocols, method statements, and design intent documentation, and adherence to approved methodologies during execution.
- The Contractor shall facilitate and make all necessary arrangements for third-party inspections and testing as may be required during the course of project execution. This shall include provision for official visit charges for up to four (4) representatives nominated by the Client, Project Management Consultant (PMC), or their designated authorities. Such visits may encompass, but shall not be limited to, the following activities:
- Selection and approval of samples and materials at quarry sites, showrooms, or other designated locations.
- Any other inspection, verification, or review activity as may be reasonably required or directed by the Client or PMC in connection with the scope of works
- Preparation, submission, and adherence to a detailed micro project schedule aligned with the overall project timeline, covering both the bidder’s scope and NC works.
- Submission of all process test reports, material test certificates, product guarantees, and warranties as per specification.
- Execution of on-site mock-ups and obtaining sample approvals for all applicable products in accordance with project specifications.
- Establishment, provision and its regular maintenance of temporary infrastructure works including internal roads motorable for all whether conditions, barricading, illumination in common areas, labour camps, batching plant facilities etc.
- Establishment and maintenance of construction power and water supply for his scope of works.
- Resolution of all snag items to the satisfaction of the Engineer-in-Charge prior to handover.
- Preparation and submission of final “as-built drawings” in both soft and hard copy formats.
- Execution of material certification processes required to achieve the desired Green Building rating.
- Completion of deep cleaning across all areas prior to final handover of the project.
- Submission of Fire rating certification as applicable.
- Operation and comprehensive maintenance of all MEP systems within the bidder’s scope, as per project requirements and during the Defect Liability Period as per the Service Level Agreement.

1.1 Civil works

Civil works shall include, but not be limited to, miscellaneous excavation, hard rock excavation and breaking, reinforced cement concrete (RCC) works, rubble soling, masonry, plastering, waterproofing, interior and exterior painting, and all associated works as per approved drawings, BOQ specifications, and instructions of the PMC/EIC. The scope shall also include demolition, breaking, modification, and repair of existing RCC and masonry structures as required by site conditions.

1.2 Interior works

Interior works shall include flooring, dado, wall cladding, basin counters, pantry counters, doors, windows, fabrication works, false ceilings, railings, signage, thermoplastic painting, and all other finishing works. All finishes and materials shall be approved by the Architect prior to execution.

1.3 Facade

Exterior ACP cladding, glass cladding, structural glazing, framing systems, and associated façade works shall be executed using Architect-approved systems, materials, and finishes. The completed façade shall comply with applicable IGBC Gold Rating requirements.

1.4 Miscellaneous Architectural Works

Miscellaneous works shall include rolling shutters, railings, loose furniture, reception counters/tables, and all other associated architectural works required for completion of the project.

1.5 Electrical works

Electrical works shall include, but not be limited to:

i) Intra Building Electrical Works

- Distribution Boards (DBs)
- Point wiring
- Lighting fixtures
- Switches and sockets
- Buzzers
- Protection systems
- Cables and cable tray work
- Lift area electrification
- Earthing and earth grid works
- Electrical panels
- Isolators
- Floor trunking works
- Internal lighting systems

ii) Infrastructure Electrical Works

- Fire Fighting Panel
- Plumbing Panels
- External Lighting Distribution Boards (LDB)
- DG Set with Synchronization Panel
- Distribution Boards
- Substation and Pump Room Panels
- Earthing System
- Cabling and Cable Trays
- Outdoor Lighting

- Solar Power System
- Façade Lighting
- Miscellaneous Electrical Works

Shop drawings shall be submitted and approved by the PMC/EIC prior to execution. The scope shall include all associated wiring, conduits, accessories, fixtures, finishing plates, supports, and other necessary components.

1.6 ELV Works

The scope shall include design coordination, supply, installation, testing, and commissioning of:

- Fire Alarm System
- Public Address System
- IP CCTV System
- Building Management System (BMS)

All shop drawings shall be approved by the PMC/EIC before commencement of work.

1.7 Plumbing works

Plumbing works shall include:

- Sanitary fixtures
- Water supply systems
- Drainage systems
- Municipal incoming water connection
- Structural plumbing works
- Pumps and associated equipment
- Rainwater Harvesting System
- OHT & UGT

Shop drawings and material specifications shall be submitted for approval prior to execution. The scope shall include all pipes, fittings, fixtures, valves, sealants, supports, testing, and commissioning.

1.8 Fire Fighting Works

Fire Fighting Works shall include:

- Fire Electrical Pumps
- Diesel Engine Driven Pumps
- Piping Network
- Valves
- End Line Strainers
- Butterfly Valves
- Non-Return Valves
- Hydrant Valves
- Sprinkler Systems
- Water Curtain System
- Panel Suppression System
- Fire Extinguishers
- Fire Fighting Accessories

The scope shall comprise complete supply, installation, testing, and commissioning as per approved Fire Fighting Drawings. Shop drawings shall be approved by the PMC/EIC before execution.

1.9 HVAC works

HVAC works shall include:

- VRV/VRF Systems
- DX High-Wall Units
- Air Handling Units (AHUs)
- Ventilation Fans
- Low Side Works
- Sheet Metal Ducting
- Insulation Works
- Refrigerant Piping
- Drain Piping
- Related Accessories

Shop drawings shall be submitted and approved by PMC/EIC before execution.

1.10 Associated Works

Any other associated civil, architectural, structural, electrical, ELV, plumbing, firefighting, HVAC, or related works required for successful completion of the project and instructed by the PMC/EIC shall be deemed part of the Contractor's scope.

The concrete used for the project shall be Ready-Mix Concrete (RMC) of approved design mix. Unless otherwise specified in the drawings and BOQ, the minimum grade shall preferably be M35 or higher.

The scope of work includes provision and maintenance of site offices, toilets, drinking water, construction water, electricity, welfare facilities, and all other temporary facilities for the Contractor's staff and labourers at no additional cost to the Client.

The Contractor shall execute all construction, finishing, furniture, fit-out, and MEPF works in accordance with project requirements, applicable statutory regulations, SEEPZ SEZ requirements, and approvals of the PMC.

The Contractor shall carry out the following works, including all labour, materials, equipment, tools, consumables, supervision, testing, commissioning, scaffolding, transportation, quality control, and safety measures necessary and all ancillary activities required for the complete, satisfactory execution and operational in condition of the project.

The Contractor shall be deemed to have fully considered and included in its Bid Price all costs, expenses, risks, liabilities, and obligations associated with the implementation of the arrangements specified in this Section. All such costs shall be deemed to be included in the Contractor’s quoted rates and shall form part of the Contractor’s overheads and incidental expenses. No separate or additional payment, compensation, reimbursement, claim, or any other monetary consideration shall be admissible or payable by the Client on this account.

Since the project is targeted for IGBC Gold rating, appropriate proportion of recycled content wherever necessary needs to be considered in materials selection and green practices need to be integrated in execution methodology by the contractor. Documentary evidence should be submitted immediately as per instructions from Client/PMC.

The Client / PMC shall be responsible for obtaining all required/applicable pre-construction statutory approvals such as Fire NOC (Provisional) -- MIDC / CFO / DFO, Fire NOC, MIDC Building Construction Approval – MIDC, Building Height Clearance -- DGCA / AAI, Environment Clearance – MOEF, Consent to

Establish (CTE) -- Pollution Control Board, Power NOC – PWD, Flamingo Zone Approval (if applicable). The Contractor shall provide all necessary support during the approval process, including preparation and submission of required documents, attendance at meetings, coordination with concerned authorities, compliance-related assistance and coordination support to assist the Client throughout the approval process required for obtaining such approvals and clearances.

The Contractor shall be solely responsible for obtaining and maintaining all statutory approvals, permissions, licenses, registrations, No Objection Certificates (NOCs), and clearances required for commencement of site oprations from local bodies and other applicable authorities. This shall include, but not be limited to, royalties, compliance with labour laws and welfare legislations, Employees' State Insurance (ESIC), Provident Fund (PF), Workmen's Compensation, labour cess, local body taxes, pollution control (PUC) charges, transportation expenses, and all other statutory obligations applicable to the Works. All costs associated with the above shall be deemed to be included in the Contract Price, and no reimbursement, claim, compensation, or additional payment shall be payable to the Contractor under any circumstances.

Consideration of all expenditures necessary for successful delivery of materials to site, including but not limited to shipping, customs clearance, insurance, inland transportation, loading, unloading, and compliance with package milestones as specified in the tender documents.

The Contractor shall prepare and submit coordinated shop drawings as per the tender drawings and specification requirements. All engineering calculations associated with these components shall be provided to the satisfaction of the approving authority.

Deployment of all required machinery and equipment for installation works, including gondolas, floor cranes, scaffolding, hoisting and staging systems, loading/unloading equipment, metal scaffolding, safety doors, barricades, and other necessary tools for his as well as scope of Nominated Contractors work.

Application for and procurement of all statutory permissions and clearances from relevant government authorities required for execution of works at site.

Submission of detailed installation procedures, QA/QC protocols, method statements, and design intent documentation, and adherence to approved methodologies during execution.

The Contractor shall facilitate and make all necessary arrangements for third-party inspections and testing as may be required during the course of project execution. This shall include provision for official visit charges for up to four (4) representatives nominated by the Client, Project Management Consultant (PMC), or their designated authorities. Such visits may encompass, but shall not be limited to, the following activities:

Selection and approval of samples and materials at quarry sites, showrooms, or other designated locations.

Any other inspection, verification, or review activity as may be reasonably required or directed by the Client or PMC in connection with the scope of works

Preparation, submission, and adherence to a detailed micro project schedule aligned with the overall project timeline, covering both the bidder’s scope and NC works.

Submission of all process test reports, material test certificates, product guarantees, and warranties as per specification.

Execution of on-site mock-ups and obtaining sample approvals for all applicable products in accordance with project specifications.

Establishment, provision and its regular maintenance of temporary infrastructure works including internal roads motorable for all whether conditions, barricading, illumination in common areas, labour camps, batching plant facilities etc.

Establishment and maintenance of construction power and water supply for his scope of works.

Resolution of all snag items to the satisfaction of the Engineer-in-Charge prior to handover.

Preparation and submission of final “as-built drawings” in both soft and hard copy formats.

Execution of material certification processes required to achieve the desired Green Building rating.

Completion of deep cleaning across all areas prior to final handover of the project.

Submission of Fire rating certification as applicable.

Operation and comprehensive maintenance of all MEP systems within the bidder’s scope, as per project requirements and during the Defect Liability Period as per the Service Level Agreement.

Civil, interior & Miscellaneous works shall comply with applicable IGBC Gold Rating requirements.

1.11 Site Levelling

The Contractor shall carry out site levelling, including filling, spreading, compacting, and grading using suitable earth available within the project premises, wherever feasible and directed by the PMC/EIC.

1.12 Time Schedule

Time shall be the essence of the Contract. The Contractor shall complete the works within the stipulated project duration. The Contractor shall visit the site and familiarize himself with the site conditions before submitting the bid.

1.13 Site Investigation

The Contractor shall study the soil investigation report, contour survey drawings, and all available site information and shall verify site conditions through a physical site visit before commencement of work.

1.14 Concrete Grade

The grade of concrete for RCC works shall be M30, M35, M40, or M45, as specified in the structural drawings and BOQ. The Contractor shall consider the same while quoting.

1.15 Complete Scope Responsibility

The Contractor's scope includes execution of all related works necessary for successful completion of the project as directed by the PMC/EIC. The scope shall include supply, transportation, unloading, storage, handling, labour, plant, machinery, tools, equipment, consumables, testing, and all other incidental requirements, unless specifically excluded.

1.16 Temporary Facilities

The Contractor shall provide and maintain temporary site offices, storage facilities, cranes, tools, tackles, machinery, and all necessary resources for safe and timely completion of the works. The quoted rates shall be deemed inclusive of such provisions.

1.17 Resource Mobilization

The Contractor shall deploy adequate manpower, equipment, and resources to ensure timely completion of the multi-storied office building project. Any local issues arising during execution shall be handled by the Contractor without impact to the project schedule.

1.18 Sanitation Facilities

The Contractor shall provide adequate sanitation and welfare facilities at site prior to commencement of work, in accordance with MIDC, IOD, OC, labour laws, and statutory requirements.

1.19 Key Personnel

The Contractor shall deploy qualified and experienced personnel, including:

- Planning Engineer

- Safety Officer
- Civil Engineer
- MEPF Engineer
- Civil Supervisors
- MEPF Supervisors

as specified in the tender documents.

1.20 Royalties and Taxes

All royalties, duties, cess, permits, fees, and statutory charges applicable to the works shall be borne by the Contractor. No additional payment shall be made by SEEPZ SEZ.

1.21 Approval of Finishing Materials

All finishing materials specified in the BOQ shall be submitted to PMC/EIC for review and approval before procurement and installation.

1.22 Planning and Reporting

Before commencement of work, the Contractor shall submit a detailed execution schedule in Primavera or MS Project, including resource deployment plans as specified under SCC.

The Contractor shall submit:

- Daily Progress Reports (DPR)
- Weekly Progress Reports (WPR)
- Monthly Progress Reports (MPR)

including manpower deployment, material consumption, achieved progress, planned progress, delays, recovery plans, and critical activities.

1.23 Material Testing

Materials specified in the BOQ and Technical Specifications may be subject to random testing for strength, thickness, fire rating, ductility, or any other relevant parameter based on submitted MTCs. Testing requirements shall be determined by PMC/EIC. No additional payment shall be made for such testing.

1.24 Material Approval

The Contractor shall submit material specifications, TDS, test certificates, required IGBC Gold approval certifications and relevant approvals for review and approval by PMC/EIC before use.

1.25 Shop Drawings

The Contractor shall thoroughly review all GFC drawings and site conditions and prepare detailed shop drawings for approval by the PMC, Consultant, Architect, and EIC before execution.

1.26 Sustainable Construction Practices

The Contractor shall adopt sustainable construction practices and comply with all directions of the PMC/EIC regarding:

- Solid waste management
- Air pollution control
- Water pollution control
- Material handling
- Site housekeeping
- Environmental protection measures

1.27 Material Storage

All materials shall be stored, protected, and handled in an organized manner. Suitable covered storage sheds shall be provided for different materials to prevent damage and deterioration.

1.28 Monsoon Consideration

Monsoon conditions shall be deemed to have been considered by the Contractor while planning the works and shall not constitute grounds for extension of time or claims for delay.

1.29 Measurement for Billing

All measurements submitted for billing shall be subject to verification and certification by the PMC/EIC prior to payment.

1.30 Mock-Up Requirements

The Contractor shall provide mock-ups of any item specified in the BOQ whenever requested by the Architect, PMC, or EIC. No additional payment shall be made for such mock-ups.

1.31 Inclusive Rates

The Contractor's quoted rates shall be deemed inclusive of all materials, labour, equipment, temporary works, overheads, taxes, duties, wastage, testing, and all requirements necessary for complete execution of the works. No additional claims shall be entertained on account of increased execution costs.

1.32 Material Delivery Intimation

Prior to delivery of materials to site, the Contractor shall provide details of approved materials, quantity, make, Technical Data Sheets (TDS), and vehicle information for inspection and record purposes.

1.33 Delay and Liquidated Damages

The Contractor shall complete the works within the stipulated timeline. In case of delay attributable to the Contractor, Liquidated Damages (LD) shall be levied as per the provisions of the tender document.

1.34 Aluminium Formwork

For RCC columns, the Contractor shall use aluminium formwork or equivalent approved system formwork to ensure dimensional accuracy, alignment, surface finish, and durability.

1.35 Formwork Availability

The Contractor shall maintain formwork inventory equivalent to a minimum of 1.8 times the area of a typical floor slab to facilitate timely construction cycles.

1.36 Statutory Approvals, NOCs and Certifications

The Contractor shall be solely responsible for obtaining, coordinating, complying with, and securing all statutory approvals, clearances, certifications, and NOCs required for completion and occupancy of the project, including but not limited to:

a) Lift NOC

b) Fire NOC

c) Water Connection NOC

d) Electrical NOC

e) IGBC Gold Certification

f) Drainage NOC

g) Completion Certificate (CC) and Occupancy Certificate (OC)

h) Tree Authority NOC

i) Any other approval, certification, clearance, or compliance required by statutory authorities, local bodies, utility agencies, SEEPZ SEZ authorities, or Government departments.

All costs, fees, documentation, Liasioning, inspections, and compliance requirements associated with these approvals shall be borne by the Contractor and deemed included in the Contract Price

1.37 Contractor should carry out additional soil test survey before execution for execution methodology and works to carry out on time which is non payable from Client.

1.38 Excavated pit should be dewatered will be responsible of contractor. Dewatering will not be paid extra it should come under site maintenance.

2. SPECIAL CONDITIONS OF CONTRACT:

Please note that "Scope of Work" will be read along with the 'Special Conditions' of this contract. Contractor shall be required to abide by the conditions stated in General terms & conditions attached.

Prior to quote for the job, the vendor will be required to visit the site & clarify all the doubts (if any) from SEEPZ SEZ / PMC. Otherwise, it will be presumed that the party has understood the scope of work in all respect.

3. FIRE & SAFETY REGULATIONS

The work shall be carried out in a safe manner as per Fire& Safety Rules & Regulations. Work permit condition shall be scrupulously followed.

Contractor shall arrange all required safety gadgets like safety helmet, safety Belt, safety shoes, Gloves, Goggles, Fire hoses, Fire Extinguishers, etc. for their workmen, site team, to execute the job as per permit conditions.

All Equipment and tools to be used at site shall accompany valid Test Certificates. For Cranes contractor shall arrange the Third party inspection including load test at site before starting the activities without any extra cost to SEEPZ SEZ. Contractor shall maintain a record of all equipment and tools being used at site with their identifications numbers and test certificates in a separate file.

Contractor shall arrange for temporary lighting inside the plot area wherever required without any extra cost to SEEPZ SEZ. If flameproof light fittings are required to be used as per work permit conditions the same shall be provided by SEEPZ SEZ on returnable basis. Contractor shall arrange all other necessary materials such as cables, ELCBs, etc. and carryout all necessary works as per requirement without any extra cost. Scaffolding will be as per SEEPZ SEZ standards. As far as practicable the danger zone around the work area should be adequately fenced off and sign painted.

Safety regulations and sign boards shall be installed throughout the site. TBT shall be performed regularly.

4. MOBILIZATION FOR WORK.

As mentioned in tender document.

5. SCOPE OFSUPPLY:

BY SEEPZ SEZ (free issue): NIL

BY SEEPZ SEZ (Chargeable): The contractor shall make his own arrangement for water and power supply (Electrical) for construction as well as drinking purposes. However The SEEPZ SEZ may provide these facilities on chargeable basis as per actual cost incurred. Vendor has made all accessory arrangements and put meter for recovery.

BY CONTRACTOR

All materials tools, tackle, machinery equipment etc. required for construction including materials i.e. AAC block, tiles, paint colour, cement, sand, pipes, ducting sheet, sanitary fixtures, plumbing assembly, wood, ply, finishing materials, ACP, glass & any other materials to complete the work in all respect as per scope of work & as specified in BOQ & TS.

Water & electricity /power required for execution, will be provided by vendor including all requirement of facilities for their workmen/ supervisors/ engineer. if available on chargeable basis.

All equipment like JCB, crane, trailer, truck, DG set construction crane & any other equipment to complete the work in all respect as per scope of work.

Transportation of all type of materials required for the job in & outside SEEPZ SEZ premises in contractor's scope.

6. SPECIAL CONDITIONS OF CONTRACT

NO EXTRA shall be paid for complying with and/or implementation of any of the below listed clauses

6.1 The Contractor shall install a 'Display Board' at the conspicuous place on site indicating:-

i) Name & address of developer, architect, structural engineer and contractor.

ii) Building name, Zone, Road etc.

iii) Date and No. of development permission.

iv) Approved FSI/Built-up area, no. of buildings and floors permitted.

6.2 The contractor shall have to carry out and submit Fire Audit before applying for plinth completion certificate and shall obtain and submit final Fire NOC from Fire Officer before applying for Occupancy Certificate. The contractor shall provide at his own cost all firefighting requirement along with necessary accessories as prescribed in National Building Code and as per Fire Officer/Fire Advisor's remarks, as applicable.

6.3 The Contractor shall follow all the Energy Conservation Building Code (ECBC) norms.

6.4 CONTRACTOR shall assist Client (SEEPZ SEZ) / Architects / PMC to obtain and submit final NOC from all the other relevant Authorities as applicable before applying for Occupancy Certificate of the building, as applicable;

6.5 The contractor should not cut / removed/ transplant any tree without local authority permission.

6.6 Contractor is required to submit Shop Drawings & as Built Drawings: Building Information Modelling in REVIT format for MEPF and interior works; No Extra shall be paid for this, as applicable;

6.7 Contractor is required to construct building incompliance with as per MIDC, Mumbai approved drawings.

6.8 The contractor shall comply with SEEPZ SEZ HSSE guideline.

7. IGBC Gold Certification – Construction Stage Requirements

The Contractor shall be solely responsible for implementing, maintaining, monitoring, documenting, and demonstrating compliance with all applicable IGBC Gold Rating requirements during the construction stage. The Contractor shall coordinate with the PMC, Client, Architect, and IGBC Consultant and provide all supporting documents, records, photographs, test reports, certificates, and compliance reports required for obtaining IGBC Gold Certification. No additional payment shall be made for compliance with these requirements unless specifically stated otherwise in the Contract.

7.1 Protection and Preservation of Existing Vegetation

The Contractor shall protect and preserve all existing trees, shrubs, ground cover, and other vegetation within and adjacent to the project site throughout the construction period.

a) A detailed tree and vegetation survey shall be conducted and documented prior to commencement of any construction activity.

b) All existing trees and vegetation shall be clearly identified and marked on the approved site survey and construction drawings.

c) Adequate protective fencing, barricading, and safeguarding measures shall be provided around all trees and protected vegetation to prevent damage from construction activities, equipment movement, material storage, or excavation.

d) No unauthorized cutting, uprooting, pruning, or disturbance of existing vegetation shall be permitted.

e) In the event of removal of trees approved by statutory authorities, compensatory plantation shall be carried out at a minimum ratio of 1:4 (one tree removed to four trees planted) or as required by local regulations, whichever is more stringent.

f) Documentation including photographs before, during, and after construction shall be maintained and submitted to the PMC/IGBC Consultant.

7.2 Construction Water Conservation

The Contractor shall adopt measures to reduce potable water consumption during construction activities.

a) Low-water-consumption curing techniques, curing compounds, membrane curing systems, recycled water, ponding alternatives, or equivalent approved methods shall be utilized wherever feasible.

b) Water consumption records shall be maintained and submitted periodically.

c) Water-efficient construction practices shall be implemented to minimize wastage.

7.3 Use of Recycled and Sustainable Building Materials

The Contractor shall ensure incorporation of recycled-content materials and BIS-approved industrial by-products in accordance with IGBC requirements.

The following minimum requirements shall be achieved:

a) Structural Concrete

- Minimum 25% replacement of Ordinary Portland Cement (OPC) with fly ash, GGBS, silica fume, or other BIS-approved supplementary cementitious materials, by weight of cementitious content.

b) Masonry Units

- Minimum 40% recycled/waste material content by volume in AAC blocks, fly ash bricks, concrete blocks, or other approved masonry products used for both load-bearing and non-load-bearing walls.

c) Mortar and Plaster

- Minimum 25% replacement of OPC with fly ash or other BIS-approved waste materials in masonry mortar and plaster works.

d) Supporting documentation including technical data sheets, manufacturers' declarations, material test certificates, purchase orders, invoices, and approved mix designs shall be maintained and submitted for certification purposes.

7.4 Air Pollution Prevention and Dust Control

The Contractor shall implement adequate measures to control air pollution and minimize dust generation throughout the project duration.

The following minimum measures shall be maintained:

a) Wheel-washing facilities shall be provided at all site entry and exit points.

b) Fine aggregates, loose soil, excavated earth, debris, and dust-generating materials shall be covered using geotextile sheets, tarpaulins, or equivalent protective covers.

c) Regular water sprinkling shall be carried out on roads, stockpiles, excavation areas, and dusty surfaces.

d) Vehicle movement shall be controlled to minimize dust generation.

e) Diesel Generator Sets shall be equipped with approved chimney stacks complying with applicable pollution control norms and positioned to minimize environmental impact.

f) Open burning of construction waste shall be strictly prohibited.

g) Records and photographic evidence of dust-control measures shall be maintained.

7.5 Compliance with National Building Code

The Contractor shall comply with all relevant provisions of the latest applicable National Building Code (NBC), including but not limited to:

- Volume I – General Development Control Rules and General Building Requirements.
- Applicable statutory regulations and local authority requirements.

Any amendments issued during the Contract period shall also be complied with.

7.6 Construction Safety and Worker Welfare

The Contractor shall comply with all statutory safety requirements, labour regulations, NBC provisions, and IGBC construction-stage safety requirements.

The following measures shall be implemented throughout the project duration:

a) Personal Protective Equipment (PPE)

Mandatory provision and use of:

- Safety helmets

- Safety shoes
- Safety jackets
- Protective gloves
- Dust masks/respirators
- Safety goggles
- Full-body safety harnesses

for all workers, engineers, supervisors, visitors, and site personnel.

b) Safety Nets and Fall Protection

Safety nets, guardrails, lifelines, edge protection systems, and fall-arrest arrangements shall be installed wherever required.

c) Safety Training

Regular induction programs, toolbox talks, awareness sessions, and safety training workshops shall be conducted and documented.

d) Labour Accommodation

Where labour accommodation is provided, it shall comply with statutory and welfare requirements and include:

- Proper ventilation
- Adequate daylight
- Clean drinking water
- Sanitation facilities
- Fire safety measures
- Waste collection systems

e) Drinking Water

Safe drinking water facilities shall be provided throughout the project.

Monthly water quality testing shall be carried out and records maintained.

f) Sanitation Facilities

Separate toilet and bathing facilities shall be provided for male and female workers and maintained in hygienic condition at all times.

g) Worker Welfare Facilities

Where applicable, welfare facilities including crèche/day-care facilities, rest shelters, dining facilities, and first-aid services shall be provided in accordance with statutory requirements.

h) Housekeeping

Waste collection bins shall be located throughout the site and labour camp to ensure a clean and hygienic environment.

i) First Aid and Emergency Response

A fully equipped first-aid room and emergency response system shall be established and maintained throughout the construction period.

7.7 Soil Erosion and Sedimentation Control Plan

Prior to commencement of construction activities, the Contractor shall prepare and submit a Soil Erosion and Sedimentation Control Plan for review and approval by the PMC and IGBC Consultant.

The plan shall include:

a) Sedimentation basins, silt traps, check dams, and runoff control systems sized appropriately for the site.

b) Temporary and permanent drainage measures.

c) Temporary seeding and mulching.

d) Geotextile barriers and erosion-control blankets.

e) Construction staging and grading plans.

f) Procedures for maintenance and monitoring of erosion-control measures throughout the construction period.

7.8 Monsoon Excavation Management

Excavation activities shall be minimized during the monsoon season wherever practicable in order to reduce soil erosion and sediment migration.

Where excavation during monsoon is unavoidable, appropriate slope stabilization, shoring, dewatering, silt-control, and erosion-prevention measures shall be implemented.

7.9 Construction Activity, Storage and Waste Management Plan

Before commencement of work, the Contractor shall prepare and obtain approval for a detailed Construction Management Plan covering the following:

a) Construction Activity Zones

Clearly demarcated construction work zones restricted to approved site areas.

b) Material Storage Areas

Dedicated material storage areas with proper containment measures to prevent contamination, spillage, and wastage.

c) Hazardous Material Management

Measures for handling, storage, containment, spill management, transportation, and disposal of hazardous substances including:

- Paints
- Solvents
- Fuels
- Adhesives
- Petroleum products
- Cleaning chemicals

d) Construction Waste Management

Separate collection, segregation, storage, recycling, reuse, and disposal of:

- Concrete waste
- Metal scrap
- Plastic waste
- Wood waste
- Packaging materials
- Hazardous waste

through authorized recyclers and disposal agencies.

e) Vehicular Movement Plan

Traffic management and logistics plans to minimize dust generation, congestion, and environmental impacts.

7.10 Sustainability Documentation and Photographic Records

The Contractor shall maintain comprehensive records of all sustainability, environmental, waste management, resource conservation, worker welfare, and safety initiatives implemented at site.

Activity-wise photographic records shall be maintained throughout all stages of construction and submitted periodically to the PMC/IGBC Consultant.

7.11 Mandatory Testing and Monitoring Requirements

The Contractor shall conduct the following tests through NABL-accredited or other approved laboratories and maintain complete records for IGBC documentation:

Water Quality Testing

a) Drinking Water Quality Test Report Frequency: Monthly

b) Construction Water Quality Test Report Frequency: Every six (6) months throughout the construction period.

Environmental Monitoring

a) Ambient Air Quality Monitoring Report Frequency: Every six (6) months throughout the construction period.

b) Construction Noise Monitoring Report (Outdoor) Frequency: Every six (6) months throughout the construction period.

Sustainable Material Verification

a) Fly Ash / Supplementary Cementitious Material Content Verification in Concrete Frequency: As per each approved mix design and batch records.

b) Recycled Content Verification in AAC Blocks / Fly Ash Bricks / Masonry Materials Frequency: For each procurement batch through manufacturer certification and test reports.

Soil Testing

a) Topsoil Fertility Test Report

- To be conducted before commencement of excavation.
- Minimum two (2) representative locations within the site.
- Testing shall be carried out through an ICAR-accredited or equivalent approved laboratory.

All testing records, reports, compliance documents, calculations, certificates, and supporting evidence shall be maintained by the Contractor and submitted to the PMC, Client, and IGBC Consultant as and when required for certification documentation.

7.12 IGBC Documentation Responsibility

The Contractor shall provide all documentation required for IGBC Gold Certification, including but not limited to material invoices, purchase orders, manufacturer declarations, recycled-content certificates, environmental monitoring reports, waste disposal manifests, photographs, water consumption records, training records, and compliance statements. Failure to maintain required documentation shall not relieve the Contractor of its responsibility to achieve compliance with applicable IGBC construction-stage requirements

8. Ordered of preference - In case of contradiction between relevant Indian standards, GCC, SCC, Specifications, Drawings and Schedule of Rates/Prices, the following shall prevail in order of precedence:

a) Detailed Purchase Order along with Statement of Agreed Variations, if any, and its Enclosures such as Schedule of Rates/Prices etc.

b) Letter of Acceptance (FOA)

c) Special Conditions of Contract & its Annexure

d) Job Specifications / Technical Specifications

e) Drawings

f) General Conditions of Contract

g) Indian Standards

Any ambiguity in technical specifications shall be brought to the notice of EIC before quoting for the job. After award of the job, for ambiguity in technical specifications stringent technical conditions will super cede and decision of engineer in charge will be final.

9. **Completion time -** The overall contractual completion period shall be 27 Months from the date of LOA or Purchase Order whichever is earlier.

10. **LD clause-** As per SCC / GCC / Tender Document

11. **Defect liability clause-** The Defect liability period shall be minimum 24 months from the actual completion of work / as mentioned in tender documents.

12. **PREAMBLE**

Note: This Document Shall Form Part & Parcel of the BOQ & Tender Documents – it is important to read this document, and it shall be deemed that contractor having signed the agreement has read this Preamble

12.1 All Items are deemed to be completed in all respects - Contractor to quote for any factor, which, as per him seems missing, in the specification, for him to complete the item, in all respects

12.2 It shall be part of contractor's scope to submit all Detailed Working/Shop Drawings for work as per scope, based on the architectural, MEPF and interior fitouts drawings, good for Construction.

12.3 In continuation to the above, if the contractor needs to appoint any external consultants for the understanding, review, up gradation and/or modification of the works / details, the same shall be at his risk and cost and the fees for the same shall not be payable

extra, in any way;

12.4 Post completion of work, the Contractor shall prepare the 'As Built Drawings' and submit to the Architect for review & certification, for the Employer's good record – these drawings shall be as per actual work done at site, duly drafted in CAD soft copy & Hard Copy prints

12.5 A very high standard of quality in work shall be maintained in this project for long term durability. Special care shall be taken to eliminate the use of In-appropriate materials & Poor construction practices.

12.6 If any issues/ mistakes are observed at any part of contractor's scope work, the part shall be isolated and dismantled to be rebuilt/ re-fixed to acceptable standards. The decision of the Architect/ Owner shall be final and binding in such case.

12.7 The BOQ shall be read in conjunction with the technical specification and the drawings/ notes, made available with the tender documents.

12.8 Notwithstanding any limits in the wording of the individual items and or the explanations in this preamble, it is to be clearly understood by the tenderer that the rates and sums which he enters in the Bill of Quantities are to be for the work finished complete, in every respect, including wastage of material and labour on any account, tools, temporary work, carriage, all tests as specified or required etc. and deemed to have taken full account of all requirements and obligations, whether expressed or implied, covered by all parts of this contract and to have priced the items herein accordingly, Rates should

also include all taxes applicable such as factory, works contract tax etc. Excluding GST

12.9 Rates and prices set against items are to be the all-inclusive value of the finished work shown on the Drawings and/or described in the Specifications or which can reasonably be inferred there from and are to cover the cost of provision of plant, labour, supervision, materials, erection, insurance, maintenance, overheads and profits and every incidental and contingent cost whatsoever and all the Contractor's obligations under the Contract and all matters and things necessary for the proper completion and maintenance of the works.

12.10 The Specifications are intended to cover the supply of material and execution of all work necessary to complete the works. Should there be any details of construction of material which have been referred to in the Specifications or in the Bill of Quantities and Drawings, the necessity for which may reasonably be implied or inferred there from, or which are usual or essential to the completion of all works in all trades, the same shall be deemed to be included In the rates and prices named by the Contractor in the Bill of Quantities.

13. Mode of Measurement: Unless otherwise mentioned in the description of the item or specification, the mode of measurement as per the provision of IS 1200 shall be applicable.

TECHNICAL SPECIFICATION

STAGE 1: DEMOLITION OF THE EXISTING GROUND + 03 RCC STRUCTURE OF SDF 01, SUB-STATION, AND CANTEEN BUILDING AND ASSOCIATED ALLIED WORKS

B. Technical Specification.

Stage 1: "Demolition of the Existing Ground + 03 RCC Structure of SDF 01, Sub-station, and Canteen Building and Associated Allied Works".

1. Specification for DSR Items.

The work shall be executed strictly in accordance with CPWD Specifications, Volume I & II (latest edition), including all latest amendments. In the event of any discrepancy, the relevant provisions of the Bureau of Indian Standards (BIS) shall prevail. For any items not covered under the above specifications, the decision of the Engineer-in-Charge shall be final and binding.

Link for CPWD Specifications: https://cpwd.gov.in/Documents/cpwd_publication.aspx

2. Specification for Non DSR Items.

All works covered under these Non-Schedule Items shall be executed strictly in accordance with:

i) CPWD Specifications (Vol. I & Vol. II – latest editions)

ii) CPWD Safety Code and Manual on Safety, Health & Environment

iii) IS 4130: Safety Code for Demolition of Buildings

iv) IS 6922 and DIN 4150: Criteria for evaluation of vibration in buildings.

v) DGMS and CMRI-based guidelines if precision machinery or sensitive instruments are present in adjacent building.

vi) CPCB & MPCB guidelines for Air and Noise Pollution Control

vii) MoEF & CC notifications, Environment (Protection) Act, 1986

viii) Noise Pollution (Regulation & Control) Rules, 2000

ix) All applicable labour laws, local authority by-laws, and statutory requirements of MCGM (BMC)/ MIDC / SEEPZ-SEZ Authority

These clauses form an integral part of the BOQ technical specifications and shall be complied with in totality.

The Client shall be fully responsible for obtaining all statutory approvals, clearances, NOCs, consents, and permissions required for the demolition and construction of the residential buildings under this contract. This shall include, but not be limited to, the following:

a) All statutory payments, fees, and government charges required for obtaining approvals from the concerned authorities shall be borne by SEEPZ-SEZ Authority; however, all coordination, document preparation, submission, Liasioning, and follow-up activities shall be the sole responsibility of the Contractor until the necessary approvals are secured.

b) Tree cutting permission.

All statutory payments, fees, levies, and government charges required for obtaining approvals, clearances, and permissions from the concerned authorities shall be borne entirely by the Contractor. The Contractor shall be solely responsible for all coordination, preparation of documents, submission of applications, Liasioning with authorities, and follow-up activities until the requisite approvals are duly secured. The Contractor shall ensure that all such activities are carried out in compliance with applicable laws, rules, and regulations, without causing delay to the progress of works under this Contract.

All mitigation measures, monitoring, penalties, repairs, and consequences for non-compliance shall be deemed included in the quoted rates and no extra payment shall be made.

Any damage to adjoining buildings, underground/overhead utilities, pavements, roads, or public/private property due to demolition, vibration, dust, or negligence shall be made good by the Contractor at his own risk and cost.

A. Comprehensive Demolition, Dismantling, and Disposal of Old RCC and Steel Structure:

1.1 Scope:

a) Comprehensive demolition, dismantling, and removal of the entire existing RCC and structural steel building including foundations, slabs, beams, columns, brick masonry, PCC, doors, windows, flooring, roofing, finishes, plumbing, electrical and mechanical installations, fixtures, utilities, tanks, staircases, underground structures and services and all appurtenant structures at any height or depth above and below ground.

b) Excavation & Demolition of Underground Structures and Services: Demolition and removal of all underground structures and services including UGTs, STPs, sumps, chambers, pipelines, cables, ducts, foundations, drains, and abandoned services.

Execution & Backfilling

i) Controlled excavation with shoring, dewatering, barricading, and confined space safety.

ii) Filling and levelling of excavated areas up to Finished Ground Level (FGL) without compaction, unless otherwise directed.

c) This point covers the procedure and safety requirements for demolition and dismantling of masonry (Brick & Stone), concrete (Plain /Reinforced) and structural steel works which are not covered under CPWD Specification.

d) Safety documentation of Demolition equipment with Third party Inspection, Insurance, operator license as per acts, laws and regulations of all applicable statutory authorities like BMC, SEZ, CPWD etc. is mandatory and should be submitted to Client/Engineer-In-Charge.

1.2 General:

a) Apart from this specification, the demolition and dismantling of structures (part or whole) shall follow all statutory safety regulations, Health Safety & Environment (HSE) policy of Client and any other special requirement as shown/noted on the drawings and tender specifications. Prior consent and approval of the Client / Engineer-in-charge shall be obtained in writing before starting any dismantling works. Any restrictions imposed regarding noise level, dust control working hours shall also be strictly followed by the Contractor.

b) All materials recovered from dismantling / demolition work arising from the demolition shall become the property of the Client and Contractor shall pass rebate of all material though the Demolition rate to the Client.

c) Where it becomes necessary to disconnect any existing service line(s) (such as electrical, piping etc.) during dismantling/demolishing work and if advised by the Engineer-in- charge, suitable alternate arrangement shall be made by the Contractor to maintain the continuity and proper functioning of the affected service line(s) with the approval of the Engineer-in-charge at no extra cost to the Client.

d) The dismantling and demolition work shall also comply to IS 4130-1991- Demolition of Buildings – Code of Safety.

e) Checking Safety and stability of adjacent structures before start of Demolition and during the demolition. Continuous Documentation and submission of Safety and stability of adjacent structures during entire demolition period as per recommendation of Engineer-In-Charge is mandatory.

f) Underground and Above ground utilities and services to be checked and Documentation to be submitted to Engineer-In-Charge before demolition.

g) All utilities and services to be disconnected and written approval of Engineer-In-Charge to be taken before starting demolition.

1.3 Methodology & Safety Precautions.

a) Demolition shall be carried out only by top-down controlled/mechanical methods; blasting is strictly prohibited.

b) Debris generated during demolition shall be removed in a controlled manner. Throwing or free-fall dumping of debris from height is strictly prohibited. Debris shall be lowered safely by manual handling or approved mechanical means, ensuring compliance with CPWD General Specifications, BMC environmental norms, and all statutory safety regulations.

c) Demolition sequence and methodology along with structural stability analysis shall be submitted and

approved by the Engineer in Charge before commencement.

d) Adequate scaffolding, shoring, propping, bracing, barricading, and temporary protection works shall be provided as per CPWD Safety Code and IS standards.

e) The Contractor shall adhere to safe demolishing/dismantling practices at all stages of work to guard against accidents, hazardous and unsafe working procedures.

f) Necessary propping, shoring, strutting and/or underpinning shall be done for the safety of all surrounding structures (whose safety is likely to be endangered) before taking up the demolishing and dismantling work.

g) Temporary enclosures made from good GI or other sheeting, fencings, danger lights etc. shall be provided by the Contractor and got approved by the CLIENT / Engineer-in-charge before start of work to prevent accidents.

h) Contractor must ensure the availability of adequate first aid and fire-fighting equipment / arrangements before starting actual demolishing/dismantling work. These facilities shall be made available throughout the entire operation of demolition and dismantling of structures.

i) All equipment, pipes, fittings and instruments, underground utilities etc. located in the vicinity shall be protected by suitable means, as decided by the Engineer-in-charge, during demolishing, dismantling operations.

j) Roads and working spaces shall be kept free of any debris/dismantled materials at the end of day's work.

k) Necessary measures shall be taken to keep the dust, debris, and noise nuisance to minimum level i.e., not exceeding 85dB.

l) Dismantled elements/components shall not be dropped from a height or thrown from a distance and chutes; pulley buckets and other similar material handling equipment shall be used.

m) Dismantling of elements fixed by screws/bolts/hooks etc. shall be done by taking out the fixtures with proper tools only. Such fixtures may be allowed to be cut by sawing or flame cutting, in the event of their being stuck-up due to corrosion etc. However, the decision of Engineer-in-charge in this regard shall be final and binding. Welds shall be removed by flame cutting. Tearing or ripping of elements shall not be resorted to under any condition.

n) During dismantling of part of structure, careful observation shall be made of the balance part of structure to be retained to notice any uncalled-for deformation noticed. In such case demolition work shall be stopped immediately after securing loose/ dismantled parts and Engineer-in-Charge shall be informed.

o) First Aid kit with medicines well within expiry date shall be always kept ready at site during dismantling works.

p) Good quality safety shoes, hand gloves, helmets, safety belts shall be used by labours during dismantling. Safe access to upper floors either through staircase or temporary tower staircase with handrails shall be provided all time during work.

1.4 Demolition & Dismantling Procedure:

a) Entire work of demolishing & dismantling shall be meticulously planned. Prior to start of work, the Contractor shall thoroughly understand the scope and nature of the work and then prepare and submit the proposed work execution plan for demolishing & dismantling to the Engineer in charge for his review. Comments, if any, shall be taken care of by the contractor and execution of the work shall be done based on the approved execution plan.

b) Demolition and dismantling shall be restricted to the extent shown on drawings or as directed by the Engineer-in-charge.

c) Dismantling shall be done in a systematic manner. All attached elements to the items being removed shall be carefully removed without causing any damage and stored at a designated place. Demolition of any structure shall be carried out in the sequence reverse to that followed at the time of its construction. Primary load carrying members and stability members shall be the last parts of structure to be dismantled.

d) Blasting in any form shall not be permitted.

e) Pockets/holes of specified size shall be made/cut by drilling/chiselling.

f) All demolished/dismantled usable materials such as bricks, stones, reinforcement bars, structural steel, sheeting etc. shall be separated out, cleaned, and stacked in separate lots within the plant boundary as directed by the Client / Engineer-in-charge.

g) The rate or quoted price for demolishing shall include supply of Labor, tools & tackles, necessary safety measures, propping, underpinning, scaffolding, handling, cutting, straightening, scraping & cleaning of reinforcement bars and other embedment (in case of reinforced concrete works), sorting out and stacking of all serviceable materials, disposal of all unserviceable material, clearing the site, etc. all complete as specified and directed by the Engineer-in-charge.

h) Contractor shall mobilize all types of required Laborers - skilled, semi - skilled, riggers, certified welders, certified gas cutter, licensed electricians, mechanics, foreman, etc. All dismantling engineers and supervisors as required shall be posted at site by the contractor.

i) The contractor shall inform Client / Engineer-in-charge well in advance of the requirement for dismantling purposes. These facilities should be provided at one point. The battery limit for all such services shall be intimated by the contractor. Necessary connection from these points to dismantling site shall be the contractor's responsibility.

j) All the unusable materials and debris shall be disposed by the contractor as directed by Engineer-in-charge at an unobjectionable place identified by local statutory authority or pollution control board.

k) All precautions shall be taken by providing guard rails, barricading and covers in the interest of the safety of passers-by.

l) The debris shall be stacked as neatly as possible and carted away as soon as possible to the Municipal approved dumping area.

1.5 Vibration Control:

a) Ground-borne vibration at adjacent and sensitive structures shall not exceed the permissible limits specified in IS 6922 / DIN 4150.

b) Unless otherwise approved, PPV limits shall generally not exceed:

   i) 5 mm/sec for residential/commercial/old structures

   ii) 3 mm/sec for heritage/sensitive structures

   iii) For sensitive structures (which includes precision industries like Jewellery units or electronic part manufacturing units in adjacent building):

Dominant Frequency	Maximum PPV
< 8 Hz	2 mm/s
8–25 Hz	5 mm/s
> 25 Hz	10 mm/s

IS 14884, ISO 4866, DGMS and CMRI-based guidelines to be followed if precision machinery or sensitive instruments are present in adjacent buildings as per recommendation of Engineer-In-Charge.

c) The Contractor shall continuously monitor vibration and modify demolition methods immediately upon approaching threshold limits.

1.6 Dust & Noise Control:

a) Continuous water spraying, misting/anti-smog guns, and dust screens shall be deployed.

b) Green net/hessian cloth covering shall be maintained around the demolition zone.

c) Ambient noise levels shall strictly comply with CPCB Noise Rules for industrial/commercial areas.

1.7 Debris Management:

a) Segregation of salvageable and unserviceable materials at source.

b) Salvageable materials to be stacked or handed over as directed by the Engineer-in-Charge.

c) Unserviceable debris to be transported to authorized MCGM dumping grounds with valid challans and records.

1.8 Inclusions:

Labour, machinery, tools & plants, scaffolding, lifting arrangements, transportation (all leads), dumping fees, royalties, dust/noise/vibration mitigation measures, insurance, site cleaning, and final levelling.

1.9 Statutory Approvals & Compliance:

a) Demolition permission from MCGM/MIDC/SEEPZ-SEZ Authority

b) Utility disconnection certificates

c) MPCB consent (if applicable)

d) Labor license, ESI, EPF, workmen compensation, third-party insurance

e) All permissions and approvals as recommended by Engineer-In-Charge.

B. Trench Excavation:

The work of trench excavation shall be executed strictly in accordance with State of Maharashtra PWD Specifications including all latest amendments. In the event of any discrepancy, the relevant provisions of the CPWD and Bureau of Indian Standards (BIS) shall prevail. For any items not covered under the above specifications, the decision of the Engineer-in-Charge shall be final and binding.

C. Barricading Work with GI Sheet and Structural Steel Works for Barricading work as per BMC (MCGM) Guidelines:

1.1 Scope of Work:

a) This specification covers design, fabrication, supply, erection, and maintenance of continuous barricading using GI sheets and structural steel around the full perimeter demolition site, including all safety, environmental, and statutory requirements mandated by BMC / MCGM, all other Statutory and codal guidelines.

b) The Barricading Should not be removed and should be kept in good condition while handing over the Site to Engineer-In-Charge. Any Damage to the Barricading during handing over should be made good.

c) The barricading shall ensure:

- Safety of pedestrians, adjoining properties, and traffic
- Prevention of unauthorized access
- Dust and debris containment during demolition.
- Air Pollution Mitigation: As required under latest guidelines, circulars and acts for proper hoarding / fencing shall be provided before and during demolition works.

d) The cost towards design, fabrication, supply, erection, maintenance, manpower, and all other incidental activities related to the Barricading Work and Structural Steel Works for Barricading shall be deemed to be included in the Contractor's quoted rates and overall contract price.

e) No separate payment or reimbursement whatsoever shall be made by the Client on this account.

f) The Client shall not entertain any claim, deviation, or extra item for design, fabrication, supply, erection, maintenance, manpower, shifting, and repairing, or replacement of the Barricading Work and Structural Steel Works for Barricading at any stage during the contract period.

g) The Contractor shall quote his rates, accordingly, keeping the above provisions in view.

h) The Barricading Work to include Materials, Fabrication, Erection, and Maintenance after completion.

1.2 Applicable Codes, Circulars & Regulations.

Barricading works shall comply with the following:

a) MCGM Revised Barricading Circular U/No. MGC/F/6342 dated 05-05-2018 – for type, material, structural system, and continuity of barricades.

b) BMC "28-Point Guidelines for Air Pollution Mitigation" under Circular Ch.E./DP/Gen/15831/Dtd 08-11-2024 (Sanction dated 25-10-2024) – mandatory height and enclosure for demolition sites exceeding 1 acre.

c) Mumbai Municipal Corporation Act, 1888 – Section 354 – legal requirement for hoarding/fencing during demolition.

d) BMC Environment and Climate Change Department Circular No. MGC/F/6526 dated 13-05-2025.

1.3 Type of Barricading.

The barricading shall be of MAJOR WORK TYPE – Structural Steel Barricade as defined by MCGM.

1.4 Structural Design and Approval Requirement for Barricading.

The entire barricading system, including GI sheet panels, structural steel supporting members, connections, bracings, and foundations, shall be structurally designed by a qualified Structural Engineer of Contractor.

The Structural Engineer shall design the barricading system considering dead loads, wind loads, impact loads, soil bearing capacity, site conditions, and monsoon effects, in accordance with relevant Indian Standards and applicable BMC (MCGM) guidelines.

Detailed structural design calculations, drawings, foundation details, and connection details for the barricading system shall be prepared, signed, and stamped by the Contractor's Structural Engineer.

The Contractor shall submit the complete structural design package to the Engineer-in-Charge for approval prior to commencement of barricading work.

No barricading erection work shall be started until written approval of the barricade and foundation design is obtained from the Engineer-in-Charge.

The cost of Structural Design and any modification required by the Engineer-in-Charge or local authority shall be incorporated by the Contractor at no extra cost.

The Contractor shall remain fully responsible for the structural safety, stability, and performance of the barricading and its foundation throughout the demolition period.

1.5 Height and Extent of Barricading:

The barricading shall have a minimum height of 35 feet and shall be erected continuously along the entire site perimeter without gaps, openings, or weak points.

Temporary access gates, where required, shall be of robust construction and shall remain secure and supervised at all times.

1.6 Materials Specification:

a) GI Sheet Panels

Material: Galvanized Iron Sheets

Thickness: 22 gauge (minimum) as per MCGM standard use.

Sheet height shall be modular and lapped to achieve total height of 35 ft.

Fixing: Self-drilling bolts / clamps with neoprene washers

Overlaps: Minimum 50 mm vertical and horizontal overlap

b) Structural Steel Framework

Vertical posts:

ISMB / ISMC / ISLC sections (minimum ISLC 250 or equivalent) for major barricades

Horizontal members:

minimum ISA 50×50×6 mm

Spacing of vertical posts:

Maximum 2.5 m centre-to-centre

Steel grade: IS 2062 E250 or higher.

c) Foundations

Each vertical structural post shall be supported on a properly designed concrete foundation capable of resisting vertical, lateral, and uplift forces.

Foundation depth, size, and reinforcement shall be as per the approved structural design and site soil conditions.

1.7 Structural Stability Requirements:

a) Barricade shall be designed to withstand Wind loads and Accidental pedestrian impact.

b) Adequate bracing shall be provided at corners and long straight runs.

c) Barricading shall remain stable during monsoon conditions.

1.8 Safety, Visibility & Traffic Management:

a) Continuous barricading with no intermediate gaps, as mandated by MCGM.

b) Reflective warning tapes and blinkers at night

c) Danger boards: “DEMOLITION IN PROGRESS – ENTRY PROHIBITED”

d) Access gates to have Security personnel and

e) Signage at all locations within plot.

1.9 Painting and Appearance:

a) All exposed steel members shall be painted with one coat of red oxide primer followed by two coats of approved synthetic enamel paint.

b) The barricading shall be maintained in clean and presentable condition throughout the demolition period.

1.10 Maintenance & Responsibility:

a) Contractor shall:

- Inspect barricading daily.
- Rectify damages immediately.
- Ensure stability during monsoon.

b) Any accident due to barricade failure shall be sole responsibility of contractor.

1.11 Completion & Removal:

a) Barricading shall be removed only after written permission from BMC / Engineer-in-Charge.

b) Site to be restored to original condition after removal.

D. Loose Sand Filling in Trench Without Compaction.

a) Scope of Work: Providing, supplying, and filling approved clean coarse sand in trenches in layers not exceeding 200 mm thickness without compaction or consolidation.

b) Standards: CPWD Specifications and IS 383.

c) Execution: Sand shall be free from organic matter, clay, and deleterious materials. Filling shall be done uniformly to required levels and profiles.

d) Inclusions: Materials, leads, lifts, labour, watering (if directed), tools & plants, and cleaning of site.

E. External Scaffolding & Green Net / Hessian Cloth Covering.

a) Scope of Work: Designing, Providing, fixing, and maintaining External Scaffolding & green safety net (minimum 50 GSM) or hessian cloth around demolition and working areas. Structure shall withstand the site-specific wind pressure without failure.

b) Execution: Conventional scaffolding shall be of vertical members of steel/bamboo, spaced and filled with suitable horizontal members secured to each other firmly. This scaffolding shall be double, both connected and braced properly, and secured by connecting with the members of permanent structure, at regular intervals. No holes shall be permitted in external brickwork. Necessary platforms, railings and safety nets, safety belts, helmets, etc. shall be provided to ensure the safety of workers. To reduce the height of falling debris intermediate platforms on the scaffolding shall be erected. Access for labour and staff to the platform from the flats at the relevant levels will be given, if possible. Alternatively, adequate, and safe lifting tackle for men and materials shall be provided by the tenderer at his own cost.

Stitched hessian shall be tied to the external face of the scaffolding/platforms in order to avoid lumps of broken concrete flying around and causing accidents. Fencing at ground level shall be erected to dissuade third persons entering the work area.

Any additional arrangement and/or any alterations/additions to the normal scheme of the scaffolding for overcoming obstructions in the plan and elevations of the building shall be thought of and provided for at the quoted rates.

Netting shall be securely fixed to scaffolding / barricades without gaps. Maintenance and replacement during demolition shall be included.

The cost towards designing, Providing, fixing, and maintaining, manpower, and all other incidental activities related to the External Scaffolding & Green Net / Hessian Cloth Covering shall be deemed to be included in the Contractor's quoted rates and overall contract price.

No separate payment or reimbursement whatsoever shall be made by the Client on this account.

The Client shall not entertain any claim, deviation, or extra item for designing, Providing, fixing, and maintaining, shifting, repairing, or replacement of the External Scaffolding & Green Net / Hessian Cloth Covering at any stage during the contract period.

The Contractor shall quote his rates, accordingly, keeping the above provisions in view.

c) Purpose: Dust containment, safety, and environmental protection.

F. Sensor Based Air Quality Monitor and LED Display.

Providing, installing, commissioning, operating, and maintaining Sensor Based Air Quality Monitor and LED Display as per BMC Environment and Climate Change Department Circular No. MGC/F/6526 dated 13-05-2025 and strictly as per applicable latest guidelines and statutory requirements of BMC and the directions of applicable authorities.

The Make, Model, Technical Specification, location and Installation procedure and plan of Sensor Based Air Quality Monitor and LED Display should be sent for approval of Engineer-In-Charge.

The cost towards procurement, installation, commissioning, operation, maintenance, calibration, consumables, manpower, and all other incidental activities related to the Air Quality Monitor and LED Display shall be deemed to be included in the Contractor's quoted rates and overall contract price.

No separate payment or reimbursement whatsoever shall be made by the Client on this account.

The Client shall not entertain any claim, deviation, or extra item for providing, installing, commissioning, operating, maintaining, shifting, repairing, or replacement of the Air Quality Monitor and LED Display at any stage during the contract period.

The Contractor shall quote his rates, accordingly, keeping the above provisions in view.

G. Anti-Smog Gun for Dust Suppression.

a) Scope of Work: Providing, installing, operating, and maintaining high-pressure anti-smog gun systems during demolition and excavation.

General Requirement

The contractor shall provide mobile, high-efficiency Anti-Smog Guns (Fog Cannons) capable of controlling PM_{10} and $PM_{2.5}$ dust generated during demolition, debris handling, loading/unloading and vehicle movement, in compliance with CPCB / MPCB / BMC air pollution mitigation guidelines applicable to Mumbai.

The cost towards procurement, installation, commissioning, operation, maintenance, calibration, consumables, manpower, and all other incidental activities related to the Anti-Smog Gun shall be deemed to be included in the Contractor's quoted rates and overall contract price.

No separate payment or reimbursement whatsoever shall be made by the Client on this account.

The Client shall not entertain any claim, deviation, or extra item for providing, installing, commissioning, maintaining, shifting, repairing, or replacement of the Anti-Smog Gun at any stage during the contract period.

The Contractor shall quote his rates, accordingly, keeping the above provisions in view.

Minimum Technical Requirements

i) Water droplet size: ≤ 50 microns

ii) Effective control of PM_{10} and $PM_{2.5}$

iii) Pump capacity: Minimum 15 HP

iv) Horizontal throw ≥ 50 m; Vertical throw ≥ 20 m

v) Area coverage: Minimum 2,500–3,000 sqm per unit

vi) Airborne dust reduction efficiency: ≥ 70% reduction in PM_{10} under continuous operation

vii) Automatic oscillation 0°–180°

viii) Accessories & Controls

ix) Heavy-duty MS trolley with pneumatic wheels

x) Stainless steel nozzle ring and axial fan

xi) Control panel with dry-run protection and remote operation.

b) Inclusions: Electricity, water supply/tankers, consumables, operation staff, servicing, and maintenance for the entire demolition period.

H. Vibration Monitoring System.

a) Scope of Work: Supplying, installing, commissioning, and operating calibrated continuous vibration monitoring systems (PPV monitors) at designated sensitive and adjacent locations.

The cost towards procurement, installation, commissioning, operation, maintenance, calibration, consumables, manpower, and all other incidental activities related to the Vibration Monitoring System

shall be deemed to be included in the Contractor's quoted rates and overall contract price.

No separate payment or reimbursement whatsoever shall be made by the Client on this account.

The Client shall not entertain any claim, deviation, or extra item for providing, installing, commissioning, operating, maintaining, shifting, repairing, or replacement of the Vibration Monitoring System at any stage during the contract period.

The Contractor shall quote his rates, accordingly, keeping the above provisions in view.

b) Standards: IS 6922 and DIN 4150.

c) Requirements: Continuous real-time monitoring with data logging using DGMS-compliant triaxial geophones and full vibration monitoring systems or any DGMS-compliant vibration monitoring systems approved by Engineer-In-Charge. Automatic SMS/email alerts on threshold exceedance. Daily, weekly, and event-based graphical reports.

d) Inclusions: Equipment rental, calibration certificates, trained technician, shifting of sensors, and reporting.

I. Noise Level Monitoring.

a) Scope of Work: Carrying out ambient and boundary noise monitoring during demolition using calibrated Sound Level Meters. The cost towards procurement, installation, commissioning, operation, maintenance, calibration, consumables, manpower, and all other incidental activities related to the Noise Level Monitoring System shall be deemed to be included in the Contractor's quoted rates and overall contract price. No separate payment or reimbursement whatsoever shall be made by the Client on this account. The Client shall not entertain any claim, deviation, or extra item for providing, installing, commissioning, operating, maintaining, shifting, repairing, or replacement of the Noise Level Monitoring System at any stage during the contract period. The Contractor shall quote his rates, accordingly, keeping the above provisions in view.

b) Standards: Noise Pollution (Regulation & Control) Rules, 2000 and CPCB guidelines.

c) Execution: Day-time and night-time monitoring as applicable and Continuous/logged measurements in sensitive areas.

d) Reporting: Periodic compliance reports to PMC/Authority and Immediate reporting in case of exceedance.

J. Miscellaneous Requirements.

1.1 Covering Windows of Adjacent Building:

The Covering windows of all adjacent building with UV Stabilized Green Net / Hessian Cloth shall be deemed included in the quoted rates and no extra payment shall be made.

Window Covering: Windows/doors/openings shall be covered with plywood or tin sheets and properly secured to protect the shutters and glass panes from falling debris, and to keep the dust out.

Any equipment, furniture, fixtures, fittings etc., adjacent to the work area, should be either removed or adequately covered (as advised by the consultant) to avoid damage/breakage during the progress of work. This entire activity should be deemed included in the quoted rates and no extra payment shall be made.

1.2 Propping & Shoring.

The guidelines outlined on tender documents and drawings shall be followed.

Steel tube adjustable props are preferred. The sections of timber props, if used, shall be adequate to support the structure temporarily as directed by consultant.

Bracings, base plates and wedging etc. are an integral part of the system. Providing adequate bracings, base plates and wedges is obligatory to have been included in the scheme for propping and shoring.

The propping and shoring shall be kept and maintained in position till required as directed by the Consultant.

1.3 Pre-Demolition Baseline Monitoring (Mandatory)

Scope

Prior to commencement of any demolition or excavation activity, the Contractor shall carry out baseline monitoring and documentation to establish existing site conditions.

Baseline Requirements

a) Vibration Baseline: Installation and recording of baseline PPV readings at all identified sensitive and adjoining structures for a minimum continuous period of 48 hours.

b) Noise Baseline: Ambient noise level monitoring (day and night) at site boundary and sensitive receptors as per CPCB methodology.

c) Structural Condition Survey: Joint condition survey with PMC/Client of all adjoining structures, utilities, pavements, roads, and boundary walls, supported with photographs and videography.

Baseline reports shall be submitted to and approved by the Engineer-in-Charge before start of demolition. Any claim related to pre-existing damages shall not be entertained unless recorded in the baseline survey.

Fixed PPV Trigger Values & Escalation Ladder

PPV Trigger Levels (as per IS 6922 / DIN 4150):

a) Alert Level: 75% of permissible PPV limit

b) Action Level: 100% permissible PPV limit

c) Critical Level: 110% permissible PPV limit

Escalation Protocol

a) At Alert Level: Immediate review and modification of demolition methodology.

b) At Action Level: Immediate stoppage of work and resumption only after written clearance of Engineer-in-Charge.

c) At Critical Level: Suspension of work, detailed investigation, condition assessment of adjoining structures, and resumption only after written approval of Client/PMC.

Penalty & Recovery

The following penalties shall apply without prejudice to other remedies and shall be recoverable from running/final bills or Retention Money / Security Deposit:

Vibration (PPV) Exceedance:

Penalty of 0.25% of Contract Value per incident per location, subject to a minimum of costs for structural survey, repairs, strengthening, and monitoring as directed by the Engineer-in-Charge.

Noise Limit Exceedance:

Penalty of 0.10% of Contract Value per day per location for violation of CPCB noise limits, particularly in silence/sensitive zones.

1.4 Dust / Air Quality Non-Compliance:

Penalty of 0.10% of Contract Value per day per location, including recovery of costs for additional anti-smog guns, tankers, and enhanced monitoring.

Repeated or persistent violations shall attract suspension of work, escalation under contract clauses, and may lead to termination at Contractor’s risk and cost. The cumulative penalties under this clause shall be

subject to an overall cap of 10% (Ten Percent) of the Contract Value, in line with CPWD GCC provisions, without limiting the Contractor's liability for rectification of damages, statutory penalties, or third-party claims.

1.5 Silence Zone & Operational SEEPZ Buildings

Demolition works are located within an operational SEEPZ campus with live industrial units, jewellery units, offices, utilities, substations, and security installations. The Contractor shall:

a) Strictly comply with CPCB silence-zone noise limits in identified sensitive areas.

b) Carry out high-noise activities only during approved working hours.

c) Not undertake night-time demolition without written approval from SEEPZ-SEZ Authority and MPCB.

1.6 Demolition Near Live Substations & Utilities

Demolition near live HT/LT substations, transformers, DG sets, underground/overhead services, fire mains, and data cables shall be undertaken only with approved method statements, protection schemes, and shutdown coordination. Any damage or service disruption shall be rectified immediately at Contractor's risk and cost.

K. Tree Transplantation.

General Note.

- Tree transplantation is undertaken to conserve existing trees affected by infrastructure and development works. As the trees proposed for transplantation are mature and well-established specimens, the process shall require scientific planning, phased execution, careful handling, and sustained post-transplant care and maintenance for a minimum period of one (01) year, to ensure survival and long-term establishment. All activities related to tree transplantation shall be carried out under the direct supervision of a qualified, trained, and experienced horticulturist holding a bachelor's degree (B.Sc.) in Horticulture as part of the Contractor's team.
- The Contractor shall undertake tree transplantation in a systematic and scientific manner and shall achieve a minimum survival rate of 80% (Eighty Percent) of the total number of affected trees that cannot be preserved in situ, in accordance with project requirements.

  Tree transplantation shall be undertaken only after obtaining all requisite permissions and approvals from the Tree Authority constituted under the Maharashtra (Urban Areas) Protection and Preservation of Trees Act, the concerned Local Authority / Municipal Corporation or Local Body, Maharashtra Industrial Development Corporation (MIDC), and statutory authority, as applicable. All tree transplantation activities shall be carried out in strict conformity with the terms, conditions, and stipulations prescribed in the approvals granted by the respective authorities.

Principles of Tree Transplantation

Tree transplantation is based on developing a compact fibrous root system through phased root pruning and conditioning, enabling safe relocation while minimizing transplant shock and supporting post-transplant recovery.

Transplantation Procedure

The procedure includes the activities described below, with detailed methodologies under respective headings mention in document. All tree plantation works shall be executed in phased operations over an adequate period under the supervision of qualified (BSc. in Horticulture) trained and experienced horticulturist in contractors' team.

- Preparation of a Tree Preservation and Transplantation Plan (TPPP) based on detailed site surveys, existing site constraints, road alignment, utility corridors, tree typology, species characteristics, girth, height, canopy spread, and age classification (young, semi-mature, mature, or over-mature trees)
- Identification, tagging, mapping, and categorization of trees proposed for preservation in situ,

transplantation, or removal, supported by qualified (BSc. in Horticulture) trained and experienced horticulturist's justification and approvals, wherever required.

- Preliminary inspection and comprehensive health assessment of identified trees, including evaluation of structural integrity, physiological condition, pest or disease infestation, and transplant suitability.
- Investigation of root spread, depth, root density; treatment of weak or infected trees; and treatment of all cut surfaces using approved pesticides and fungicides as per tree typology and age. and overall root health diagnosis based on existing ground conditions.
- Phased root pruning in accordance with tree size, species, and age to encourage the development of new fibrous roots prior to transplantation.
- Drainage, and root zone pH (alkaline/acidic) management; phased root pruning; and removal of underground obstructions, if encountered.
- Soil sampling, testing, amendment, and improvement; preparation of transplantation pits at receiving locations considering soil profile compatibility and drainage conditions.
- Root ball formation as per recommended standards, including packing, stitching, wrapping, securing, and protection to prevent desiccation and mechanical damage.
- Supply and application of suitable fertilizers, soil conditioners, bio-inoculants, pesticides, and insecticides based on species-specific and site-specific requirements
- Provision of temporary and permanent mechanical supports, including scaffolding, stays, guy wires, anchoring, and protective barriers for both preserved and transplanted trees.
- Safe lifting of trees using cranes or other approved lifting equipment, ensuring load balance and protection of root ball and trunk.
- Transportation of packed trees using suitable trolleys, trailers, or trucks, taking into account tree size, weight, and transit safety
- Excavation of transplantation pits using mechanical (JCB) or manual methods as appropriate to site conditions and tree typology with necessary soil improvement
- Placement, correct orientation, vertical alignment, backfilling, watering, soil compaction, and stabilization of trees at the new location
- Selective pruning of canopy, crown balancing, and reduction based on tree species, age, and physiological needs to enhance post-transplant survival.
- Post-transplantation care includes scheduled watering, fertilization, mulching, pest and disease control, replacement of supports if required, and continuous monitoring and reporting.
- Maintenance of preserved and transplanted trees for the specified period (minimum one year), including survival assessment, corrective measures, and replacement where failure occurs, to ensure healthy establishment and long-term sustainability.

Pre-Execution Surveys & Planning.

Detailed surveys and planning shall be carried out prior to execution to ensure technical feasibility, regulatory compliance, and transplantation success. All proposals shall be approved by the Engineer-in-Charge.

a) Tree Inventory, Tagging & Mapping.

All trees within the project area shall be inventoried, tagged, mapped, and categorized for preservation, transplantation, or removal, forming the basis of the approved Tree Preservation and Transplantation Plan (TPPP).

i) Tree Inventory and Documentation.

A comprehensive Tree Survey shall be carried out by a qualified arborist/landscape professional.

Each existing tree with GBH ≥ 150 mm at 1.0 m height (or as per local authority norms) shall be:

- Assigned a unique identification number.

- Physically tagged with durable, weatherproof labels Mapped using total station/GIS coordinates.

  The inventory shall record the following minimum details:

- Botanical and common name
- Girth at breast height (GBH)
- Height and canopy spread.
- Health and structural condition
- Ecological and heritage value (native, endangered, heritage tree, etc.)
- Photographic record
- Age class (semi-mature, mature) The age and growth stage of trees proposed for transplantation shall not be determined arbitrarily and shall be scientifically assessed and categorized by a qualified, trained, and experienced horticulturist holding a bachelor's degree (B.Sc.) in Horticulture, deployed as part of the Contractor's team.

  Tree age assessment shall be carried out based on a combination of measurable field parameters and regional reference data, including but not limited to:

- Species specific growth characteristics (GBH)
- Bark texture, branching pattern, and physiological condition.
- Visible indicators of maturity or decline
- The categorization shall be further validated using average regional growth patterns of the same species, derived from:
- Local plantation records
- Horticulture practice data relevant to the Mumbai/Maharashtra region
- Observed growth performance of similar species under comparable soil and climatic conditions.

  For Example –

  Neem trees in Maharashtra typically exhibit an average radial growth of 1.5–2.5 cm per year under normal urban soil and moisture conditions.

  Observed GBH: ~120 cm.

  Indicative age range (based on regional growth rates): ≈ 35–45 years.

  25–30 cm GBH at 8–10 years

  80–100 cm GBH at 25–30 years

  100–120 cm GBH at 35–45 years

b) Health Assessment & Transplant Feasibility.

- Only healthy, structurally stable trees free from irreversible disease shall be selected for transplantation, based on trained and experienced personnel through phased operations over a period of 3–4 months, depending on tree species, size, health, and age. This phased approach shall promote development.

Trees shall be categorized as follows:

- Category A – Trees to be Preserved.

  Healthy, structurally sound trees that can be retained without conflict with proposed development.

- Category B – Trees to be Transplanted.

  Trees affected by development but viable for relocation based on species, size, and health.

- Category C – Trees to be Removed.

  Trees that are dead, diseased, invasive, structurally unsafe, or unavoidable due to critical infrastructure requirements, subject to statutory permissions

c) Soil Sampling, Testing & Improvements at Site.

Soil at receiving sites shall be tested and improved as required. Drainage, moisture, pH, sunlight, wind exposure, and adequate growing space shall be ensured for healthy establishment. Soil at receiving sites shall be tested to assess texture, nutrients, moisture, pH, drainage, and compaction.

Removal of Unsuitable Soil

Excavated soil containing debris, construction waste, salts, clay lumps, or contaminants shall be removed from the pit.

Well-draining soil shall be retained or reused after amendment. Soil improvement measures such as organic amendment, decompaction, drainage correction, and pH adjustment based on test results.

a) Heavy clay soil: Mix with coarse river sand (not fine sand) and organic compost to improve drainage and aeration.

b) Sandy soil: Incorporate well-decomposed organic matter to improve moisture and nutrient retention.

Recommended mix (typical):

a) 50–60% (Fifty Sixty Percent) native soil

b) 20–30% (Twenty Thirty Percent) organic compost / farmyard manure

c) 10–20% (Ten Twenty Percent) sand or soil conditioner (as required)

d) Drainage

Proper soil drainage shall be ensured to provide adequate moisture and oxygen to roots. Compacted or poorly drained soils shall be corrected prior to planting to prevent root stress and failure.

e) Water

Providing the correct amount of water is essential for healthy tree growth. Tree species shall be carefully selected based on site conditions, particularly in low-lying areas where water may remain standing, groundwater levels may be close to the surface, or heavy clay soils are present. Such conditions typically result in low soil oxygen availability, which can adversely affect many tree species.

Trees that are tolerant of excessive moisture and periodic waterlogging are better suited to these challenging environments. Water availability at the receiving site shall be adequate (it should not be acidic in nature). These species possess adaptive characteristics that allow them to survive and perform well under reduced soil oxygen conditions, making them more appropriate for poorly drained sites and areas with a high-water table.

f) Sunlight

Receiving locations shall provide suitable sunlight conditions based on species requirements, with protective measures where necessary to prevent leaf scorch or desiccation.

Considerations For Tree Transplantation.

Tree suitability, season, site conditions, equipment availability, and post-transplant care arrangements shall be assessed prior to transplantation. Failure due to improper assessment or execution shall be treated as Contractor’s deficiency. The Contractor shall, at no additional cost, replace all failed or dead transplanted trees. Each failure shall be made good through compensatory planting, carried out strictly in accordance with the guidelines, norms, and recommendations prescribed by the approving statutory authority.

a) Assessment Of Underground Utilities & Obstructions

   Subsurface utilities and obstructions shall be identified prior to excavation. Required mitigation measures shall be approved before proceeding with root cutting or pit preparation.

b) Tree Conditioning & Root Preparation

   Tree conditioning is a phased process carried out in advance of transplantation to improve health,

initiate fresh root growth, and enhance survival potential.

Initial Preparation & Treatments.

Tree conditioning is a phased process carried out in advance of transplantation to improve health, initiate fresh root growth, and enhance survival potential. Roots and soil shall be examined and treated for pests, disease, or deficiencies. Bio-treatments and soil conditioning shall be completed prior to root pruning. Drainage, and root zone pH (alkaline/acidic) management; and removal of underground obstructions, if encountered.

a) Root Pruning and Initiation of Fresh Root Growth.

1. Root pruning shall be executed strictly within a maximum duration of four (4) months, through phased operations, by a qualified and experienced horticulturist holding a B.Sc. in Horticulture.
2. The duration of the phased operations shall be pre-determined and approved by the Engineer-in-Charge prior to commencement and shall not be extended under any circumstances, irrespective of tree species, size, age, or health condition.
3. The contractor shall ensure that the phased approach promotes the development of a compact and fibrous root system within the stipulated timeframe. All necessary measures, including regular watering, nutrient supplementation, and continuous monitoring, shall be undertaken concurrently and within the approved period to ensure uniform root regeneration and successful adaptation, without affecting the overall project schedule.
4. Delay or inefficiency attributable to planning, execution, or resource deployment shall not be considered grounds for time extension.

b) Preparatory Measures During Root Cutting.

1. Obstructions encountered during root cutting shall be removed or mitigated. Extra care shall be taken during monsoon periods to maintain tree stability.

c) Crown & Canopy Pruning (Pre-Lifting).

1. Selective crown and canopy pruning shall be carried out prior to lifting and transplantation to maintain an appropriate root–shoot balance, reduce transpiration stress, and improve post-transplant survival, without excessive removal of functional canopy.
2. Pruning shall be undertaken only by trained and experienced horticulturists/arborists, using clean, sharp tools and in accordance with standard Arboriculture practices.
3. Extent of Pruning
4. Total canopy reduction shall not exceed 15–20% (Fifteen Twenty Percent) of the live crown volume in any single operation.
5. Under no circumstances shall pruning exceed 25% (Twenty Five Percent) of the existing canopy, even for large or mature trees.
6. Any requirement beyond 20% (Twenty Percent) pruning shall require prior written approval of the Engineer-in-Charge, supported by qualified (BSc. in Horticulture) trained and experienced horticulturist.

d) Feeding, Watering & Monitoring for Adaptation.

1. Considering the high rainfall intensity, prolonged monsoon season (June–September), high humidity, and clayey soils prevalent in Mumbai, feeding, watering, monitoring, and stabilization measures prior to transplantation shall be executed with special emphasis on controlled moisture management, root aeration, and fungal disease prevention, to condition the tree for lifting and relocation in the guidance of qualified (BSc. in Horticulture) trained and experienced horticulturist.
2. The pre-transplant adaptation and conditioning period shall be a minimum of 03 (Three) to 04 (Four)

months, inclusive of the monsoon period where applicable, and shall not exceed 04 (Four) months, unless otherwise approved in writing by the Engineer-in-Charge.

3. Adequate drainage provisions shall be ensured around the root-pruning trench and root ball area, including grading to direct surface runoff away from the trunk.
4. Soil mounding against the trunk shall be strictly prohibited, to avoid collar rot and fungal infection.
5. Soluble fertilization, including organic or inorganic nutrients, shall be applied as and when required to promote root development and overall plant Vigor. Fertilizer type, dosage, and application frequency shall be appropriate to the tree species and stage of establishment.
6. Fertilization shall be withheld during peak monsoon months, unless visible nutrient deficiency is observed.
   Organic manure / vermicompost: 5–8 kg per tree, applied once during conditioning period.
7. Low-nitrogen, high-phosphorus fertilizer (root development):
8. 0.2–0.3% solution, once every 45–60 (Forty-Five-Sixty) days
9. Excess nitrogen application leading to lush or weak shoot growth prior to transplantation is strictly prohibited.
10. Pest and disease control measures shall be implemented promptly using approved and environmentally safe methods to prevent infestation and damage during the adaptation period. Monitoring for fungal infections, borers, and leaf pathogens shall be conducted.
11. Every 07 (Seven) days during monsoon, Every 10 or 15 (Ten or Fifteen) days during dry periods
    a) Continuous monitoring of plant health shall be undertaken it shall focus on:
    b) Response to root pruning

       Canopy stress symptoms (wilting, yellowing, dieback)

       Soil settlement within root-pruning trench.

       Signs of fungal infection near trunk or root collar

       Minimum Monitoring Frequency

       Monsoon period: Weekly

       Non-monsoon period: Bi-weekly
12. Where necessary, temporary supports, staking, or guying systems shall be provided and maintained to ensure stability of the tree against wind and external forces until adequate root anchorage is achieved. Such supports shall be periodically checked and adjusted to avoid damage to the trunk or root zone.

Site Preparation

Planting sites shall be prepared to suit species-specific soil, water, light, and drainage requirements to ensure survivability and long-term growth.

a) Site Conditions & Microclimate Assessment.

1. The site conditions at the receiving location shall be carefully evaluated, as these significantly influence tree health and survivability. Assessment shall include soil type, drainage pattern, water availability, sunlight exposure, wind intensity, and surrounding microclimatic impacts.
2. The location of the planting site in relation to buildings, pavements, compound walls, utilities, and other vegetation shall be examined, as these elements affect temperature, moisture retention, and wind exposure. Protected microclimates generally improve transplant success, while exposed locations may require additional support and protection measures. Efforts shall be made to match species-specific environmental requirements with the selected site conditions to enhance longevity and performance of transplanted trees.

b) Soil Texture, Drainage & Amendments.

Soil texture and drainage shall be evaluated and corrected. Compacted or poorly drained soils shall be improved prior to planting.

c) Pit Size, Excavation & Preparation

Pits shall be excavated and prepared in advance and shall be sized larger than the corresponding root ball to facilitate proper placement and backfilling. The pit diameter shall be not less than 300–450 mm greater than the root ball diameter on all sides. The pit shall be filled with approved improved soil suitable for tree establishment. Light watering shall be carried out after pit preparation to settle the soil and eliminate air pockets. The pit depth shall be equal to or marginally shallower than the root ball depth, ensuring that the root collar remains at or slightly above the finished ground level after planting. Over-excavation leading to settlement or instability shall be strictly avoided.

d) Water Availability & Drainage Provisions.

Adequate drainage provisions and water availability shall be ensured before transplantation to prevent root suffocation or moisture stress.

Season of Tree Transplantation.

Tree transplantation in Mumbai shall be carried out preferably during the monsoon season (June–September), when soil moisture conditions are most favourable for root establishment and early recovery. Transplantation may also be undertaken during the post-monsoon and early winter period (October–January), subject to adequate soil moisture and site conditions.

Transplantation during peak summer months (February–May) shall be avoided and shall be permitted only under exceptional circumstances with approved mitigation measures. Evergreen species shall preferably be transplanted during late monsoon to early post-monsoon, while deciduous species may be transplanted during the post-monsoon period where ground conditions permit.

Any failure arising from transplantation undertaken during unsuitable seasonal conditions shall be treated as contractor deficiency and shall be rectified at no additional cost to the Employer.

Root Ball Packing.

Root ball packing is a critical operation that preserves the newly developed fibrous root system and minimizes transplant shock. This activity shall be undertaken only after successful completion of phased root pruning and approval from the Engineer-in-Charge.

a) Root Ball Specifications.

A preliminary investigation should be carried out to examine the root condition and underground environment. This ensures that Roots are free from rot, decay, or termite infestation No major structural obstructions adversely affect root health.

The size of the root ball shall be determined based on the girth of the tree, species rooting characteristics, physiological condition, and available root spread at site. Preservation of the maximum possible fibrous root mass within the root ball is essential to ensure successful transplantation and post-transplant establishment.

Root Ball Diameter (in metres) ≥ 10–12 times the Trunk Diameter (in centimetres)

This range shall be selected based on tree species, health, soil condition, and transplantation feasibility, with the higher multiplier adopted for mature or sensitive species.

For trees exceeding 2.0 m girth:

Such trees shall be treated as large or heritage trees, and the root ball size shall not be determined by formula alone. The root ball dimensions shall be finalized based on detailed tree health assessment, species characteristics, soil profile, stability requirements, and site constraints, generally adopting a minimum of 12 (Twelve) times the trunk diameter or as recommended by a qualified arborist and approved by the

Engineer-in-Charge The final size and geometry of the root ball shall be determined after site-specific assessment, considering soil condition, underground obstructions, stability requirements, and professional arborist recommendations, and shall be subject to approval of the Engineer-in-Charge.

b) Root Pruning and Initiation of Fresh Root Growth.

Root pruning shall be executed in a systematic and uninterrupted phased manner, enabling gradual adaptation of the tree in preparation for transplantation. After completion of each phase of root cutting, exposed surfaces shall be promptly treated with approved root-promoting and protective agents to encourage rapid regeneration of fibrous roots.

The entire root-pruning and conditioning process shall be completed strictly within a maximum period of 3–4 (Three-Four) months, as approved prior to commencement. Continuous labour deployment, regular monitoring, and timely execution of each phase shall be ensured without gaps or idle periods, and delays arising from inadequate planning or resource allocation shall not be permitted.

Prior to initiation of root cutting, trees shall be inspected for pest or disease incidence and treated as necessary. Such inspections and treatments shall be undertaken at the same time and shall not result in postponement or extension of the approved schedule.

c) Hessian / Wire Mesh Wrapping & Stitching.

Once fresh root growth has been initiated and the root ball is formed, the entire root ball shall be tightly wrapped using hessian cloth to retain soil integrity and moisture. The hessian shall fully encase the root ball without gaps, ensuring protection against dryness during lifting and transportation.

Galvanized wire mesh shall be placed outside the hessian wrapping to provide structural support and prevent soil collapse. The mesh shall be secured firmly using jute or coir rope stitching at regular intervals to maintain shape and rigidity of the root ball.

All wrapping and stitching shall be carried out by skilled personnel to align with root architecture and avoid damage to emerging fibrous roots. The packed root ball shall be kept continuously moist using water spray or damp coverings until transplantation.

Temporary scaffolding may be provided during packing to stabilize the tree and prevent tilting. Hessian and wire mesh shall not be removed at the time of planting; biodegradable materials shall be left intact to allow gradual decomposition and root penetration.

d) Challenges During Root Cutting.

- Subsurface obstructions such as debris, concrete remnants, pipelines, sandy soil strata, or rocky layers may be encountered.
- Such conditions are rectified by:
- Removing debris and obstructions
- Breaking rock or concrete locally
- Replacing unsuitable soil with good quality planting soil
- These measures, though essential for survival, may involve additional effort and cost.
- Canopy pruning intensity depends on:
- Distance of transplantation
- Traffic and transportation constraints
- Presence of overhead utilities
- During monsoon periods, extra care is taken as loosened soil may increase the risk of toppling due to wind pressure.
- Root ball packing shall protect fibrous roots and retain moisture and shall be undertaken only after completion of root preparation and approval.

Tree Packing, Lifting, Loading & Transportation.

a) Tree Packing, Feeding & Monitoring.

- Once fresh root growth is initiated, the root ball is packed using suitable material, securely stitched and wrapped.
- Regular feeding with soluble fertilizers and scheduled watering is provided.
- Continuous monitoring is conducted for:
- Fertilizer applications
- Pest and disease control
- Skilled manpower ensures proper packing aligned with root architecture.
- Temporary scaffolding is provided during packing and removed after backfilling. Permanent external support is installed as required.

b) Mechanical / Manual Lifting and Staking.

Lifting of trees shall be carried out using cranes, hydra, or other approved mechanical equipment, depending on tree size, weight of the root ball, and site conditions. Properly positioned lifting belts, slings, or harnesses shall be used to ensure balanced lifting and to prevent damage to the trunk, bark, or root ball.

Where crane lifting is not required or feasible, tree handling and placement may be carried out through alternative approved methods, including manual handling with suitable mechanical aids, rollers, winches, or combined manual-mechanical techniques, as directed and approved by the Engineer-in-Charge.

Manual assistance shall be provided as necessary to guide positioning and to prevent uncontrolled movement, swinging, or sudden impact during lifting and placement. Temporary mechanical support or staking shall be provided where trees are tall, heavily foliaged, slow to recover, or planted in sandy or weak soil conditions. Where site and stability conditions permit, certain trees may be allowed limited natural sway, as controlled movement promotes stronger trunk development and improved structural stability.

Where staking is required, two or more stakes shall be installed on opposite sides of the tree and the trunk shall be secured using non-abrasive, flexible materials such as soft boards, fabric straps, or approved ties, ensuring no injury to the bark and allowing limited movement.

All lifting, handling, staking, and associated operations, including the use of cranes, alternative lifting methods, manpower, equipment, materials, and supervision, shall be deemed to be included in the scope and cost of the respective BOQ items. No separate payment shall be made, and the entire cost shall be borne by the Contractor within the quoted BOQ rates.

c) Transportation Within / Outside Project Site.

Packed trees shall be transported using suitable trailers, trolleys, or trucks with adequate support and cushioning. Transport routes shall be planned to minimize vibration, overhead obstructions, and delays. Trees shall be shifted immediately after lifting to reduce exposure and stress.

d) Protection During Transit.

During transit, root balls shall be protected from drying, heat, strong winds, and mechanical damage. Damp coverings shall be maintained throughout transportation. Trees shall not be exposed to direct sunlight or extreme temperatures for extended duration.

Post-Transplantation Treatments

Post-transplant care is mandatory to ensure survival, recovery, and establishment.

a) Watering Regime

Immediately after transplantation, copious watering shall be carried out. Copious watering shall consist of

- Slow and continuous application of water

- Full saturation of the entire root ball and surrounding planting pit
- Settlement of soil and elimination of air voids.

Wetting of soil up to the full rooting depth without surface runoff or prolonged stagnation. The planting site shall be thoroughly watered immediately after placement of the tree. Soil moisture within the root zone shall be regularly monitored to avoid.

- Moisture stress due to drying.
- Waterlogging due to over-watering

In the absence of adequate rainfall:

- Deep watering shall be carried out at intervals of 10–14 (Ten-Fourteen) days.
- Watering shall ensure penetration through the entire root ball and active root zone.

Watering frequency and quantity shall be adjusted based on:

- Tree species and size
- Soil type and drainage conditions
- Prevailing climatic conditions.

All watering operations shall be carried out under the direction and supervision of a qualified and experienced horticulturist holding a B.Sc. in Horticulture.

Any moisture stress, drying of the root zone, or waterlogging resulting from improper watering practices shall be treated as contractor deficiency and rectified immediately at no additional cost.

b) Mulching.

Mulching around trees helps to conserve soil moisture, moderate soil temperature, suppress weed growth, and improve soil conditions within the tree root zone.

Mulch shall be placed on the soil surface over the effective root spread of the tree, ensuring uniform coverage without disturbing the root system.

Both organic and inorganic mulches may be used, subject to site conditions and approval.

Organic mulches may include bark chips, wood chips, straw, partially decomposed leaves, or other biodegradable materials, which also contribute to improved soil structure and nutrient content over time.

Mulch shall be applied to a uniform thickness of 75–100 mm (3–4 inches) to ensure effectiveness.

A mulch-free collar of 100–150 mm (4–6 inches) shall be maintained around the tree trunk to prevent collar rot, pest infestation, and moisture-related diseases.

Inorganic mulches, such as crushed stone, gravel, or woven geotextile fabric, may be used where organic mulch is not suitable. However, impermeable plastic mulches shall be avoided, as they restrict air and water movement and may impede root development.

c) Fertilization

For the first few years, woody trees rarely need nutrients beyond those naturally occurring in the soil. No fertilizer or manure should be mixed with the fill soil, as this could cause root damage. If nutrient deficiency is observed during establishment, only soluble fertilizers shall be applied as per qualified (BSc. in Horticulture) trained and experienced horticulturist.

d) Pest & Disease Control.

Regular inspections and timely treatments shall be carried out to control pests and diseases during the maintenance period.

Pruning (Post-Establishment).

Only necessary pruning shall be undertaken to remove dead, diseased, or damaged parts. Major pruning shall be avoided during the initial establishment period.

Removal of Supports & Final Establishment.

Supports shall be removed once trees are stable and established, generally after the first growing season.

Maintenance Period.

The Maintenance Period shall be for a minimum duration of twelve (12) months, commencing from the date on which tree transplantation is certified as successful, based on expert assessment confirming visible signs of new growth and/or structural and physiological stability of the transplanted tree.

During the Maintenance Period, the Contractor shall be responsible for rectifying, at their own cost, any defects, deficiencies, shrinkages, or failures in the works arising from:

Faulty materials

Improper workmanship

Non-compliance with specifications or approved drawings

Routine maintenance activities-

- Watering: Regular and adequate watering as per tree species, soil conditions, and seasonal requirements, ensuring optimal soil moisture without causing waterlogging or moisture stress.
- Nutrient Management: Application of soluble or slow-release fertilizers, organic manures, or soil conditioners as required to promote root development, canopy health, and overall Vigor.
- Pruning and Canopy Care: Selective pruning of dead, damaged, or diseased branches to maintain root–shoot balance and healthy structure, without excessive canopy reduction.
- Mulching: Maintenance of appropriate mulch layers to conserve moisture, regulate soil temperature, suppress weed growth, and improve soil conditions, while keeping a mulch free collar around the trunk.
- Pest and Disease Control: Monitoring, prevention, and control of pests, fungi, and diseases using approved and environmentally safe methods.
- Structural Support: Inspection, adjustment, and maintenance of staking, guying, or other support systems to ensure tree stability until adequate root anchorage is achieved; removal once stability is confirmed.
- Weed Management: Regular removal of weeds within the tree basin to prevent competition for water and nutrients.
- Monitoring and Inspection: Periodic inspection by qualified personnel to assess tree health, Vigor, stability, and growth indicators such as new leaf flush and shoot development.
- Corrective Measures: Prompt implementation of remedial actions, including soil improvement, additional irrigation, fertilization, or re staking, in case stress symptoms or instability are observed.
- The Contractor shall undertake all necessary measures to achieve and maintain a minimum survival rate of 80% (Eighty Percent) of the transplanted trees during the minimum one-year Maintenance Period.
- Each failure more than 80% (Eighty Percent) survival shall be made by way of compensatory planting, carried out in full compliance with the prescribed statutory guidelines, norms, and technical recommendations of the competent approving authority.

Monitoring & Reporting:

The Contractor shall carry out regular monitoring at defined intervals during the entire maintenance period (Minimum 1 Year) to assess the overall health and stability of each transplanted tree. Monitoring should include, but not be limited to, the following parameters:

- Survival status and rate
- Leaf emergence, colour, wilting or defoliation
- Branch dieback, canopy density, and new growth
- Soil moisture condition and adequacy of watering
- Root zone settlement or exposure

- Stability of tree and effectiveness of staking/guying system
- Incidence of pests, insects, fungal attack, or disease
- Physical damage to trunk, bark, branches, or root ball

Any symptoms of stress such as yellowing, drying, fungal infection, pest infestation, poor growth shall be immediately recorded and addressed through appropriate corrective actions, including additional watering, soil treatment, fertilization, pest control, pruning, or adjustment of supports.

The Contractor shall prepare and submit structured monitoring reports for all transplanted trees in accordance with the approved monitoring frequency.

Report submission schedule shall be as follows:

- Weekly reports for the first 2 (Two) weeks after transplantation
- Bi-weekly reports from the 3rd week up to 3 (Three) months
- Monthly reports for the remainder of the maintenance period

Each monitoring report shall include, as a minimum:

Tree identification/reference number and location

- Date of inspection
- Observations against prescribed monitoring parameters
- Photographic documentation (before and after corrective action, where applicable)
- Details of corrective measures undertaken
- Recommendations, if any, for further intervention

All monitoring reports shall be submitted to the Engineer-in-Charge within 03 (three) days of the respective inspection.

Non-submission, delayed submission, or submission of incomplete reports shall be treated as non-compliance with Technical Specifications.

Any failure or mortality of trees attributable to lack of reporting, delayed reporting, or inaccurate reporting shall be deemed a Contractor's deficiency and shall be rectified at no additional cost, without entitlement to time extension or additional payment.

Survival Certification:

- Final survival certification and acceptance of tree transplantation works shall be issued only after:
- Completion of the full maintenance period (Minimum 01 (one) Year)
- Satisfactory establishment of all surviving trees
- Until such certification is issued, the Contractor shall remain fully responsible for the health, safety, and survival of transplanted trees, and no claim for completion or release of related payments shall be entertained.

TECHNICAL SPECIFICATION

STAGE 2: CONSTRUCTION OF NEW ENTERPRISES & SERVICES TOWER (NEST)-3

Stage 2: "Construction of New Enterprises & Services Tower (NEST)-3"

This Section comprising of 03 (three) towers simultaneously, each consisting of 01 (one) Basement Level, 01 (one) Ground Floor, 01 (one) Podium Level, and 10 (ten) Upper Floors / Storeys, including all associated civil, structural, architectural, MEPF, infrastructure, external development, testing, commissioning, statutory approvals, and ancillary works, whether specifically mentioned herein or not, as required for the complete and functional delivery of the Project, including but not limited to the following:

CIVIL AND ARCHITECTURAL WORK SPECIFICATIONS

WATERPROOFING METHODOLOGY

NEST 3

1. METHOD STATEMENT - BELOW GROUND WATERPROOFING (RAFT) – HIGH WATER TABEL

Product Name: Dr. Fixit Prebond W – Pre-applied fully bonded HDPE Weldable membrane

Scope

The scope of this document covers the application methodology of Dr Fixit Prebond W-Pre-applied fully bonded weldable HDPE membrane for Raft & Confined Retaining walls.

Materials required-

- Dr. Fixit Prebond W (1.5mm)
- Dr. Fixit DS Tape
- Dr. Fixit SS Tape
- Dr. Fixit Polybar Plus
- Dr. Fixit Microconcrete
- Dr. Fixit Pidigrout 10M
- Dr. Fixit Feviseal HY 300

Equipment required-

- HDPE Membrane welding machine
- Hot air tool
- Heat melting scraper knife
- Hard roller
- Brush
- Hammer

Surface Preparation:

- Horizontal Blinding – Monolithic concrete blinding surface is required. The blinding must be free of loose aggregate and sharp protrusions. The surface does not need to be dry but standing water must be removed.
- Vertical confined surface – Use plum concrete/pcc, plywood, masonry or other approved facing to be provided to level the substrate. Sacrificial shuttering must be close butted to provide support and should not be more than 12 mm out of alignment.
- Ground water level needs to be kept below the PCC level; continuous dewatering needs to be done till completion of concreting. Multiple sumps are required to create a low-lying area outside PCC periphery where all water will be collected & dewatered continually.
- The PCC shall be maintained in a small slope toward the sump (1:200) so that water shall not get accumulated over the surface.
- Large honeycombs and surface undulation has to be treated before handing over.

Membrane Installation:

Horizontal Substrates

- Dr. Fixit Prebond W membrane shall be laid over the PCC before casting the RCC slab, on horizontal surface area with 100 mm selvedge for side laps and 100 mm end laps.

- Place the membrane with sand/adhesive side facing the concrete pour and HDPE film side facing the substrate. Ensure the underside of the succeeding sheet is clean, dry and free from contamination before attempting to overlap. End laps should be staggered to avoid a buildup of layers. Accurately position succeeding sheets to overlap the previous sheet by 100 mm along the marked selvedge.

- If retaining wall is un-confined, Dr. Fixit Prebond W membrane to be fixed on side shutter of raft using double sided tape keeping extending vertically up to maximum height of 200 mm from bottom or PCC level. If retaining wall is confined, membrane to be extended approx.100-150 mm above top of raft to accommodate overlap with vertical membrane.

- The HDPE membrane side and end laps to welded together by hot wedge double seam welding machine i.e. Leister (Commet/Twinny) or other suitable equipment is recommended where welding temperature should be around 380°C to 400 °C. Speed of the machine can be adjusted between 3-4 Rmt/min. It is recommended to execute trial patch before starting daily work.

- Membrane side and end overlap should be with double seam welding system, comprising of two parallel welds of 15 mm wide each with a 20 mm air channel gap in between the two weld lines. (Weld size may little vary as per machine make & model).

- Membrane overlap at roll ends and cut edges should be minimum of 100 mm. Ensure the area is clean and free from contamination. Ensure to remove sand and adhesive from membrane before proceeding for welding at joints.

- Welded overlap area to be covered with Dr.Fixit Prebond SS Tape.

- Single seam wedge or hot air welding machine is recommended to use for non-accessible areas.

- If membrane application is to be done in phase wise manner in such case, care should be taken that the Dr.Fixit Prebond W is laid with little extra length i.e. approx. 500-700 mm longer than the installed rebar in order to have accessibility on lapping with subsequent membrane.

- After completion of quality inspection of the installed membrane by QAQC team, reinforcement laying for raft slab shall be taken up and concrete casting for raft slab shall be completed within 45 days after completion of membrane laying.

- Adequate care shall be taken by main civil contractor while placing and tying rebar to avoid puncture or any other kind of damages to the membrane.

- During concrete pouring of the raft slab, care shall be taken by main civil contractor to protect the membrane from pressured needle vibrators.

Corners

- Internal and external corners to be performed by overlapping the membrane minimum 100mm size, remove sand and adhesive of membrane which will be at bottom and perform joint welding using hand operated welding machine keeping welding the welding temperature same i.e. 380 °C to 400 °C. Alternatively Dr.Fixit Prebond SS Tape/ Dr.Fixit Prebond DS Tape also can be used. While using Dr. Fixit Prebond DS tape the same to be covered with Dr.Fixit Prebond W membrane of the same size to facilitate concrete over adhesion. Ensure that the apex of the corner is covered and sealed with tape and roll firmly. Crease and fold the membrane to ensure a close fit to the substrate profile and avoid hollows.

Vertical Substrates (Confined Area)

- Membrane to be hanged vertically by nailing at the top of the membrane at suitable spacing which needs to be covered by Dr.Fixit Single Sided tape upon completion.
- Vertical welding to be incorporated using potable double seam welding machine. Overlapping locations should be beyond reinforcement locations. Membrane vertical installation and welding should be completed before placing reinforcement.

Vertical Substrates (Un-Confined Area)

- For carry out waterproofing of Unconfined retaining walls, it is recommended to use Dr. Fixit range of SBS membrane or Liquid applied system (PU/PUH) in consultation with Dr. Fixit Technical representative.
- It is recommended to fix Prebond Double sided tape, to ensure watertight overlap at junction of two membranes/successive coating. Fix double sided tape 50 mm over existing membrane and 50 mm on concrete surface. Roll the tape firmly using hard roller to ensure perfect bond. Remove top release liner from tape and overlap with next membrane/coating in minimum 100 mm width.

Repairing of damaged membrane

- For repairing of membrane minor damages mark the affected area in around 100 mm x 100 mm size, remove sand and adhesive using hot air blower followed by fixing Dr. Fixit Prebond SS Tape and roll firmly to ensure perfect adhesion. However, in case of major damage, an oversize patch of Dr. Fixit Prebond W membrane to be welded using hand weld machine with min overlap of 50mm all around.

Casting of Concrete

- It is recommended to complete concrete casting maximum within 45 days of laying of Dr. Fixit Prebond W membrane. If there is delay in concreting then HDPE sheet to be covered with PVC/Tarpolin to avoid direct exposure to UV. In case of planned delay in casting (due to pour sequencing) the extended portion of the HDPE membrane to be protected with Ply/PCC by civil contractor.
- Spilled concrete slurry beyond stopper should be immediately cleaned with water jet.

Precautions & Limitations:

- Avoid laying HDPE membrane with immediate rain forecast and also avoid water stagnation on membrane.
- Any sludge/debris stocked above membrane shall be cleared using light water jet. Do not use sharp object which may damage the membrane.
- Remove the formwork after minimum 72 hrs of casting.
- Dr. Fixit Prebond W extended beyond concrete pour area for further overlapping should be covered with tarpaulin to avoid direct UV Exposure till subsequent pour.

Starter & Construction Joint:

For Horizontal & Vertical Joints

- Clean the joints to remove cement slurry, loose concrete, dust, dirt, oil, grease etc.
- Unroll Dr. Fixit Polybar Plus-Hydrophilic swellable water bar and carefully place at the center of the joint keeping minimum 80 mm concrete cover and fixed the same by using corrosion free nailing at 300 mm c/c or using Feviseal HY 300- High Modulus hybrid sealant and adhesive

Pile cap encapsulation:

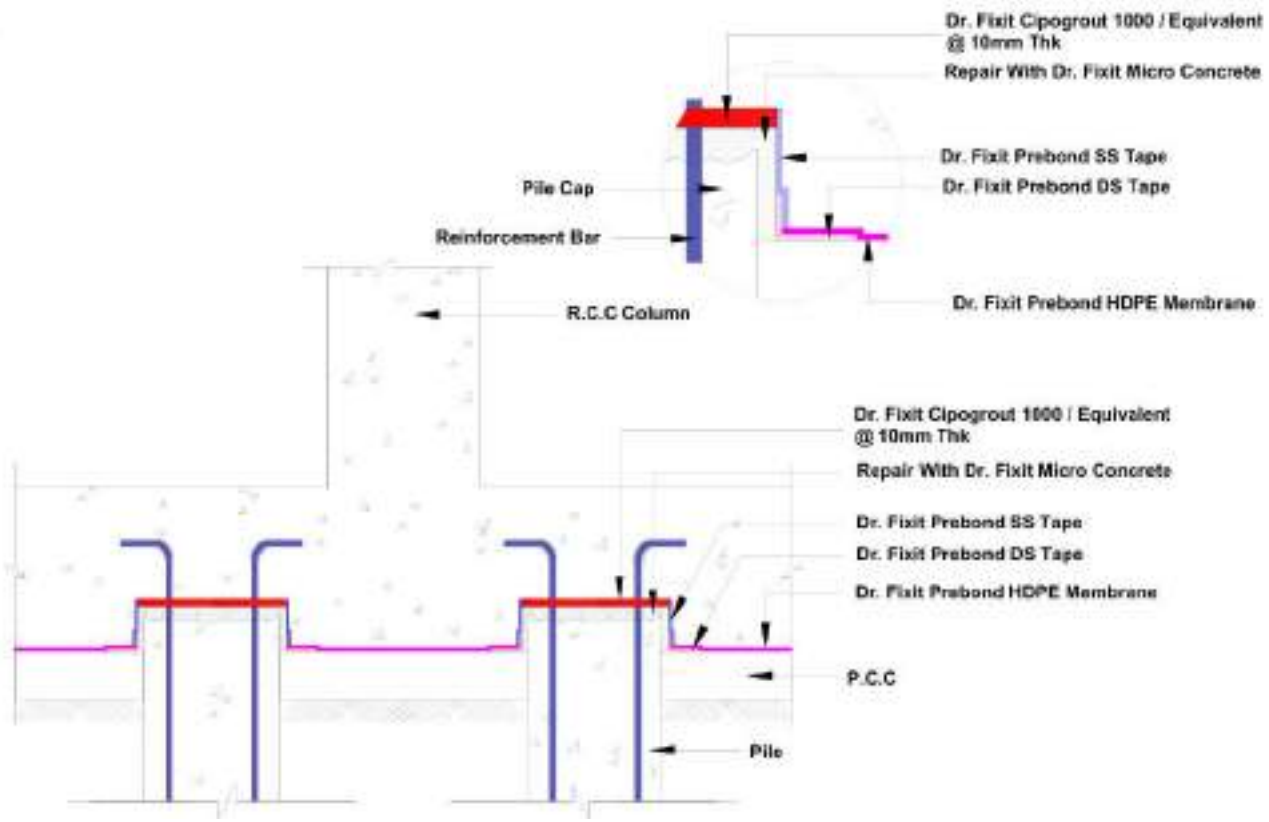
Surface preparation

- Initial cleaning the surface.
- The entire area shall be taken up for thorough surface preparation mechanical removal of debris, laitance and protrusions, etc.
- The area water proofing should be protected with proper barricades.
- Ground water level needs to be kept under footing concrete level by the contractor/client.
- The concrete surface must be free of standing water, debris and mud.

Application Procedure:

- Pile cap reprofiling needs to be carried out to make pile cap top and sides in line and level using Dr. Fixit Micro Concrete/Dr.Fixit Pidigrout 10M in approx. 20mm-50 mm thickness depending upon site condition.
- Initiate moist/hessian curing approx. after 6 hrs of completion of casting and continue the same for min 3 days.

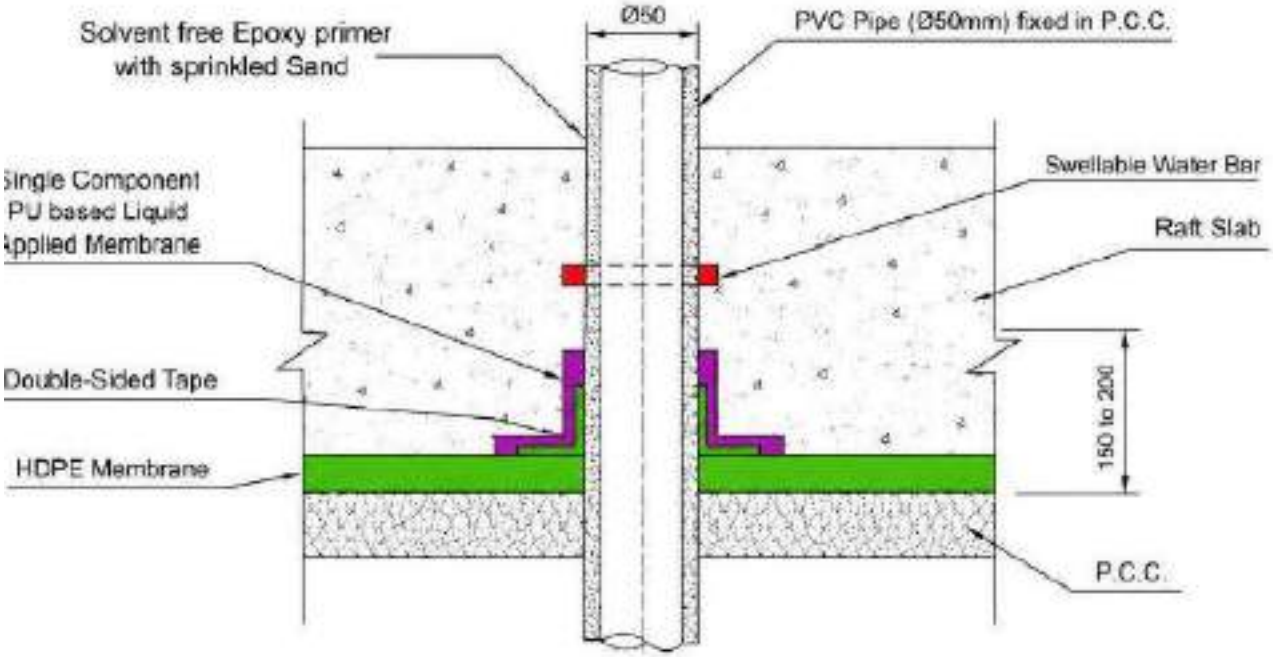
- After completion of curing position Dr. Fixit Prebond DS tape of 100 mm width around profiled pile in such a way that it will be fixed 60mm on PCC (to be cut in petal manner) and 40mm on pile vertical surface. Ensure concrete surface is dry before fixing tapes.
- Remove bottom release liner from DS tape and fix the same over PCC using steel roller to ensure 100 % adhesion without any air pockets.
- Mix and pour Dr. Fixit Cipogrout 1000 or equivalent – 3 component epoxy grout on top of pile in approx. 10 mm thickness and allow the same to cure for 24 hrs.
- Fix Dr. Fixit single sided tape on peripheral vertical side of the pile cap upto full height.
- Continue laying of Dr.Fixit Prebond membrane on PCC and overlapping with Prebond DS tape around pile cap after removing top release liner and rolling the same to ensure full adhesion without any air pockets.



PRP Treatment:

- Providing and fixing Pressure Release Pipe- 50mm dia.
  - During PCC laying, fix dummy PVC Pipe of 25 mm higher dia to create deep impression in the PCC & 50 mm below PCC.
  - Erect PRP Pipe vertically in the above depression with mix of 10 & 20 mm aggregates as filter media placed around it and fix the same with cement mortar. The height of the PRP Pipe shall be 200 mm above FFL of Raft.
  - Placing HDPE by puncturing the same at PRP locations.

- Flashing around PRP
    - At the junction of HDPE membrane with PRP Pipe, Liquid PU flashing or Dr. Fixit Samshield XL 1500 Selfadhesive membrane shall be applied as a flashing with approx. 100 mm overlap on the membrane and 100 mm overlap around the PRP / PRV sleeves etc. complete, as required at site.



PRESSURE RELEASE PIPE

All Dimensions are in MM

Rock Anchor:

Passive Anchors

- Carry out surface preparation to remove loose concrete, mud, dust etc.
- Cast pedestal of 50 mm at junction of rock anchor and PCC using Dr.Fixit Microconcrete and allow the same to cure for 3 days.
- The Pre-bond HDPE membrane shall be cut and terminated around the junction of anchor sleeves bottom and PCC top.
- The Rock Anchors shall be dressed with Flexi PU 270 (I) flashing over the Pre-bond membrane to seal the gap between membrane & sleeves.
- Caution: In case of Rock anchors placed very closed to each other having no clear space between the anchor rods, a pedestal (single pedestal clubbing 2-3 rock anchors) must be casted with Non-shrink cementitious grout, Pidigrout 10M (Mixing & placing as mentioned in Technical datasheet) and the membrane terminations and PU flashings shall be done around the pedestals.

Active Anchors:

- Carry out surface preparation to remove loose concrete, mud, dust etc.
- Cast pedestal of 50 mm at junction of rock anchor and PCC using Dr.Fixit Micro concrete and allow the same to cure for 3 days.
- The Dr. Fixit Prebond membrane shall be cut and terminated around the junction of anchor sleeves bottom and PCC top.
- The Rock Anchor sleeves shall be dressed with Dr.Fixit Flexi PU 270 (I) flashing over the HDPE membrane to seal the gap between membrane & sleeves.
- Lay Raft as per the design by the Engineer and the anchors are stressed & fixed.
- The Anchor sleeves at the junctions of RCC / Raft shall be sealed with Cipogrout 100 (The procedure of mixing and pouring as mentioned in Technical datasheet). Grouting shall be done once enough counter weight is achieved as per recommendations from consultant.
- Caution: The sleeves shall be grouted with polyester resin grouts to avoid water leakages through the Rock anchor sleeves.

2. RETAINING WALL WATERPROOFING

METHOD STATEMENT – UNCONFINED RETAINING WALL WATERPROOFING - DR. FIXIT FLEXIPU 500GC

Scope

The scope of this document covers the application methodology of Dr Fixit FlexiPU 500GC - Single component liquid applied modified urethane/ polyurea elastomeric waterproofing membrane for **Unconfined Retaining walls**.

Substrate Requirements:

Concrete substrate compressive strength should be at least 25MPa and cohesive bond strength at least 1.5MPa.

	Minimum	Maximum
Surface Temperature	+5°C	+60°C
Ambient Temperature	+5°C	+35°C
Residual Moisture	-	-
Relative Humidity	5%	85%
Dew point	Substrate temperature must be 3°C above the dew point	

Materials required-

- Dr. Fixit Flexi PU 500 GC
- Dr. Fixit Cipoxy 16D
- 225 GSM chop strand mesh
- Dr. Fixit Microconcrete
- Dr. Fixit Pidigrout 10M
- Dr. Fixit Feviseal HY 300

Equipment required-

- HDPE Membrane welding machine
- Hot air tool
- Heat melting scraper knife
- Hard roller
- Brush
- Hammer

Surface Preparation:

- Clean the substrate using suitable mechanism / vacuum cleaner to ensure the same is free from laitance, loose or friable materials, debris etc.
- Ensure the concrete substrate is profile free with no ridges or troughs. All contaminants should be removed by mechanical vacuum assisted preparation equipment such as scrabbling/shot blasting/diamond grinding to achieve preferred surface profile of CSP 3.

- Angle Fillets/Vata/Coving must be provided of size of 50 x 50 mm on all vertical up-stands & junctions /corners with polymer modified mortar or using Dr. Fixit Joint Tape as per recommended methodology.

Repairing of Surface Imperfections:

- If concrete surface is found to be defective with pinholes/bug roles/honeycombs etc., it must be filled/ repaired using scratch coat (prepare scratch coat by mixing Dr. Fixit Cipoxy 16D primer and silica flour of 200 mesh in 1:1 ratio). Apply the scratch coat by using suitable spatula/squeeze to get levelled surface.

Cracks treatment and Construction Joint treatment:

- Visible surface cracks/joint gap which are wider than 1 mm should be cut open in square or V -groove manner up to 10 mm width by using mechanical cutter.
- Clean the groove with wire brush/air blower to remove dust, dirt etc. and fill the prepared cracks with Feviseal HY300 sealant and allow it to cure as per datasheet.
- Once sealant is dry 100 wide strip coating to be carried out over cracks/joints by applying single coat of Dr.Fixit FlexiPU 500GC.

Pipe insert/ outlet treatment:

- Apply Dr Fixit FlexiPU 500GC around pipe inserts/outlets using brush/roller and saturate 225 gsm glass fiber strand while the coating is still wet to ensure air pocket and wrinkle free finish.
- Alternatively Dr.Fixit Triflex ProDetail also can be recommended for treatment around pipe insert/out let treatment.

Application – Waterproofing:

Waterproofing membrane application:

- Before application Dr.Fixit FlexiPU 500GC to be stirred using slow speed drill fitted with mixing paddle to ensure material is in homogeneous condition without any solid settlement.

Spray Machine Parameters (in case material required to be sprayed):

- Type of Machine: Single Component Spray Machine with compressor
- Pressure: 5000 psi
- Tip: 0.033 to 0.035 thou

Application over Unconfined Retaining Walls:

- Apply the material using roller or spray over prepared surfaces coverage 0.8-0.9 kg/m2 in single coat.
- While the 1st coat is still wet install 225 gsm chopped glass fiber strand mat and saturate the same by rolling to ensure wrinkle and air-pocket free finish.
- Allow the first coat to cure for 16-24 hrs @ 24°C & 50 % humidity before application of 2nd coat.
- Apply 2nd coat coverage @ 0.5-0.6 kg/m2 to ensure final surface is free from pin holes and wrinkles.
- Total consumption should be 1.4-1.45 kg/m2 in 2 coats to achieve 1.5 mm DFT with chopped glass strand mat.
- Allow the material to cure for 48 hrs before fixing protection board.

Note : To accelerate curing in low temperature or low humidity water can be added to Dr.Fixit FlexiPU 500GC by 2.5-5 % by volume and mix using slow speed drill. In such case mixed material pot life will be 20-30 mins. (Water addition not recommended while adopting spray application)

Termination:

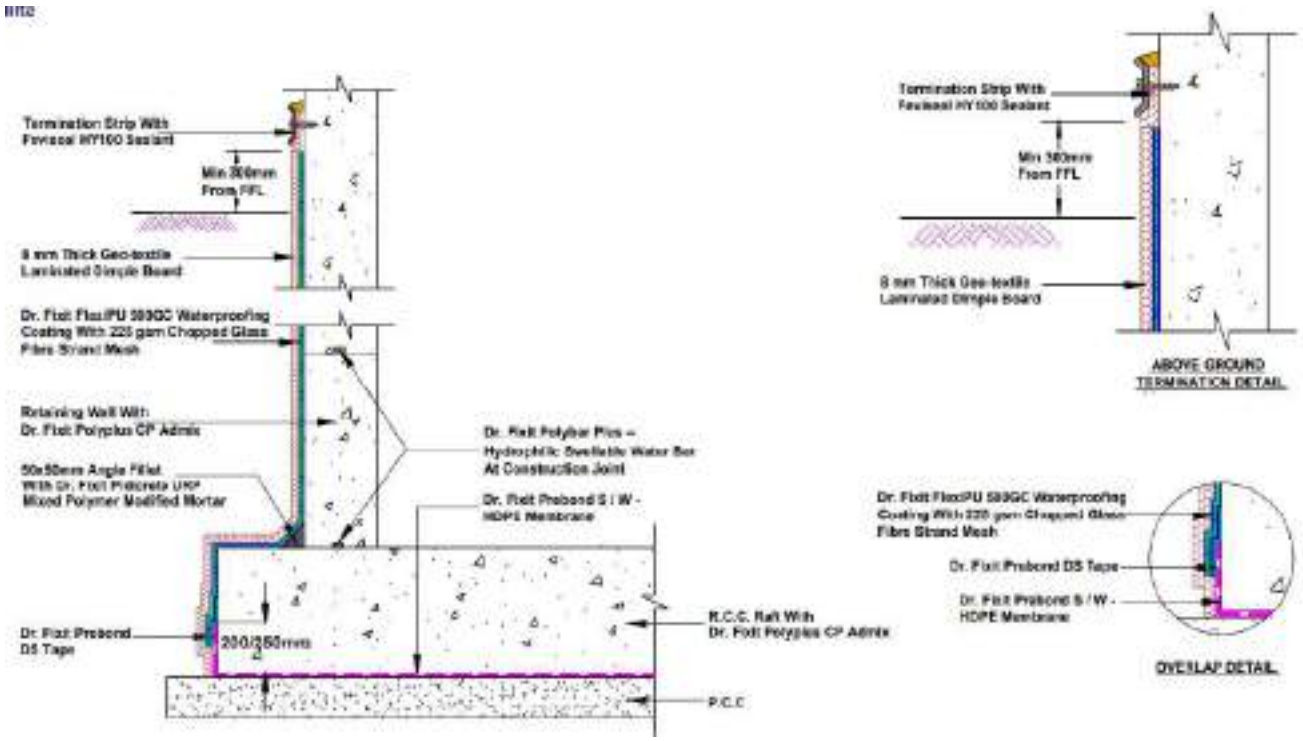
- Dr.Fixit FlexiPU 500GC to be terminated min 300 above FFL level.

Application of Protection Board:

It is recommended to install suitable protection board over polyurea surface min after 48 hrs of completion of coating. Protection board to be fixed by using suitable adhesive by spot bonding method.

<u>Precautions & Limitations:</u>

- Do not apply coating while there is standing or flowing water over substrate.
- Do not apply over any kind of existing coating/curing compound.
- Not recommended for water retaining structures.
- Material should be strictly recommended for use as mentioned above.
- Not recommended to add thinner/solvent into the material.



3.0 METHOD STATEMENT – OVERHEAD/UNDER GROUND WATER TANK WATERPROOFING

Dr. Fixit TankPro W– Polyurethane Coating for Waterproofing and Protection of Water Tanks

MATERIALS NEEDED

1. Dr. Fixit Tank Pro W
2. Dr. Fixit Tank Prime
3. Dr. Fixit Pidicrete AM: Expansive plasticizing admixture
4. Dr. Fixit Pidigrout 10M: Non-shrink cementitious grout
5. Dr. Fixit Pidicrete URP: SBR latex for waterproofing, bond coat and repairs
6. Dr. Fixit Pidigrout 10M: Non-shrink cementitious grout

MACHINERIES & TOOLS NEEDED

1. Buckets, cleaning tools, Nylon Brush, Woolen Roller
2. Wire Brush, Masking Tape, Air Blower, Water Jet Spray
3. Trowel, Hand Grinder and grouting pump.
4. Drilling machine, Chisel and hammer.
5. Accessories: Scale, Sandpaper, Notch Trowel, Brushes, rollers, brushes, buckets etc.

Installation of Hydrophilic Swellable Water bar for vertical and overhead concrete construction joints

- Clean the concrete surface thoroughly to remove dust, slurry, and loose particles, ensuring a sound substrate.
- Position the Dr. Fixit Polybar Plus (20 mm × 10 mm) either in a groove or directly on the concrete surface. Ensure it is placed at the center of the joint with a minimum 80 mm concrete cover on all sides.
- Secure the water bar using Feviseal HY300 adhesive or alternatively with corrosion-free nails at approximately 300 mm spacing. Maintain close contact with the substrate (concrete, steel, or PVC penetrations) to ensure full waterproofing.
- Clean, dampen, concrete surfaces to ensure proper adhesion to ensure proper adhesion before installation. Supply and install Dr. Fixit Polybar Plus hydrophilic swellable 20 mm x 10 mm water bars at the center of construction joints prior to concrete pouring.
- Provide a 20 mm side lap at overlaps. For thicker walls, install two water bars to enhance safety and performance

Surface Preparation:

- Surface needs to be made clean, dry and sound, free of any contamination by wire brushing, which may affect the adhesion of the liquid applied membrane to the substrate. Substrate concrete compressive strength should be cured for 28 days and achieve minimum 20 MPa compressive strength. Wash the concrete substrate with water pressure jet to remove all loose particles and dust.
- Ensure the substrate has properly cured and the concrete is profile free, no ridges or troughs. All contaminants should be removed by mechanical vacuum assisted preparation equipment such as scrabbling/shot blasting/diamond grinding to achieve a light abrasive blast to achieve preferred surface profile of CSP 3.

- If concrete surface is found to be defective with pinholes/bug roles/honeycombs etc., it must be filled/ repaired using scratch coat (prepare scratch coat by mixing Dr. Fixit Cipoxy 16D primer and silica flour of 200 mesh in 1:1 ratio). Apply the scratch coat by using suitable spatula/squeeze to get level surface for the upcoming primer.

Corner treatment – Wall Floor joints and Walls to Walls joint of the water tank:

- Angle Fillets/Vata/Coving must provide at size of 50 x 50 mm for entire length of wall floor joints with cement sand Polymer modified mortar all around the periphery.
- Roughen the wall floor junction with wire brush and remove loose and dirt particles with the air blower. Moisten the surface with water & apply a bonding coat of Dr. Fixit Pidicrete URP and cement (1:1) by volume on cleaned RCC surface. Place angle fillet / coving by using Polymer modified mortar prepare with 1 kg Dr. Fixit Pidicrete URP, 5 kg fresh cement, and 15 kg graded quartz sand. (i.e., in the ratio of 1:5:15) on RCC surface (slab and wall junction) and smooth finish.
- Alternatively, V" grooves shall be cut along the wall & slab joints or construction joints for 10 x 10 mm using a hand cutter.
- After cleaning the groove thoroughly, apply one coat of Dr. Fixit Pidiprime A primer and fill the gap with Feviseal PU/Hybrid sealant (Air curing for 24 to 72 hours according to the room temperature) in the groove. For Hybrid sealant, primer is not required.
- After curing of sealant, apply one coat of Tank Prime primer in a width of 120mm, let it dry and fix the Dr. Fixit Corner Joint tape along the wall-slab joints using Dr. Fixit TankPro W.

Treatment of crack and construction joint in RCC surface

- Existing surface cracks which are more than 1 mm and construction joints should be cut open in square or V - groove manner up to 10 mm width by using mechanical cutter.
- Clean the groove with air blower to remove dust, dirt etc. primmed the groove with Dr. Fixit Pidiprime A and allow it to dry for 2-3 hours. For Hybrid sealant, primer is not required.
- Slide the Feviseal PU/Hybrid Sealant into the applicator gun; extrude the sealant into the cracks ensuring that no air is trapped inside.
- The treated cracks require minimum 6 hours to set and allowed to cure completely for a day. (Self-curing according to the room temperature). The curing rate of the sealant will depend on the depth of the applied sealant.
- **Pipe penetrations and Core Cut treatment:**
- The surface of the pipe shall be free from dust, laitance, oil and water. The core cut shall be free from debris, dust or any foreign materials.
- The pipe to be inserted should appropriately roughened with hacksaw-blade. Dr. Fixit Epoxy Bonding agent shall apply on pipe periphery at bore pack area and followed by sand sprinkle with 2 mm downsize dry and clean sand which will act as a mechanical key to receive non-shrink grout.
- The bore packing shall be done with non-shrink free flow cementitious grout, Dr. Fixit Pidigrout 10M. Mix ready to use grout with water @ ratio of w/p = 0.13 – 0.15 (depending upon the flowability required) with paddle mixer and pour by providing necessary shuttering and support. Allow the grout to set for 24 hrs. And do the moist curing for 5 days.
- The top 10mm widths x 10mm depth around the pipe is to be filled with Feviseal HY 100 Sealant / Dr. Fixit PU Sealant.

- **PRE PONDING TEST:**

1. Pre-Ponding of the tank shall be carried out by filling water to full height for 48 Hrs.
2. In case there is drip leakage or seepage observed, carry out the cementitious injection grouting treatment. Drilling holes and injecting cement slurry by adding shrink compensating plasticizing compound Dr. Fixit Pidicrete AM @ 225 gms. / 50kg bag of cement in the water/cement ratio of 0.45. Inject the slurry through the nozzles of 10 - 12mm diameter with @ 300 mm c/c using mechanical injection grouting pump at an inclined angle over the surface. Post applications seal the packers with Polymer modified mortar.

- **Application of Waterproofing Coating:**

Priming:

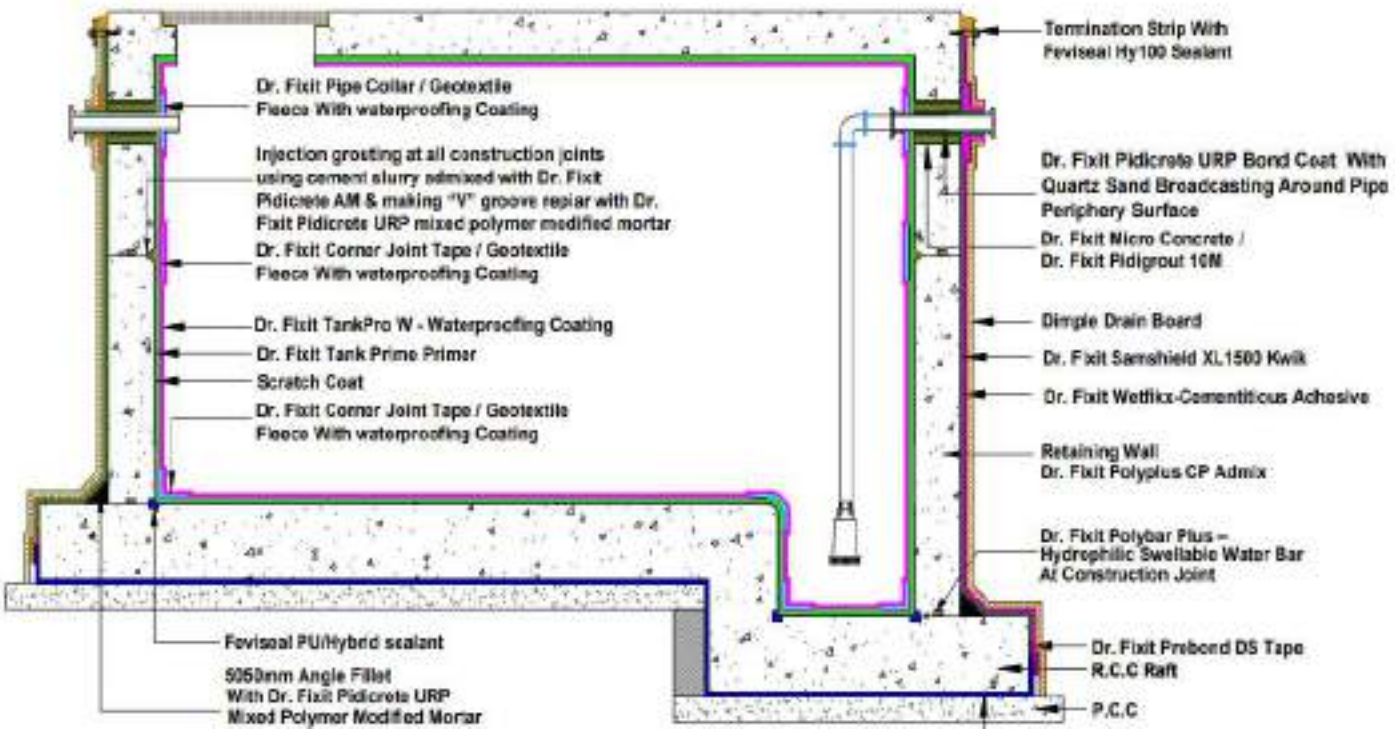
- The entire internal floor & wall concrete surfaces shall be sundried / thumb dry (moisture content <5%), all loose scaling, dust and other deposits shall be blown off with a compressor.
- Dr. Fixit Tank Prime shall be mixed well and applied using sponge roller over the prepared RCC surface in one coat with coverage of 200 gm/m2.
- Self-curing time of 3-12 hours depends upon the climatic conditions.

- **Waterproofing:**

- While mixing, both the components A & B shall be poured into a fresh container and mixed well with slow speed stirrer. Use slow speed (100-300 RPM) paddle mixer for mixing the components.
- Both the components of Dr. Fixit TankPro W should be stirred well before using. Mix the individual material of Part A and Part B. Pour part A into part B and mix properly for 2-3 minutes to get a homogenous solution. Transfer the mixed material into a flat/shallow paint tray so the entrapped air is released. Apply the mixed material on the primed surface by using trowel and finishing with a sponge roller to achieve the desired thickness.
- Apply Dr. Fixit TankPro W when the primer is tack free or before 24 hours from application of primer. In case if it exceeds 24 hours, then a thin coat of primer is recommended.
- Apply with roller in two coats with consumption of 1.4 kg/m2. Since the coating is thixotropic in nature, any pinholes observed should be sealed in the first coat. Hence, the first coat coverage is suggested to be maintained at 0.5Kg/m2 and remaining 0.9Kg/m2 in the second coat. Apply the waterproofing coating to all internal surfaces of the water tank, including walls, floor, and tank cover slab.
- Apply second coat of Dr. Fixit TankPro W in perpendicular direction to first coat between 6 to 12 hr of completion of first coat. In case of it exceed 12 hrs it is suggested to apply fresh coat of primer.
- Any pinholes visible in the 1st coat shall be touched up appropriately with Feviseal PU or Hybrid sealant/Scratch coat (as suggested above).
- Let the coating cure for 3-5 days for full cure.

POND TEST:

Ponding of the slab shall be carried out to check the efficacy of waterproof coating by filling water to 50mm depth for 48 Hrs.


Termination Strip With
Feviseal Hy100 Sealant
Dr. Fixit Pipe Collar / Geotextile
Fleece With waterproofing Coating
Injection grouting at all construction joints
using cement slurry admixed with Dr. Fixit
Pidicrete AM & making "V" groove repiar with Dr.
Fixit Pidicrete URP mixed polymer modified mortar
Dr. Fixit Corner Joint Tape / Geotextile
Fleece With waterproofing Coating
Dr. Fixit TankPro W - Waterproofing Coating
Dr. Fixit Tank Prime Primer
Scratch Coat
Dr. Fixit Corner Joint Tape / Geotextile
Fleece With waterproofing Coating
Dr. Fixit Pidicrete URP Bond Coat With
Quartz Sand Broadcasting Around Pipe
Periphery Surface
Dr. Fixit Micro Concrete /
Dr. Fixit Pidigrout 10M
Dimple Drain Board
Dr. Fixit Sarnshield XL1500 Kwik
Dr. Fixit Wetfixx-Cementitious Adhesive
Retaining Wall
Dr. Fixit Polyplus CP Admix
Dr. Fixit Polybar Plus –
Hydrophilic Swellable Water Bar
At Construction Joint
Feviseal PU/Hybrid sealant
50x50mm Angle Fillet
With Dr. Fixit Pidicrete URP
Mixed Polymer Modified Mortar
Dr. Fixit Prebond DS Tape
R.C.C Raft
P.C.C

5.0 PODIUM WATERPROOFING

METHOD STATEMENT- LANDSCAPE PODIUM – DR. FIXIT FLEXI PU 500GC

Scope

The scope of this document covers the application methodology of Dr Fixit FlexiPU 500GC - Single component liquid applied modified urethane/ polyurea elastomeric waterproofing membrane for podium & roof slab.

Substrate Requirements:

Concrete substrate compressive strength should be at least 25MPa and cohesive bond strength at least 1.5MPa.

	Minimum	Maximum
Surface Temperature	+5°C	+60°C
Ambient Temperature	+5°C	+35°C
Residual Moisture	-	-
Relative Humidity	5%	85%
Dew point	Substrate temperature must be 3°C above the dew point	

Material Requirement-

- Dr. Fixit Flexi PU 500 GC
- 225 GSM chop strand mesh
- Dr. fixit Cipoxy 16D
- Dr. fixit Pidicrete URP
- Dr. Fixit Pidiproof LW+
- Dr. Fixit Feviseal HY 300
- Dr. Fixit joint tape

Surface Preparation:

- Clean the substrate using suitable mechanism / vacuum cleaner to ensure the same is free from laitance, loose or friable materials, debris etc.
- Ensure the substrate is properly cured and the concrete is profile free, no ridges or troughs. All contaminants should be removed by mechanical vacuum assisted preparation equipment such as scrabbling/shot blasting/diamond grinding to achieve preferred surface profile of CSP 3.
- Angle Fillets/Vata/Coving must be provided of size of 50 x 50 mm on all vertical up-stands & junctions /corners with polymer modified mortar or using Dr. Fixit Joint Tape as per recommended methodology.
- Mechanical installations e.g. solar panels, AC outdoor unit stands, ladders, lamppost etc. shall be treated using Dr. Fixit Triflex ProDetail as per recommended application methodology.

Repairing of Surface Imperfections:

- If concrete surface is found to be defective with pinholes/bug roles/honeycombs etc., it must be filled/ repaired using scratch coat (prepare scratch coat by mixing Dr. Fixit Cipoxy 16D primer and silica flour of 200 mesh in 1:1 ratio). Apply the scratch coat by using suitable spatula/squeeze to get levelled surface.

Cracks treatment and Construction Joint treatment:

- Visible surface cracks/joint gap which are wider than 1 mm should be cut open in square or V -groove manner up to 10 mm width by using mechanical cutter.
- Clean the groove with air blower to remove dust, dirt etc. and fill the prepared cracks with Feviseal HY300 sealant and allow it to cure as per datasheet.
- Once sealant is dry 100 wide strip coating to be carried out over cracks/joints by applying single coat of Dr.Fixit FlexiPU 500GC.

Pipe insert/ outlet treatment:

- Apply Dr Fixit FlexiPU 500GC around pipe inserts/outlets using brush/roller and saturate 225 gsm glass fiber strand while the coating is still wet to ensure air pocket and wrinkle free finish.
- Alternatively Dr.Fixit Triflex ProDetail also can be recommended for treatment around pipe insert/out let treatment.

Expansion joints:

- Prepare the substrate by means of sand blasting, grinding etc., followed by vacuuming and cleaning. The surface should be slightly rough but levelled.
- Substrate should be dry and the moisture content shall generally be less than 5%.
- Put masking tape, approximately at a distance of 50-75mm, on each side of the joint.
- Apply the Dr. Fixit Tape Adhesive - 2K epoxy based adhesive on each side of the joint up to the total defined area by the masking tapes.
- Choose the right width of the Dr. Fixit Seal Tape (FPO based tape), where at least 50mm stays beyond the edge of the gap on both sides.
- Press the tape firmly into the adhesive bed, avoid air pockets by using rubber roller. Once the 1st layer adhesive is starts setting, covering layer of the same adhesive shall be applied. Care should be taken to avoid any adhesive application at the centre of the tape by covering it with masking tape.
- Once the 2nd layer of adhesive is applied, remove the masking tapes applied on the expansion joint tape and on either side of the joint. Smoothen the edges of epoxy with a brush after removing the masking tapes before the epoxy is set.
- Allow it to cure for 7days.
- To avoid any physical damage and in case of higher water pressure > 1.5 bar up to 3 bars or negative pressure, protect the joint with a metal plate as a best practice.

- For larger spans, the tape can be overlapped minimum 100mm over each other and heat welded by hot air gun at temperatures ~300 °C to make it watertight.

Application – Waterproofing:

Waterproofing membrane application:

- Before application Dr.Fixit FlexiPU 500GC to be stirred using slow speed drill fitted with mixing paddle to ensure material is in homogeneous condition without any solid settlement.

Spray Machine Parameters (in case material required to be sprayed)

- Type of Machine: Single Component Spray Machine with compressor
- Pressure: 5000 psi
- Tip: 0.033 to 0.035 thou

Application over Podium / Roof Slab:

- Apply the material using roller or spray over prepared surfaces coverage 0.8-0.9 kg/m2 in single coat.
- While the 1st coat is still wet install 225 gsm chopped glass fiber strand mat and saturate the same by rolling to ensure wrinkle and air-pocket free finish.
- Allow the first coat to cure for 16-24 hrs @ 24 °C & 50 % humidity before application of 2nd coat.
- Apply 2nd coat coverage @ 0.5-0.6 kg/m2 to ensure final surface is free from pin holes and wrinkles.
- Total consumption should be 1.4-1.45 kg/m2 in 2 coats to achieve 1.5 mm DFT with chopped glass strand mat.
- Allow the material to cure for 48 hrs before carrying out water ponding / fixing protection board.

Note : To accelerate curing in low temperature or low humidity water can be added to Dr.Fixit FlexiPU 500GC by 2.5-5 % by volume and mix using slow speed drill. In such case mixed material pot life will be 20-30 mins while water is added.

Termination

- Dr.Fixit FlexiPU 500GC to be terminated min 300 above FFL level.

Protection of coating

Podium & Roof Slab:

Loosely lay more than 100 GSM geotextile fabric over fully cured Dr. Fixit Flexi PU 500GC as separation layer. Protect the coating with M- 20 grade with polypropylene fibres at minimum thickness of 50 mm and at 1:100 slope toward drain outlet. Angle fillet must be provided while screed application using polymer modified mortar at all junctions. Control joints shall be provided along the length and breadth of entire screed area by using a saw cutting machine within 18-24 Hours of application of screed. The panel size of 3.25 m x 3.25 m is recommended with a maximum panel size of 15 m2, or as specified. All joints to be filled with Dr. Fixit PU sealant or any other elastomeric material.

Protection over waterproof coating (Vertical areas)

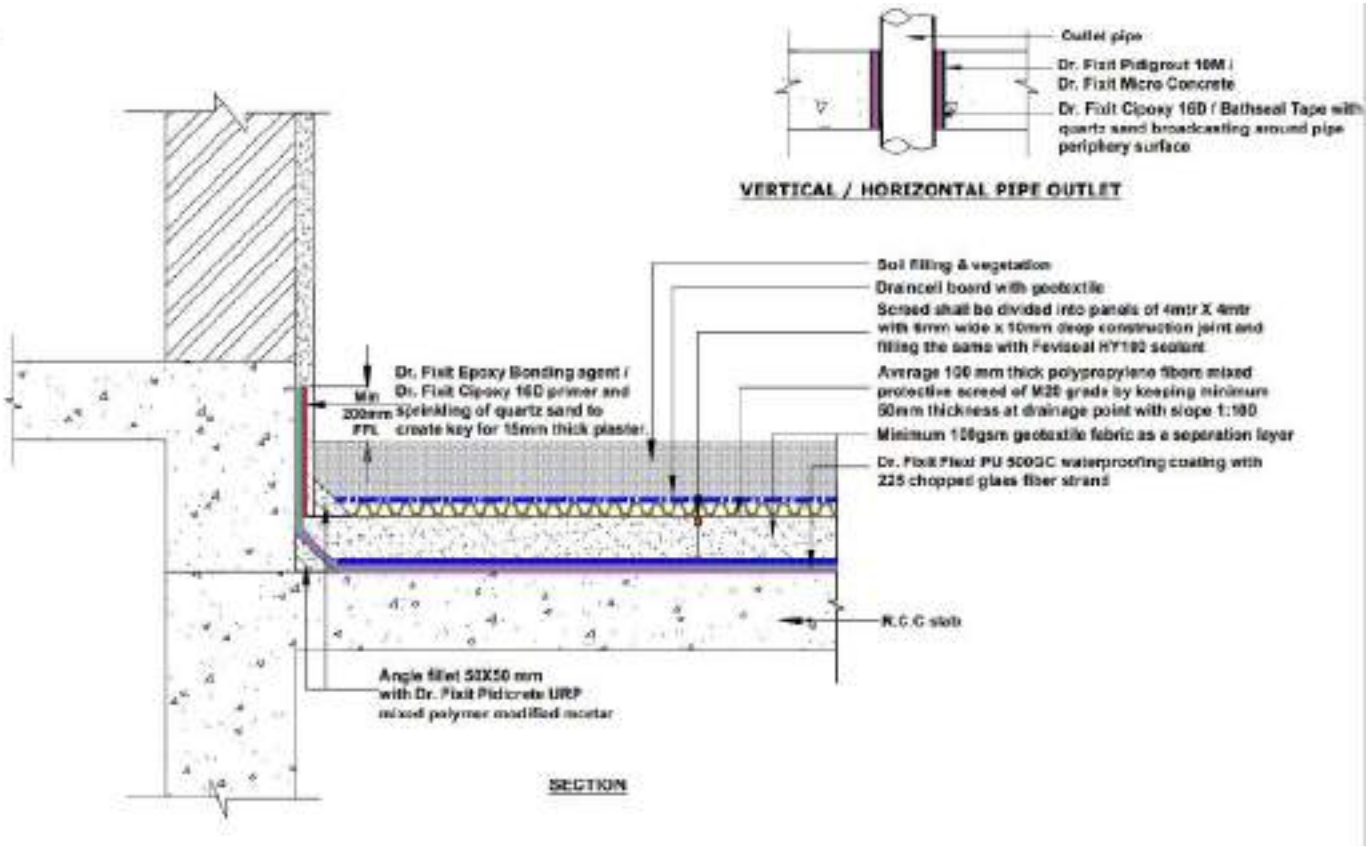
- Over the waterproofing coating apply Dr. Fixit Cipoxy 16D primer consumption @ 75-100 ml/m2, sprinkle dry sand while primer is still wet to create mechanical key. Allow it to dry to form key for the plaster.
- Apply15mm thick plaster in two coats over the prepared surface of cement sand mortar admixed with integral waterproof compound conforming to IS 2645-2003, Dr. Fixit Pidiproof LW+.
- Curing of plastered surface by water sprinkling shall be done for 7 days.

Laying of Drainage Board with filter layer

- Drain Board with filter layer needs to be laid over protection screed to allow excess rainwater or irrigation water to drain away so that growing medium does not become saturated. Specifications of Drainage layer shall be recommended by landscape architects.

<u>Precautions & Limitations:</u>

- Do not apply coating while there is standing or flowing water over substrate.
- Do not apply over any kind of existing coating/curing compound.
- Not recommended for water retaining structures.
- Material should be strictly recommended for use as mentioned above. •
- Not recommended to add thinner/solvent into the material



5.0 METHOD STATEMENT BALCONIES, DECKS, TOILET AREA, KITCHEN, UTILITY, REFUGE AREA DR. FIXIT FASTFLEX ULTRA

MATERIALS NEEDED

1. Dr. Fixit Fastflex Ultra: Two component flexible polymer modified cementitious coating
2. Dr. Fixit Pidicrete AM: Expansive plasticizing admixture
3. Dr. Fixit Pidigrout 10M: Non-shrink cementitious grout
4. Dr. Fixit Pidicrete URP: SBR latex for waterproofing, bond coat and repairs
5. Dr. Fixit Pidigrout 10M: Non-shrink cementitious grout
6. Cement, sand and aggregates etc.,

MACHINERIES & TOOLS NEEDED

1. Buckets, cleaning tools, Nylon Brush, Woolen Roller
2. Wire Brush, Masking Tape, Air Blower, Water Jet Spray
3. Trowel, Hand Grinder and grouting pump.
4. Drilling machine, Chisel and hammer.
5. Accessories: Scale, Sandpaper, Notch Trowel, Brushes, rollers, brushes, buckets etc.

SUBSTRATE PRE -REQUIREMENTS:

Concrete substrate compressive strength should be at least 25MPa and cohesive bond strength at least 1.5MPa, the new concrete to be cured for at least 28 days

SURFACE PREPARATION:

1. Careful surface preparation is essential for optimum finish and durability. The surface needs to be made clean, dry and sound, free of any contamination by wire brushing, which may harmfully affect the adhesion of the membrane.
2. Dirt, fats, oils, organic substances, and dust should be removed with the wire grinding machine. Wash the surface with water pressure jet.
3. Undulation in RCC roof slab surface shall be repaired with Polymer Modified Mortar mixed by adding 1 kg Dr. Fixit Pidicrete URP, 5 kg fresh cement, and 15 kg graded quartz sand. (i.e., in the ratio of 1:5:15)

ANGLE FILLET TREATMENT:

1. Angle Fillets/Vata/Coving must provide at size of 50 x 50 mm for entire length of wall floor joints with cement sand Polymer modified mortar all around the periphery.
2. Roughen the wall floor junction with wire brush and remove loose and dirt particles with the air blower. Moisten the surface with water & apply a bonding coat of Dr. Fixit Pidicrete URP and cement (1:1) by volume on cleaned RCC surface. Place angle fillet / coving by using Polymer modified mortar prepare with 1 kg Dr. Fixit Pidicrete URP, 5 kg fresh cement, and 15 kg graded quartz sand. (i.e., in the ratio of 1:5:15) on RCC surface (slab and wall junction) and smooth finish.

CRACK & CONSTRUCTION JOINT TREATMENT

1. Shrinkage cracks which are more than 1mm should be cut and widen in V shape with mechanical cutter up to 10mm Width. Clean the cracks with the air blower to remove the dust & dirt. Apply a bond coat Dr. Fixit Pidicrete URP & Cement mixed in ratio 1:1 over prepared crack.
2. Fill the crack with Polymer modified mortar mixed with Dr. Fixit Pidicrete URP @ 10% by weight of cement in the ratio of 1:3 (Cement: Sand). Moist cure the surface for minimum 3-4 days.
3. Existing construction joints should be opened in a V-shape, towards the inside, along their entire length, to a depth of 25mm, the area should be dampened well followed by Injection grouting (cementitious grouting) at all construction joints, angle fillet areas & weaker sections @ 1m C/C through the PVC nipples with 40PSI grout pump using cement slurry mixed with non-shrink admixture Dr. Fixit Pidicrete AM @225gms per bag of cement. The same to be filled with polymer modified mortar.

PIPE PENETRATIONS AND CORE CUT TREATMENT:

1. The surface of the pipe shall be free from dust, laitance, oil and water. The core cut shall be free from debris, dust or any foreign materials.
2. The pipe to be inserted, should be appropriately roughened with hacksaw-blade followed by applying a coat of SBR latex or epoxy based bonding agent and over this, sprinkling sand which will act as a key to receive non-shrink grout.
3. The bore packing shall be done with non-shrink free flow cementitious grout, Dr. Fixit Pidigrout 10M or Dr. Fixit Micro Concrete. Mix ready to use grout with water @ ratio of w/p = 0.13 – 0.15 (depending upon the flowability required) with paddle mixer and pour by providing necessary shuttering and support. Allow the grout to set for 24 hrs. And do the moist curing for 5 days.
4. Later, the area around the pipes shall be dressed in high-performance elastomeric cementitious waterproof coating Dr. Fixit Fastflex as follows:
    a. Clean the area at the junction of slab/wall and the pipe inserts. Stir well the material of Dr. Fixit Fastflex to avoid any clotting and material settlements.
    b. Apply 1 coat of Fastflex over the slab/wall extending it to the pipe inserts surface 50mm on both the surfaces in manner of "L" shape.
    c. Lay 45 GSM glass fibre mesh over the Fastflex coating in wet-on-wet condition immediately after the coating is done to soak and stick to the coating. Allow the coating to air cure for 72 hrs.

PRE PONDING TEST:

1. Pre-Ponding of the tank shall be carried out by filling water to full height for 48 Hrs.
2. In case there is drip leakage or seepage observed, carry out the cementitious injection grouting treatment. Drilling holes and injecting cement slurry by adding shrink compensating plasticizing compound Dr. Fixit Pidicrete AM @ 225 gms. / 50kg bag of cement in the water/cement ratio of 0.45. Inject the slurry through the nozzles of 10 - 12mm diameter with @ 300 mm c/c using mechanical injection grouting pump at an inclined angle over the surface. Post applications seal the packers with Polymer modified mortar.

APPLICATION OF DR. FIXIT FASTFLEX ULTRA COATING:

1. Use slow speed mechanical mixer, add powder component slowly to the polymer in a clean container. Stir till smooth and homogeneous slurry, without any lumps, is achieved.
2. Allow the mixed slurry to stand for 2-3 minutes for releasing entrapped air during.
3. The surface of application must be pre-wetted thoroughly with water & brought to a touch dry state. Take up the first coat application of Dr. Fixit Fastflex Ultra with a stiff nylon brush. Work well into the substrate, to ensure that all small undulations are filled with the coating.
4. All corners, angle fillet, (Wall & floor junctions) and vertical angles, drainage flange, & PVC / CI pipes joints must be sealed with liberal amount Dr. Fixit Fastflex Ultra sandwich with 45-50 GSM glass fibre mesh minimum 100mm wide. Wait until first coat is dry then apply the second coat to completely embed the glass fibre mesh with Dr. Fixit Fastflex Ultra. Ensure reinforcing mesh fully wetted out and free from creases &/or air pockets.
5. After completion of first coat and allowed to cure for minimum 4 to 6 hours, take up second coat application in a direction perpendicular to the first. Apply at coverage 0.45 - 0.50 M2 / Kg / 2 coats with a roller or brush on the prepared concrete substrate.
6. Apply the coating on the mother slab and continue up to 300mm above on the vertical walls.
7. On shower wall area without ledge wall, the coating should be extended up to 2000mm above FFL and on opposite shower wall, side shower wall, chased wall area, the coating should be extended up to 900mm above FFL. On un chased walls, the coating should be extended up to 450mm from FFL.
8. Allow to air cure coating completely for 3-5 days before lying of CM screed & tile installation work

POND TEST:

Ponding of the slab shall be carried out to check the efficacy of waterproof coating by filling water to 50mm depth for 48 Hrs.

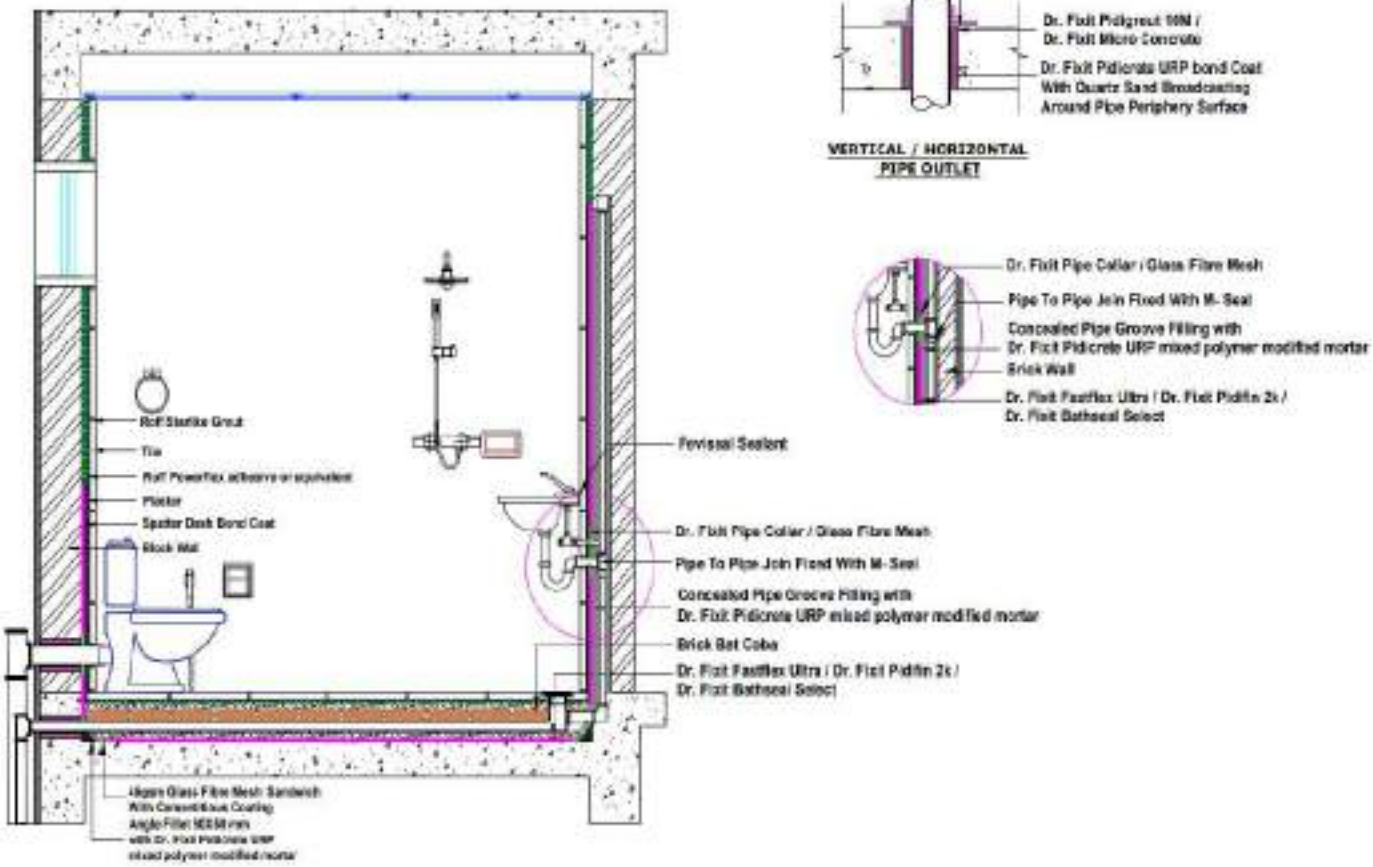
HORIZONTAL SLOPE & PROTECTION: (BRICK BAT COBA)

1. Lay cement sand mortar to provide protection to the coating and bedding mortar of 12mm thick screed and provide slope of 1:80 towards the drain outlets for effective and efficient draining of water, admixed with integral waterproofing admixture Dr. Fixit Pidiproof LW+ conforming to IS 2645:2003 @ 200 ml per bag of cement.
2. Brick bats bed~100mm shall be laid to required slope/gradient over the screed of cement mortar leaving 15-25 mm gap between two bats finishing and applied over the surface, preparing the haunches/ gola on the floor wall junction. The surface should be neatly finished with the help of wooden / steel hand float.
3. The finished surface smooth, curing of the surface by ponding shall be done for 7 days.

PROTECTION TO WATERPROOF COATING ON VERTICAL SURFACES – CIVIL CONTRACTOR SCOPE

1. Apply 1 coat of spatter dash bond coat over the waterproof coating on the vertical walls. For preparing of dash coat mix 1 part Dr. Fixit Pidicrete URP: Cement and 2 parts of clean fine coarse sand and 1 part water to make thick slurry coat which is flicked on the surface for providing key and the base for the final plastering.

2. Lay 12mm thick plaster over the prepared surface of cement sand mortar admixed with integral waterproofing compound Pidiproof LW+.
3. The surface brooming, curing of the surface by water sprinkling shall be done for 7 days.



6.0 TERRACE WATERPROOFING

METHOD STATEMENT – TERRACE WATERPROOFING – DR. FIXIT FLEXI PU 500 GC

Scope:

The scope of this document covers the application methodology of Dr Fixit FlexiPU 500GC - Single component liquid applied modified urethane/ polyurea elastomeric waterproofing membrane for podium & roof slab.

Substrate Requirements:

Concrete substrate compressive strength should be at least 25MPa and cohesive bond strength at least 1.5MPa.

	Minimum	Maximum
Surface Temperature	+5°C	+60°C
Ambient Temperature	+5°C	+35°C
Residual Moisture	-	-
Relative Humidity	5%	85%
Dew point	Substrate temperature must be 3°C above the dew point	

Material Requirement-

- Dr. Fixit Flexi PU 500 GC
- 225 GSM chop strand mesh
- Dr. fixit Cipoxy 16D
- Dr. fixit Pidicrete URP
- Dr. Fixit Pidiproof LW+
- Dr. Fixit Feviseal HY 300
- Dr. Fixit joint tape

Surface Preparation:

- Clean the substrate using suitable mechanism / vacuum cleaner to ensure the same is free from laitance, loose or friable materials, debris etc.
- Ensure the substrate is properly cured and the concrete is profile free, no ridges or troughs. All contaminants should be removed by mechanical vacuum assisted preparation equipment such as scrabbling/shot blasting/diamond grinding to achieve preferred surface profile of CSP 3.
- Angle Fillets/Vata/Coving must be provided of size of 50 x 50 mm on all vertical up-stands & junctions /corners with polymer modified mortar or using Dr. Fixit Joint Tape as per recommended methodology.
- Mechanical installations e.g. solar panels, AC outdoor unit stands, ladders, lamppost etc. shall be treated using Dr. Fixit Triflex ProDetail as per recommended application methodology.

Repairing of Surface Imperfections:

- If concrete surface is found to be defective with pinholes/bug roles/honeycombs etc., it must be filled/ repaired using scratch coat (prepare scratch coat by mixing Dr. Fixit Cipoxy 16D primer and silica flour of 200 mesh in 1:1 ratio). Apply the scratch coat by using suitable spatula/squeeze to get levelled surface.

Cracks treatment and Construction Joint treatment:

- Visible surface cracks/joint gap which are wider than 1 mm should be cut open in square or V -groove manner up to 10 mm width by using mechanical cutter.
- Clean the groove with wire brush/air blower to remove dust, dirt etc. and fill the prepared cracks with Feviseal HY300 sealant and allow it to cure as per datasheet.
- Once sealant is dry 100 wide strip coating to be carried out over cracks/joints by applying single coat of Dr.Fixit FlexiPU 500GC.

Pipe insert/ outlet treatment:

- Apply Dr Fixit FlexiPU 500GC around pipe inserts/outlets using brush/roller and saturate 225 gsm glass fiber strand while the coating is still wet to ensure air pocket and wrinkle free finish.
- Alternatively Dr.Fixit Triflex ProDetail also can be recommended for treatment around pipe insert/out let treatment.

Expansion joints:

- Prepare the substrate by means of sand blasting, grinding etc., followed by vacuuming and cleaning. The surface should be slightly rough but levelled.
- Substrate should be dry and the moisture content shall generally be less than 5%.
- Put masking tape, approximately at a distance of 50-75mm, on each side of the joint.
- Apply the Dr. Fixit Tape Adhesive - 2K epoxy based adhesive on each side of the joint up to the total defined area by the masking tapes.
- Choose the right width of the Dr. Fixit Seal Tape (FPO based tape), where at least 50mm stays beyond the edge of the gap on both sides.
- Press the tape firmly into the adhesive bed, avoid air pockets by using rubber roller. Once the 1st layer adhesive is starts setting, covering layer of the same adhesive shall be applied. Care should be taken to avoid any adhesive application at the centre of the tape by covering it with masking tape.
- Once the 2nd layer of adhesive is applied, remove the masking tapes applied on the expansion joint tape and on either side of the joint. Smoothen the edges of epoxy with a brush after removing the masking tapes before the epoxy is set.
- Allow it to cure for 7days.
- To avoid any physical damage and in case of higher water pressure > 1.5 bar up to 3 bars or negative pressure, protect the joint with a metal plate as a best practice.

- For larger spans, the tape can be overlapped minimum 100mm over each other and heat welded by hot air gun at temperatures ~300 °C to make it watertight.

Application – Waterproofing:

Waterproofing membrane application:

- Before application Dr.Fixit FlexiPU 500GC to be stirred using slow speed drill fitted with mixing paddle to ensure material is in homogeneous condition without any solid settlement.

Spray Machine Parameters (in case material required to be sprayed)

- Type of Machine: Single Component Spray Machine with compressor
- Pressure: 5000 psi
- Tip: 0.033 to 0.035 thou

Application over Podium / Roof Slab:

- Apply the material using roller or spray over prepared surfaces coverage 0.8-0.9 kg/m2 in single coat.
- While the 1st coat is still wet install 225 gsm chopped glass fiber strand mat and saturate the same by rolling to ensure wrinkle and air-pocket free finish.
- Allow the first coat to cure for 16-24 hrs @ 24°C & 50 % humidity before application of 2nd coat.
- Apply 2nd coat coverage @ 0.5-0.6 kg/m2 to ensure final surface is free from pin holes and wrinkles.
- Total consumption should be 1.4-1.45 kg/m2 in 2 coats to achieve 1.5 mm DFT with chopped glass strand mat.
- Allow the material to cure for 48 hrs before carrying out water ponding / fixing protection board.

Note : To accelerate curing in low temperature or low humidity water can be added to Dr.Fixit FlexiPU 500GC by 2.5-5 % by volume and mix using slow speed drill. In such case mixed material pot life will be 20-30 mins.

Termination:

- Dr.Fixit FlexiPU 500GC to be terminated min 300 above FFL level.

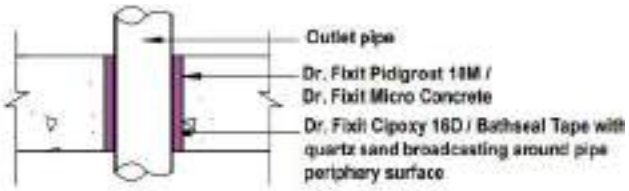
Protection of coating:

Podium & Roof Slab:

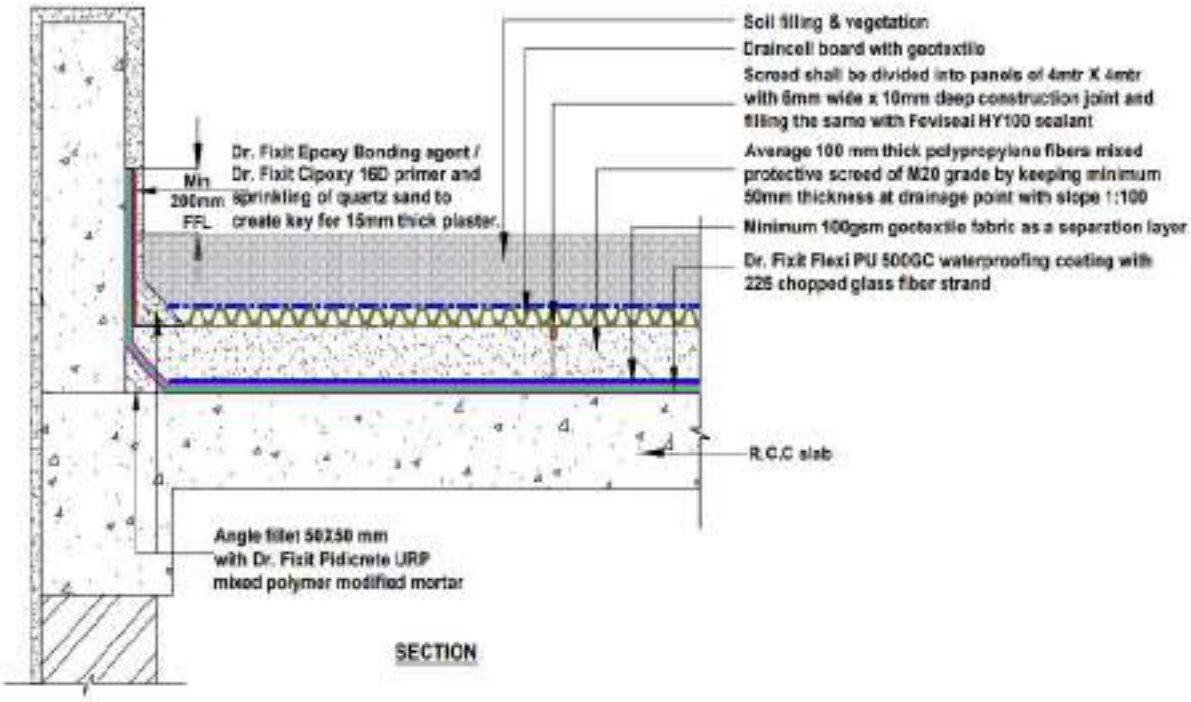
Loosely lay more than 100 GSM geotextile fabric over fully cured Dr. Fixit Flexi PU 500GC as separation layer. Protect the coating with M- 20 grade with polypropylene fibres at minimum thickness of 50 mm and at 1:100 slope toward drain outlet. Angle fillet must be provided while screed application using polymer modified mortar at all junctions. Control joints shall be provided along the length and breadth of entire screed area by using a saw cutting machine within 18-24 Hours of application of screed. The panel size of 3.25 m x 3.25 m is recommended with a maximum panel size of 15 m2, or as specified. All joints to be filled with Dr. Fixit PU sealant or any other elastomeric material.

Precautions & Limitations:

- Do not apply coating while there is standing or flowing water over substrate.
- Do not apply over any kind of existing coating/curing compound.
- Not recommended for water retaining structures.
- Material should be strictly recommended for use as mentioned above.
- Not recommended to add thinner/solvent into the material.



VERTICAL / HORIZONTAL PIPE OUTLET



SECTION

Dr. Fixit Fastflex Ultra

TWO COMPONENT, HIGHLY FLEXIBLE CEMENTITIOUS COATING

Description

Dr. Fixit Fastflex Ultra is a two-component acrylic polymer modified cementitious product, consisting of Part A liquid) and Part B (powder) when yields a flexible waterproofing coating with excellent water resistance and crack-bridging capability.

Areas of Application

Dr. Fixit Fastflex Ultra is recommended as a waterproofing membrane below concrete, mortar, tiles etc. Typical applications include:

- Wet areas, Bathrooms and kitchens.
- Flat and Pitched Roofs.
- Terraces and balconies.
- Swimming pools.
- Water tanks, sumps and reservoirs.
- For trafficable area application, it is advisable to protect the cured membrane of Dr. Fixit Fastflex Ultra by covering with protective screed or tiles.

Features & Benefits

- High polymer solids ensuring excellent barrier properties.
- Enhanced Rheology: Enables roller application, leading to time saving with easy and faster application
- Flexible: accommodates and bridges cracks >1.5mm when subject to normal building movements including hairline cracks.
- Permeable to water vapours: Allows surface to breath and water vapour to escape from the substrate.
- Resists both positive and negative hydrostatic pressure.
- Excellent bond to concrete, masonry surfaces.
- Nontoxic: Can be safely used as internal waterproofing of potable water tanks.

Method of Application

1 SURFACE PREPARATION:

- The surface of application must be thoroughly prepared by mechanical means, to remove all loose particles, laitance, etc.
- Oil and grease, if any, must be de-greased with suitable solvents. It then must be washed off with jet of water and brought to touch dry state.
- Any surface undulations, cracks and crevices must be duly filled or repaired with cement sand mortar mixed with latex polymers such as Dr. Fixit Pidicrete URP.
- All vertical up-stands & junctions /corners are provided with 45° fillet with Polymer Modified Mortar (PMM), mixed with Dr. Fixit Pidicrete URP all around the periphery of the junction. Substrate must be in a "Saturated Surface Dry" (SSD) condition (damp, without standing water) prior to application.

2 MIXING:

- Using a slow speed mechanical mixer and a clean suitable mixing vessel, slowly add the powder component to the liquid polymer and stir until a smooth and homogenous slurry, is achieved.
- Allow the mixed slurry to stand for 5 – 10 minutes before use.
- Do not dilute with water.

3 APPLICATION :

- All the pipe inserts or sanitary fittings should have been fitted grouted with suitable products from the Dr. Fixit range well before taking up the application.

- The surface of application must be pre-wetted thoroughly with water & brought to a touch dry state. Take up the first coat application with a stiff nylon brush/roller. Work well into the substrate, to ensure that all small undulations are completely filled with the coating.
- Provide and lay 45 GSM glass fibre mesh over the angle fillet when the first coat in still wet or use Dr. Fixit Corner Joint Tape and Pipe collars embedded between the 2 coats.
- 6 to 8 hrs after completion of first coat, take up second coat application in a direction perpendicular to the first.
- Complete the application and leave to air cure for 3-5 days. A moist hessian cloth can be kept over the coated surface to protect it from the effect of direct sunlight, in case of bathrooms and internal areas, leave the coating for air curing for 3-5 days at least.
- For vertical walls in bathroom ensure internal plaster is sound, levelled and mixed with Dr. Fixit Pidiproof LW+, Apply 2 coats of Dr. Fixit Fastflex Ultra on all over shower area, and upon curing apply a spatter dash bond coat, this will provide key for subsequent plaster or tile adhesive.

4 WATERPROOFING OF ROOF AND WATERTANKS:

- General waterproofing if applied in areas exposed to foot traffic must be protected with a screed overlaid, during the application itself.
- When coating for internal walls of water tanks, apply a spatter dash bond coat. This will facilitate anchoring for subsequent plaster.

5 WATERPROOFING OF SWIMMING POOLS:

- Apply Dr. Fixit Fastflex Ultra in 3 coats with each coat perpendicular direction to previous applied at the 6-8 hours interval at 3Kg/m2 coverage.
- Extend the coating up to the full height of internal RCC walls. After curing apply a spatter dash bond coat, this will provide key for subsequent plaster or tile adhesive.

Precautions & Limitations

- Do not add water or dilute Dr. Fixit Fastflex Ultra during application.
- Do not do part mixing, mix complete pack.
- Dr. Fixit Fastflex Ultra needs at least 3-5 days for curing.
- Do not cure by flooding with water or conduct any ponding test before it gets completely cured.
- Do not apply when temperatures are below 15 deg C and above 40 deg C
- The proper formation of the coating film can be affected if the coating is applied when the air temperature is below the specified temperature range (15 deg C). Temperature variations can affect the (film formation) of a coating.
- Concrete & masonry surfaces must be cured for 28 days before application.
- Overlay of a cementitious screed must be done within 24 to 48 hrs after curing.
- Additionally, for Bathrooms/Wet areas etc. The waterproofing coating should be done on levelled surface. For the application over brick/block/RCC walls, refer detailed application methodology.

Technical Information

PROPERTY	TEST METHOD	RESULTS
Nature & Mixing Ratio	Internal	2 component cementitious coating (1 part polymer & 1.2-part powder)
Mix Density @30 degC	Internal	1.55 +/- 0.1
Pot life of Mix @30 degC	Internal	60 minutes
Touch Dry Time	Internal	60 minutes
Intercoat application time	Internal	6-8 hrs
Elongation at break	ASTM D412: 2016	>200%
Tensile Strength	ASTM D412: 2016	>1.0 Mpa
Water Vapour Transmission	ASTM E96: 2022	22.6 g/m²/day
Adhesion Strength	ASTM D 7234:2019	>1.2 MPa
Water Permeability	EN 12390-8:2019	Passes 5 bar Positive pressure
Food Grade Certification	Tested at CFTRI as per US FDA CFR 175.300	Passes
Crack Bridging Ability	EN 1062 – 7 : 2004 (Method A*)	A4#

#width of the crack bridged >1250µm
* Tested under room temperature for one cycle
Note: Technical Data is based on laboratory tests under controlled conditions and specimen cured for 28 days. Actual performance may vary due to substrate, environment, application method, and equipment accuracy.

Theoretical Coverage*:

The approximate coverage is 2-2.2 Kg/sqm applied in 2 coats (DFT min.1 mm). The per pack coverage is as follows:.

PACK	COVERAGE
5Kg Polymer + 6Kg Powder	Approx. 5.0 - 5.5 m²
20Kg Polymer + 24Kg Powder	Approx. 20-22 m²

Sprayable using rotor-stator, rotoflex, or low-pressure piston pumps. For equipment guidance, contact our technical team.

Packaging

11 Kg & 44 Kg

Shelf Life & Storage

Shelf life is 12 months from the date of manufacturing if stored in original and unopened packaging in a cool dry place between 5°C and 30°C. The product should be protected from frost, sources of heat and away from direct sunlight.

DR. FIXIT®
WATERPROOFING EXPERT

Health & Safety Precautions

This product is a water-based emulsion of non-hazardous polymer. It is non-flammable and essentially non-toxic. Normal industrial hygiene procedures should be adhered, and it is recommended that gloves and eye protection be worn. In case of skin or eye contact thoroughly irrigate with water and seek medical advice if any irritation develops or persists. In the case of accidental ingestion, wash mouth out with water and seek medical attention. Spillages should be cleaned up immediately with water as they will leave a film on evaporation. See MSDS for further information.

Other Products Categories available

Dr. Fixit brings you the widest range of Construction Chemicals

Pidilite

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Dr. Fixit FlexiPU 500 GC

A SINGLE COMPONENT, LIQUID APPLIED, MODIFIED URETHANE/POLYUREA ELASTOMERIC WATERPROOFING MEMBRANE FOR DAMP/GREEN CONCRETE.

Description

Dr. Fixit FlexiPU 500 GC is a seamless and joint free waterproofing system created from a single component, moisture triggered liquid applied, coal tar free, urethane/polyurea roofing and waterproofing membrane system for vertical and horizontal surfaces specially where high moisture content in concrete is anticipated. The system can be applied in horizonal and vertical surfaces using roller, squeeze or spray method as per site requirements.

Standard compliance / Specification

Dr. Fixit FlexiPU 500 GC meets the requirements of ASTM C836.

Typical Applications

- Unconfined retaining walls
- Roof & Podium
- Wet areas
- Landscape areas

Features

- Moisture Insensitive
- Can be applied to wet concrete after 24 hrs of casting/de-shuttering
- Single component
- Can achieve 1.5 mm DFT in 2 coats on vertical surfaces
- Primerless system
- Can be applied by roller, squeeze or spray
- Suitable for vertical and horizontal substrates
- Root Resistance
- Dynamic Crack Bridging ability
- High tensile & tear strength

Method of Application

1 SURFACE PREPARATION

- Concrete substrate should be sound. Any loose cement slurry, concrete flakes, curing compound, dust etc. needs to be removed by a suitable mechanical surface preparation method to achieve CSP 3 profile. Possible surface irregularities need to be repaired.

2 TREATMENT OF JOINTS AND CRACKS

- Apply a strip coat using Dr. Fixit FlexiPU 500 GC with chopped glass fiber strands in 100 mm width for cracks wider than 1.0 mm width after application of Dr. Fixit PU Sealant.

3 APPLICATION OF WATERPROOFING COATING

- Before application Dr. Fixit FlexiPU 500GC should be thoroughly stirred using mechanical mixer at slow speed to ensure a homogeneous material. Take care not to allow entrapment of air into the material. Do not mix in an up and down motion.
- Dr. Fixit FlexiPU 500GC can be applied at 1.5-2.0 mm thickness reinforced with 225 gsm chopped glass fiber stand.
- Apply the first coat of Dr. Fixit FlexiPU 500GC on prepared surface using suitable roller or airless spray consumption @ 0.8-0.9 kg/m^2.
- While 1st coat is still wet install 225 gsm chopped glass fiber strand and roll to saturate in coating to ensure wrinkle and air pocket free finish.
- Allow the first coat to dry for 16-24 hrs @ 24^{0}C temperature and 50 % relative humidity.

- Apply the second coat in perpendicular direction using suitable roller or airless spray machine coverage @ 0.5-.6 kg/m^2.
- Allow coating to dry for min 48 hrs before commencing successive activity.

Note : To accelerate curing in low temperature or low humidity water can be added by 2.5-5 % by volume.

6 SPRAY MACHINE

- Single Component Spray Machine
- Pressure:5000 psi
- Tip: 0.033 to 0.035 inch

7 PROTECTION OF WATERPROOFING MEMBRANE

Horozontal surface

- Loosely lay minimum 100 gm/m2 geotextile over cured Dr. Fixit FlexiPU 500GC as separation layer, before concrete screed is laid. Protect the liquid applied membrane in maximum 10 days of application using M20 grade concrete screed modified with polylpropelyne fibers in 1:100 slope or with any other suitable means to protect the membrane from extended UV exposure and/or from mechanical damages and fill the saw cut joints using Dr.Fixit PU Sealant.
- Angle fillet must be provided while screed application using polymer modified mortar at all junctions. Control joints shall be provided along the length and breadth of entire screed area by using a saw cutting machine within 18-24 Hours of application of screed. The panel size of 3.25 m x 3.25 m is recommended with a maximum panel size of 15 m^2, or as specified. All joints to be filled with Dr. Fixit PU sealant or any other elastomeric material.

Vertical surface - Unconfined Retaining walls

- The membrane shall be protected after 48 hrs of curing installing a tough, weather, warp and rot proof protection board after application from damage, due to ongoing site activities or from sharp aggregates during backfilling.

Precautions & Limitations

- Do not apply coating while there is standing or flowing water over substrate
- Do not apply over any kind of existing coating/curing compound.
- Not recommended for water retaining structures.
- Material should be strictly recommended for use as mentioned in typical applications.

Technical Information

Test Parameter	Test Method/condition	Unit	Typical Value
Colour	Visual Inspection	-	Black
Specific Gravity/Density (27±2 ^{0}C)	IS-101	g/cc	1.18 ± 0.3
Solid Content (by weight)	ASTM D 2369	%	89 ± 3 %
Full curing at 24^{0}C	Visual Inspection	Days	7 days
VOC	IS 101	g/l	< 100
Tensile Strength - Plain film	ASTM D412	N/mm^2	2.0
Tensile Strength with 225 gsm chopped glass fiber strand	ASTM D412	N/mm^2	7.0
Elongation-Plain Film	ASTM D412	%	450 ± 50
Puncture Resistance with 225 gsm chopped glass fiber strand	ASTM E154	N	600
Root Resistance	CEN/TS 14416		Pass
Shore A Hardness	ASTM D2240	-	30

Tear Resistance with 225 gsm chopped glass fiber strand	ASTM D624	N/mm	60
Pull off adhesion (Plain film)	ASTM D7234	N/mm^2	> 1.0
Pull off Adhesion (with glass fiber strand)	ASTM D7234	N/mm^2	> 0.5
Service Temperature	Visual Inspection	-	- 30°C to 65°C
Dynamic Crack Bridging Ability	EN 1062-7, Method B, Class B 4.2		Pass
Resistance to Hydrostatic Head upto 7 Bar	ASTM D5385		Pass

Note:

Mechanical properties are derived from testing of Dr. Fixit FlexiPU 500GC applied as per recommended application method in controlled laboratory environment after completion of 14 days of curing. Test results achieved from testing of site-applied samples may vary by 5-7 % depending on circumstances beyond our control such as variation in sample preparation, variation of UTM machine, rate of loading, manual errors, atmospheric conditions, curing conditions & film thickness etc.

Packaging :

18.9 Ltr (22.5 kg) Drum

Dr. Fixit FlexiPU 500GC is supplied in Black color.

Theoretical Coverage :

For 1.5 mm DFT typical consumption shall be 1.4-1.45 kg/m^2 in 2 coats.

Shelf Life & Storage

- Pails should be stored in dry and cool rooms for up to 12 months. Protect the material against moisture and direct sunlight. Storage temperature: 8°C–35°C

Health & Safety

- During application wear protective clothing, gloves and eye goggles during application. Avoid product to contact eyes and skin.
- Skin Contact - Wash immediately with plenty of clean water.
- Eye contact - In the event of eye contact splash plenty of clean water immediately and seek medical advice.

Other Products Categories available

Dr. Fixit brings you the widest range of Construction Chemicals

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DR. FIXIT POLYBAR PLUS

HYDROPHILIC SWELLABLE WATER STOPPER FOR CAST IN SITU CONCRETE

Description

Dr. Fixit Polybar Plus - Hydrophilic water stop based on synthetic rubber that acts as a watertight sealing for construction joints with excellent swelling capabilities. The product retains its own shape after multiple dry-wet cycles. The product remains consistent in its performance throughout its life cycle and the flexibility allows it to fill voids and cracks in the immediate surrounding area.

Dr. Fixit Polybar Plus once come in contact with water will observe slow increase in volume which will cause the waterbar to profile itself into the gaps or cracks to fill cavities to ensure effectively stopping water seepage, even at high external water pressure.

Areas of Application

- Construction joints (Horizontal & Vertical)
- Kicker joints
- Pile Caps
- Diaphragm walls
- Pipe entries

Features & Benefits

- Easy & fast to apply by adhesive or nailing
- Consistence performance
- Unaffected swelling properties by long term wet/dry cycling
- Versatile solution for joints and detailing
- Performs effectively in saline ground water conditions
- Available in different sizes

Method of Application

- Clean the concrete area to remove any loose concrete, cement slurry etc.
- Water bar can be installed in a groove casted in concrete or directly on concrete surface.
- Fixing of Dr. Fixit Polybar Plus is recommended with Feviseal HY300 - High modulus hybrid sealant & adhesive. Alternatively, corrosion free nailing also can be adopted at aprox. 300mm c/c.
- Product to be installed at center of construction joints by keeping minimum concrete cover of 80 mm.
- The product can be adhered to concrete, steel and PVC pipe penetrations with fixing glue.
- Swellable water should be installed in such a way that it has close contact with the concrete substrate to ensure full waterproofing effect.
- For thicker sections of walls 2 water bars can be installed to provide additional safety. (Pl contact Pidilite Technical Service team for similar requirement).
- Water bars should be side lapped by minimum 20 mm at joints.

Precautions

- Dr. Fixit Polybar Plus should not be installed where free standing water is anticipated over the joints.
- Dr. Fixit Polybar Plus is not recommended for high movement joints i.e. expansion joints or isolation joints. Pl consult Pidilite Technical service team for similar requirement.
- Water bar should not be used at joints where there is no concrete above water bar, which may lead to unrestrained swelling.
- Water bar should not be installed in walls where concrete cover is less than 80 mm, to ensure that pressure arising from swelling action is accommodated.

DR. FIXIT®
WATERPROOFING EXPERT

Technical Information

PROPERTIES	TYPICAL VALUES
Color	Red
Density (g/cc)	1.2-1.4
Unrestrained volume expansion in normal water	300 %
Unrestrained volume expansion in salt water	100 %
Shore A Hardness (ASTM D2240)	40 ± 5
Service temp range	-30 °C to +60 °C
Hydrostatic Head Resistance	6 Bar
Weather resistance	Excellent

Note : Testing duration of unrestrained volumetric expansion in normal and salt water shall be 14 days.

Limitations

1 Product is approved for uses only those specifically detailed in this product data sheet. Contact Pidilite Technical Services where any other use is anticipated or intended.

2 Technical properties may vary by 5% due to practical challenges like variation in type & quality of water, testing machines, rate of loading, sample preparation, thickness measurement and other manual erros. Contact Pidilite Technical services in such situations

Packaging

Dr. Fixit Polybar Plus
20 mm x 10 mm – 10 mtr roll (50 Rmt/cartoon)
20 mm x 5 mm – 10 mtr roll (50 Rmt/cartoon)
25 mm x 15 mm - 10 mtr roll (50 Rmt/cartoon)

Feviseal HY 300 - 600 ml Sausage (Coverage : 8-10 Rmt/sausage depending upon surface profile)

Shelf Life

Dr. Fixit Polybar Plus products have a shelf life of 24 months if stored in cool and dry place in original packing to prevent from moisture and premature swellings.

Other Products Categories available

Dr. Fixit brings you the widest range of Construction Chemicals

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Dr. Fixit Polyplus CP Admix

NEW GENERATION INTEGRAL CRYSTALLINE WATERPROOFING AND DURABILITY ENHANCER

Description

Dr. Fixit Polyplus CP Admix is the new generation single component integral crystalline waterproofing and durability enhancer which produces waterproof and durable concrete with hydrophilic crystals by improving corrosion resistance, reduction in cracks and drastically reducing water permeability under hydrostatic pressure.

Dr. Fixit Polyplus CP Admix is the blend of various active chemicals which reacts with Un-hydrated cement particles in presence of water to form in-soluble needle shape crystals. These needle shape crystals fill the pores and capillary tracks and micro cracks within the concrete and permanently sealed against the penetration of water or liquids from both positive and negative side. The concrete is also protected from deterioration due to harsh environmental conditions.

Standard compliances and Specification

- Fulfill requirements of ACI-212-3R-10 Chapter 15 and categorized as PRAH - Permeability Reducing Admixture for Hydrostatic Condition.
- Dr Fixit Polyplus CP Admix possess CE approval as per EN 934-2 and all manufacturing unit are also certified with CE approval.

Areas of Application

Waterproofing of reinforced concrete

- Concrete Slabs on grade & below grade
- Water reservoirs & swimming pools
- Tunnels & subways
- Marine structures
- Warehouses & commercial floors
- Cut and cover structures
- Basements & pits
- Sewage & water treatment plants
- Foundations & civil substructures
- Parking structures
- Pre-cast concrete, cast-in-situ and shotcrete applications
- Protect concrete for durability

Features & Benefits

- Dr. Fixit PolyPlus CP admix contents zero VOC and non toxic in nature.
- Dr. Fixit Polyplus CP Admix compliance with USFDA 170.300 for intended use for aqueous food and beverages.
- Resists extremely high hydrostatic pressure up to 16 Bar.
- Can self-heal crack up to 0.5 mm in presence of moisture.
- Reduces Co-efficient of water permeability by more than 90%.
- Enhances the compressive strength of concrete in long age.
- Reduces drying shrinkage by more than 20%.
- Significantly reduces chloride penetration and improve carbonation resistance.
- Eliminates the risk of alkali silica reaction (ASR) with maximum alkali content of 9%.
- No negative corrosion effect on the reinforcement steel with limited chloride content.
- Protects against sulfate attack.

CE

1317F
Institute for testing and certification
23
1023-CPR-1317F
EN 934-2:2009+A1:2002
Dr Fixit Polyplus CP Admix
Crystalline capillary admixture
Water Resisting Admixture
Chlorie content : <0.1% by mass
Alkali content: <10.0 % mass
Compressive strength : ≥85% of control
Conventional dry material content : >99.5%
Air content in fresh concrete : ≤2% by volume
Capillary Absorption (after 90 days curing) : ≤60% by mass.

Method of Application

- Dr. Fixit Polyplus CP Admix shall mix with freshly mixed concrete at 0.8 - 1% by weight of the cement as per approved mix design quantity. IS 10262-1982 and IS 456-2000 shall adopt to establish concrete mix design to achieve desire performance parameters. Prior mix design trials shall be conducted to ensure cement, plasticizer and Dr. Fixit Polyplus CP Admix compatibility.
- For addition of Dr. Fixit Polyplus CP Admix at centralized ready mix concrete plant, all concrete constitutes e.g. Cement, Mineral admixtures, aggregates, and water shall batch and mix thoroughly as per RMC Code of Practice- IS 4926:2003. Prepare Dr. Fixit Polyplus CP Admix powder slurry by mixing 1 part of Dr. Fixit CP Admix with 1.5 part of water by volume ratio. Dose the slurry into ready mix concrete truck mixer. Ensure minimum 3 minutes mixing for uniform distribution of active ingredient of Dr. Fixit Polyplus CP Admix with entire concrete mass. Amount of water which was used for slurry shall deduct while batching the concrete at Ready mix plant.
- For addition of Dr. Fixit Polyplus CP Admix at site, follow same practice of preparing slurry at recommended ratio of 1 part (Dr. Fixit Polyplus CP Admix) and 1.5 part (Water) by volume and mix thoroughly with ready mix concrete by rotating RMC Truck drum mixer for minimum 3 minutes for uniform distribution. Amount of water which was used for slurry shall deduct while batching the concrete at Ready mix plant.
- Placing, compaction & curing of concrete as per IS 456:2000 standard engineering practice or as instructed by the engineer in charge shall follow strictly.
- Please consult Pidilite Technical advisor for specific type of application and performance parameters.

Precautions & Limitations

- Dr. Fixit Polyplus CP Admix is an effective system for rigid structures only and may not reliably seal movable cracks and joints. However, it can use with other flexible waterproofing system and design for desire waterproofing performance. Please consult Pidilite technical department for clarification and design.
- Setting time of concrete is always affected by chemical ingredients. Set retardation may occur when usage of Dr. Fixit Polyplus CP Admix. The intensity of set retardation is depending upon mix design, curing temperature, cement chemical composition and dosage of Dr. Fixit Polyplus CP Admix in specific volume of concrete. Mix design trial mixes are strongly recommended as per IS 10262 to to establish data on workability, setting time and strength development .
- The temperature of the concrete mix should be above 5ºC
- For best waterproofing performance, always maintain water to cement/ cementitious ratio within limit mentioned by IS 456-2000

Technical Information

PHYSICAL PROPERTIES	SPECIFICATION/TEST METHOD	RESULTS
Appearance	Grey powder	
Bulk density	Maximum 1.4 g/cm^3	
FRESH CONCRETE PROPERTIES (OVER CONTROL)	**TEST METHOD**	**RESULTS**
Slump	IS:1199 (Part 2):-2018	No significant change
Density	IS 1199 -(Part 3)-2018	No significant change
setting time	IS:1199 (Part 7): -2018	No significant change
HARDENED CONCRETE MECHANICAL PROPERTIES OVER CONTROL	**TEST METHOD**	**RESULTS**
Reduction in Coefficient of Water Permeability at 0.8 % dosage.	BS EN; 12390 (Part 8) :2000 (erstwhile DIN 1048)	Reduction by more than 90 % compare to reference concrete
Resist 16 bar Hydrostatic Pressure	BS EN 12390 (Part 8) :2000	Pass – Can resist 16 Bar Hydrostatic Pressure

Self-sealing Cracks in presences of moisture	Customize test method	Heal cracks up to 0.5mm in width
Reduction in Chloride diffusion co-efficient	ASTM C – 1556 – Part 4	Reduction by more than 45 % compare to reference concrete
Reduction in Shrinkage & Cracks	IS 1199:1959 – RA 2018	Reduction by more than 20 %
No detrimental Side effect due to Alkali Silica Reaction (ASR)	Compliance with DIN 18998	Alkali content < 9%
No negative effect on corrosion of steel reinforcement due to chloride content in admixture	Compliance with DIN 18998	Chloride content NIL
Food Grade certification	CFTRI as per USFDA-175.300	Passes

These test results are under lab-controlled atmosphere and actual site results may vary. Please contact technical team for finalization of dosage and properties. We always recommend trials on site before regular production.

Dosage

0.8% - 1% by weight of cement.

Packing

20 kg Bag

Shelf Life

12 months from the date of manufacturing when stored in a cool & dry place, away from direct sunlight.

Health & Safety

- Dr. Fixit Polyplus CP Admix is a dry powder that becomes reactive when mixed with water or human perspiration.
- Avoid contact with skin or eyes.
- Avoid breathing dust. Wear long sleeves, safety goggles and impervious gloves.
- Refer the Material Safety Data Sheet for this product.

Other Products Categories available

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Dr. Fixit Prebond-W

PRE APPLIED FULLY BONDED HDPE WELDABLE MEMBRANE

Description

Dr. Fixit Prebond W membrane is a preformed pre- applied HDPE fully bonded weldable membrane that bonds to the wet concrete cast on the membrane. After the membrane bonds with the concrete it forms an integral seal which prevents lateral water migration and makes it unaffected by any substrate settlement below the slabs. Reinforcement can be directly laid on top of the membrane without screed protection.

Dr. Fixit Prebond W is a unique HDPE membrane comprising of a HDPE layer and a pressure sensitive adhesive layer which is covered by a weather proof protective layer. The adhesive layer is activated when the concrete is poured on the membrane and it enables the membrane bond to underside of the concrete which prevents the ingress of water into the structure as well as prevents tracking of water between the membrane and the structure and provide a positive side protection against ingress of sub soil water. Dr. Fixit Prebond W can be used for horizontal application.

Standard compliance / Specification

Complies with IS 16471:2017 & BS 8102:2022 recommendations for providing Type A protection

Typical Application

- Basements
- Subway and UG metro Stations
- Caverns
- Other underground civil structures.

Features

- Hot welded joints to ensure zero leakage.
- Excellent Adhesion with concrete.
- Fast and easy application.
- Lesser joints and overlaps, due to large roll widths.
- Excellent UV exposure up to 45 days
- Adaptable to varying surface profile of the substrate.
- Resistant to high hydrostatic ground water-pressure
- Resistant to acid, alkali, chlorides and sulphate attack
- Tested for 25 yrs of durability

Method of Application

1 SURFACE PREPARATION

- It is essential to prepare sound and levelled substrate with no gaps,cavities or projecting ribs..
- Horizontal Surface – Monolithic concrete blinding must be free of loose aggregate and sharp protrusions. The surface does not need to be dry. However, standing water must be removed.
- Vertical Surface – Use concrete, sacrificial plywood, masonary with flush levelled joints or other approved facing to provide smooth, level and even support to the membrane.

2 MEMBRANE INSTALLATION

- Dr. Fixit Prebond W membranes to be applied at ambient temperatures of –4^{0}C or above.

3 HORIZONTAL SUBSTRATES

- Place the membrane with adhesive side facing the concrete pour and HDPE film side facing the substrate. End laps should be staggered to avoid a buildup of layers. Accurately position succeeding sheets to overlap the previous sheet by 100 mm along the marked selvedge.

- The HDPE membranes are welded together by hot wedge. End laps and side laps should be with the weld size of minimum 50 mm in case of single weld system. In case of a double weld system, comprising of two parallel welds of 15 mm wide each with a 20 mm air channel gap in between the two weld lines (weld size may little vary as per machine make & model).
- Leister Twinny or other suitable hot wedge equipment is recommended where welding temperature should be around 380°C to 400 °C. Speed of the machine can be adjusted between 3-4 rmt/min.
- After welding the overlap area should be covered with single sided hdpe tape.
- Roll Ends and Cut Edges
  Overlap all roll ends and cut edges by a minimum of 100 mm and ensure the area is clean and free from contamination. Ensure to remove sand and adhesive from membrane before proceeding for welding at joints.
- Extend the membrane on sides of the raft maximum upto 200 mm from bottom of PCC.

4 VERTICAL SUBSTRATES

- Membrane to be hanged vertically by securing the top of the membrane using a batten like termination bar fixing 50 mm below the top edge.
- Vertical welding to be incorporated using potable double seam welding machine. Overlapping locations should be beyond reinforcement locations. Membrane vertical installation and welding should be completed before placing reinforcement.

5 CORNERS

- Internal and external corners should be pre-formed as per manufacturer instruction, overlapping the membrane with a minimum of 100mm selvedge by hot air / hot wedge welding. Ensure that the apex of the corner is covered and sealed with welding.

Technical Properties

PROPERTIES	TYPICAL VALUES- 1.5 MM THICK MEMBRANE	TYPICAL VALUES- 1.8 MM THICK MEMBRANE	TEST METHOD
Colour	White/ Off White	White/ Off White	Visual Observations
Thickness of Composite Membrane	1.5mm	1.8mm	ASTM D 3767
Thickness of Bare HDPE film	0.9 mm	1.2 mm	ASTM D3767
Tensile Strength (Bare HDPE Membrane)	25 N/mm^2	28 N/mm^2	ASTM D412
Elongation (Bare HDPE Membrane)	500%	500%	ASTM D412
Puncture Resistance	1000 N	1500 N	ASTM E154
Low Temperature Flexibility (-25^{0}C)	Pass	Pass	ASTM D1970
Resistance to Hydrostatic Head	70 Mtr	70 Mtr	ASTM D5385
Peel Adhesion to Concrete	1500 N/m	1500 N/m	ASTM D903
Lap joint strength in shear	15000 N/mtr	15000 N/mtr	ASTM D6392
Water Vapour Transmission	0.05 gm/m^2/day 0.03 Perms	0.05 gm/m^2/day 0.03 Perms	ASTM E96
Water absorption	<0.5%	<0.5%	ASTM D570
UV Resistance	45 days pass	45 days pass	Internal Test Method
Dimension Stability	0.1 %	0.1 %	ASTM D1204

All test parameters are obtained under controlled Lab conditions.

Limitations

1. Product is approved for uses only those specifically detailed in this product data sheet. Contact Pidilite technical services where any other use is anticipated or intended.
2. Technical properties may vary by 5 % due to practical challenges like variation in UTM machines, type of loading, sample preparation, thickness measurement and other manual errors. Contact Pidilite Technical Services in such situations.
3. During summer season the membrane adhesive may slightly stick to shoes while walking over it. Please note that this is due to the residual tackiness of the adhesive and it is a normal phenomenon, which will not affect performance of the membrane. Contact Pidilite Technical services in such situations

Note: Tensile strength & elongation has been tested longitudinally. Results in transverse direction may vary.

Packaging

20 mtr x 2.4 mtr & 20 mtr x 2.0 mtr roll @ composite thickness of 1.5 mm & 1.8 mm.

Shelf Life

The shelf life is typically 12 months if stored as per the recommendations in a covered and secured storage space.

Other Products Categories available

Dr. Fixit brings you the widest range of Construction Chemicals

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DISCLAIMER The product information & application details given by the company & its agents has been provided in good faith & meant to serve only as a general guideline during usage. Users are advised to carry out tests & take trials to ensure on the suitability of products meeting their requirement prior to full scale usage of our products. Since the correct identification of the problems, quality of other materials used and the on-site workmanship are factors beyond our control, there are no expressed or implied guarantee / warranty as to the results obtained. The company does not assume any liability or consequential damage for unsatisfactory results, arising from the use of our products.

Dr. Fixit TankPro W

POLYURETHANE COATING FOR WATERPROOFING AND PROTECTION OF WATER TANKS

Description

Dr. Fixit TankPro W is a two-component, solvent-free, thixotropic coating, based on high quality elastomeric polyurethane resins. After polymerization, it produces a strong, elastic, hydrophobic membrane suitable for waterproofing and protection of water tanks.

Areas of Application

Waterproofing and protection of:

- Water tanks made of reinforced cement concrete (RCC).
- Prefabricated concrete tanks, Drinking Water Tanks and other waterbodies.

Features and Benefits

- Excellent adhesion on RCC surface.
- Being solvent-less, it can easily be applied in closed spaces.
- Extremely hydrophobic and hydrolysis resistant.
- Certified for potable water tanks, in accordance with the US FDA 175.300 requirements.
- Single coating for Waterproofing and Protection for water tanks giving faster turaround time.

Method of Application

1 GENERAL SURFACE PREPARATION:

- Surface needs to be made clean, dry and sound, free of any contamination by wire brushing, which may affect the adhesion of the Liquid applied membrane to the substrate. Substrate concrete compressive strength should be cured for 28 days and achieve minimum 20 MPa compressive strength. Wash the concrete substrate with water pressure jet to remove all loose particles and dust.
- Ensure the substrate has properly cured and the concrete is profile free, no ridges or troughs. All contaminants should be removed by mechanical vacuum assisted preparation equipment such as scrabbling/shot blasting/ diamond grinding to achieve a light abrasive blast to achieve preferred surface profile of CSP 4 or CSP 5.
- If concrete surface found to be defective with pinholes/bug roles/honeycombs etc., it must be filled/ repaired using scratch coat prepare by mixing Dr. Fixit Tank Prime/ Dr. Fixit Cipoxy 16D and Dr. Fixit Superseal P100 aggregates / fine silica sand in 1:1 ratio. Apply the scratch coat by using suitable spatula/squeeze to get level surface for the upcoming primer.

2 REPAIR OF CRACKS AND CONSTRUCTION JOINTS:

- Existing surface cracks which are more than 1 mm and construction joints should be cut open in square or V -groove manner up to 10 mm width by using mechanical cutter.
- Clean the groove with air blower to remove dust, dirt etc. primmed the groove with Dr. Fixit Pidiprime A and allow it to dry for 2-3 hours.
- Slide the Feviseal PU/Hybrid Sealant into the applicator gun; extrude the sealant into the cracks ensuring that no air is trapped inside. The hybrid sealant does not require any primer.
- The treated cracks require minimum 6 hours to set and allowed to cure completely for a day. (Self-curing according to the room temperature). The curing rate will depend on the depth of the selant applied.

3 CORNER TREATMENT – WALL TO FLOOR AND WALL TO WALL JOINT:

- Moisten the surface with water & apply a bonding coat of Dr. Fixit Pidicrete URP and cement (1:1) by volume on cleaned RCC surface. Place angle fillet / coving by using Polymer modified mortar prepare with 1 kg Dr. Fixit Pidicrete URP, 5 kg fresh cement, and 15 kg graded quartz sand. (i.e., in the ratio of 1:5:15) on all along the joint RCC surface (slab and wall junction) and smooth finish.
- Alternatively, V" grooves shall be cut along the wall & slab joints or construction joints for 10 x 10 mm using a hand cutter.

- After cleaning the groove thoroughly, apply one coat of Dr. Fixit Pidiprime A primer and fill the gap with Feviseal PU/Hybrid sealant is applied (Air curing for 24 to 72 hours according to the room temperature) in the groove. For Hybrid sealant, primer will not be required.
- After curing of sealant, apply one coat of Tank Prime primer in a width of 120mm, let it dry and fix the Dr. Fixit Corner Joint Tape or 40 GSM geotextile fleece as a reinforcement along the wall-slab joints using Dr. Fixit TankPro W

4 PRIMING:

- The entire internal floor & wall concrete surfaces shall be sundried / thumb dry (moisture content <5%), all loose scaling, dust and other deposits shall be blown off with a compressor.
- Dr. Fixit Tank Prime shall be mixed well and applied using sponge roller over the prepared RCC surface in one coat with coverage of 200 gm/m^2.
- The primer is equipped with a unique feature that enables it to penetrate pinholes and form a hardened micro-spume in the presence of trace moisture. This process facilitates the achievement of the desired moisture content prior to the application of the top coat.
- Self-curing time of 3-12 hours depends upon the climatic conditions.

5 APPLICATION:

- While mixing, both the components A & B shall be poured into a fresh container and mixed well with slow speed stirrer. Use slow speed (100-300 RPM) paddle mixer for mixing the components.
- Both the components of Dr. Fixit TankPro W should be stirred well before using. Mix the individual material of Part A and Part B. Pour part A into part B and mix properly for 2-3 minutes to get a homogenous solution. Transfer the mix into flat paint tray to let the entrapped air vent. Apply the mixed solution on the primed surface by using roller/trowel to achieve the desired thickness.
- Apply Dr. Fixit TankPro W when the primer is tack free or before 24 hours from application of primer. In case if it exceeds 24 hours, then a thin coat of primer is recommended.
- Apply with roller in two coats with consumption of 1.4 kg/m^2. Since the coating is thixotropic in nature, any pinholes should be sealed in the first coat. Hence, the first coat coverage is suggested to be maintained at 0.5Kg/m^2 and remaining 0.9Kg/m^2 in the second coat.
- Apply second coat of Dr. Fixit TankPro W in perpendicular direction to first coat between 6 to 24 hr of completion of first coat. In case of it exceed 24 hrs it is suggested to apply fresh coat of primer.
- Any pinholes visible in the 1st coat shall be touched up appropriately with Feviseal PU or Hybrid sealant/ Scratch coat (as suggested above).
- Let the coating cure for 3-5 days for full cure.

Note:

- For best results, the temperature during application and cure should be between 10° C and 35° C. Low temperatures retard cure while high temperature accelerates curing.
- Pot life will shorten during extreme summer and application needs to be rescheduled in the cooler evenings.
- Additionally, transferring the mixed material into a flat or shallow paint tray facilitates the release of entrapped air, thereby enhancing the pot life of the mixture.
- Use of primer is mandatory to seal the pores and avoid pinholes in the coating surface.
- Any pinholes visible after the 1st coat shall be touch up appropriately with Feviseal PU or Hybrid sealant/Epoxy putty.

Precautions & Limitations

- Although it does not contain volatile substances, it is highly recommended that closed spaces be well ventilated.
- Careful supervision during application is needed, particularly in ensuring proper consumption of material to achieve the desired average thickness & also the curing of concrete.

- Dr. Fixit TankPro W changes color upon exposure to UV light without affecting the technical perfomance of the product.
- Care should be taken, that should not be ingress of water into material from time of mixing to initial drying time of finished product for minimum 7 hours.
- Ensure the moisture should be less than 5% before application of primer and main coat.

PROPERTY	TEST METHOD	OBSERVED VALUE
Mix Ratio(Hardener Part A: Resin Part B) by weight	Internal	1:3.84
Physical Form	Internal	Off White Thixotropic liquid
Specific Gravity of mix	ASTM D1475 @25 °C	1.2-1.3
Solid Content	Internal	100%
Pot Life	@25°C	20 min
Recoat time	--	6-24hrs
Elongation	ASTM D412	100% ± 10
Tensile Strength	ASTM D412	12 MPa ± 2
Hydrostatic Pressure Resistance (Positive)	EN 12390	Passes 5 bar
Hydrostatic Pressure Resistance (Negative)	ASTM D7088	Passes 5bar
Shore A Hardness	ASTM D2240	80
Adhesion to concrete	ASTM D7234	2Mpa (concrete failure)
Water Absorption	ASTM D570	0.15 %
Crack Bridging	ASTM C1305	Pass (10 cycles)

Packaging

9Kg (Part A: ~2 Kg and Part B: ~7 Kg)

Coverage

Minimum total consumption: 1.4 kg/m^2.

Shelf Life & Storage

Can be kept for 12 months minimum in the original unopened pails in dry places and at temperatures of 5-25°C. Once opened, use as soon as possible.

Other Products Categories available

Dr. Fixit brings you the widest range of Construction Chemicals

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TECHNICAL SPECIFICATIONS

Our ref.: **Document No. W.004717-Z-10930-002**

Imputation: Project No. W.004717

RESTRICTED

Client: **Development Commissioner, SEEPZ-SEZ, Mumbai**

Project : **Preparation of Detailed Master Plan for 30 years & Detailed Architectural model building for SEEPZ-SEZ, Mumbai**

Subject: **PACKAGE 2, KD 1: Structural Technical Specifications of Model Building NEST-3**

Comments:

Revision No.	Date	Prepared / Revision By	Description
R0	30.06.2026	Project Team	Issued for approval
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R1	2026.08.05		Project Team	Amit Sarkar	Mona Srivastava	Rahul Jotshi

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CIN: U74899DL2000PTC104134

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A. TECHNICAL SPECIFICATIONS – CIVIL WORKS

1. CIVIL WORKS

EXCAVATION

SCOPE

This specification covers excavation in all types of soil, soft and decomposed rock not requiring blasting and rocks requiring blasting, shoring, dewatering, filling around foundations and to grade, compaction of fills and approaches, protective fencing, lighting, etc. Relevant to structures and locations covered under the scope of this contract.

GENERAL

Work to be provided for by the Contractor

- The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following:
- Furnish all labour, supervision, services including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. Required for the work.
- Prepare and submit working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering, including drains and outfall for drainage, space for temporary stacking of spoils, disposal area, fencing, etc. And all other details as may be required by the engineer.
- To carry out sampling and testing and submit to the engineer, results of soil compaction tests whenever required by the engineer to assess the degree of compaction.
- Construction, maintenance, and removal after completion of magazine of proper capacity as well as design for storing of explosives required for blasting work to be carried out under the scope of this tender including procurement of necessary licenses from proper authorities.
- Deployment of all equipment and machinery required for carrying out the work of excavation, backfilling, compacting and disposal.
- Deployment of approved blaster and / or blasting, agency.
- Mobile magazine for explosives.
- No work under this specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

CODES AND STANDARDS

All works under this specification, unless specified otherwise, shall conform to the latest revision and/or replacement of the following or any other Indian Standard Specifications and Codes of Practice. In case any aspect of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Engineer shall be followed: -

Table 1-1 Excavation- Codes & Standards

IS: 1200(1992)	Method of Measurement of Building and Civil (Part-I) Engineering work; Part-I Earthwork.
IS: 2720(1973)	Determination of Moisture Content (Part-II)
IS: 2720(1972)	Determination of Moisture content / Dry Relation using Light Compaction (Part-VII)
IS: 2720(1983)	Determination of Density Index (Relative Density) of cohesion less soils (Part-xiv).
IS: 2720(1974)	Determination of Dry Density of soils, in place by sand replacement methods (Part-xxviii).
IS: 2720(1975)	Determination of Dry Density, in place, by core cutter method (Part-xxix).
IS: 3764(1992)	Safety code for Excavation work.
IS: 4081 (1986)	Blasting and Related Drilling Operations
IS: 4701 (1982)	Earthwork on canals

CONFORMITY WITH DESIGNS

The Contractor is to carry out the work as per the drawings issued to him and/or Contractor's drawings which are approved by the Engineer in-charge.

The contractor shall prepare his own drawings of excavation based on drawings of foundation and any underground structure.

MATERIALS TO BE USED

All materials required for the work shall be of best commercial variety and approved by the Engineer in-charge.

Borrow material required for back-filling shall be excavated from approved locations and levels, and shall consist of material, approved by the Engineer, free from roots, vegetations, decayed organic matter, harmful salts, and chemicals, free from lumps and clods. If specified, clean graded sand free from harmful and deleterious material from approved quarries shall be used as fill material.

QUALITY CONTROL

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials, equipment, and laboratory used. The quality control operation shall include but not be limited to the following items of work: -

- Lines, Levels and Grades:
- Periodic surveys
- Establishment of markers, boards etc.
- Back-filling
- Checking the quality of fill material
- Checking moisture content of the backfill
- Checking the degree of compaction

INFORMATION REGARDING SITE CONDITIONS

Surface and Sub-surface data regarding the nature of soil, sub-soil water etc. shown on drawing or otherwise furnished to the Contractor shall be taken as guidance only and variation therefore shall not affect the terms of the contract.

The Contractor must satisfy himself regarding the character and volume of all work under this contract and expected surface, Sub-surface, and sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.

EXECUTION

Setting Out

The Contractor will prepare and submit to the Engineer, detailed drawings of the excavation work as proposed to be executed by him showing the dimensions as per drawings and specification adding his Proposa4ls of slopes, shoring, approaches, dewatering sumps, berms, etc. On receiving the approval from the Engineer with modifications and corrections, if necessary, the Contractor will set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking.

These permanent points and markers will be fixed at intervals prescribed by the Engineer and checked by the Engineer and certified by him after whom the Contractor will proceed with the work. Engineer shall be provided with necessary men, material, and instructions for such checking. It should be noted 'that this checking by the Engineer prior to start of the work will in no way absolve the Contractor of his responsibility of carrying out the work to true lines and levels and grades as per drawing and subsequent corrections, if necessary, in case any errors are noticed in the Contractor's work at any stage.

Initial Levels

Initial levels of the ground either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements.

All records of levels, measurements etc. and any drawing, cross section etc. made there from, shall be jointly signed by the authorised representative of the contractor and the Engineer before the commencement of work and they shall form the basis of all payments in future.

Clearing and grubbing etc.

The area to be excavated or filled shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. and levelled up. Trees up to 300 mm girth shall be uprooted. Trees above 300 mm girth to be cut, shall be approved by the Engineer, and then marked. Felling of trees shall include taking out roots up to 600 mm below ground level or 150 mm below formation level whichever is lower. After the tree is cut and roots taken out the potholes formed shall be filled with good earth in 250 mm layers and consolidated unless directed by the Engineer otherwise. The trees shall be cut in suitable pieces as instructed by the Engineer.

Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to approved disposal areas as may be specified. Ash shall be spread or removed. Useful materials, saleable timber, firewood, etc shall be the property of the Client and shall be stacked properly at the worksite in a manner as directed by the Engineer.

Classification

No distinction will be made whether the material is dry or wet. All earthworks shall be classified under the following categories:

Ordinary Soil

This shall comprise vegetable or organic soil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, rake, or other ordinary digging implement. Removal of gravel or any other nodular material having diameter in anyone direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

Hard Soil

This shall include:

a) Stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and shovel, closely applied.

b) Gravel and cobble stone having maximum diameter in anyone direction between 75 and 300 mm.

c) Soling of roads, paths, etc., and hard core.

d) Macadam surfaces such as water bound, and bitumen/tar bound.

Lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar, below ground level: Soft conglomerate, where the stones may be detached from the matrix with picks; and generally, any material which requires the close application of picks, or scarifiers to loosen and not affording resistance to digging greater than the hardest of any soil mentioned above

Soft and Decomposed Rock

This shall include the followings:

A) Limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars.

B) Unreinforced cement concrete which may be broken up with crowbars or picks and stone masonry in cement mortar below ground level.

C) Boulders which do not require blasting having maximum diameter in any direction of more than 300 mm, found lying loose on the surface or embedded in riverbed, soil, talus, slope wash and terrace material of dissimilar origin; and

D) Any rock which in dry state may be hard, requiring blasting, but which when wet becomes soft and manageable by means other than blasting.

Hard Rock (requiring blasting)

This shall include:

A) Any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is required

B) Reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and

C) Boulders requiring blasting.

Hard Rock (blasting prohibited)

Hard rock requiring blasting as described under clause 3.4.4 but where blasting is prohibited for any reason and excavation must be carried out by chiselling, wedging or any other agreed method. In case of any dispute regarding classification, the decision of the Engineer shall be final.

EXCAVATION FOR FOUNDATIONS AND TRENCHES

General

All excavations shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Contractor, in each individual case, for the method he proposes to adopt for the excavations including dimension, side slopes, shoring, dewatering, disposal, etc. This approval, however, shall not in any way make the Engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

All excavation in open cuts shall be made true to line, slopes and grades shown on the drawing or directed by the Engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders projecting out of the excavated surfaces shall be removed, if in the opinion of the Engineer they are likely to be a hindrance to the workers.

Method of excavation shall be in every case subject to the approval of the Engineer and the Contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works.

The Contractor shall have full responsibility of the stability of the excavation and safety of the workmen. If any slip occurs, the Contractor shall remove all slipped material from the excavated pit.

All loose boulders, semi-detached rocks, not directly in excavation but so close to the area to be excavated as to be liable, in the opinion of the Engineer, to fall or otherwise endanger the workmen, equipment of the work, etc., shall be stripped off and removed away from the areas of excavation. The method used shall be such as not to shatter or render unstable or unsafe the portion which was originally sound and safe. Any materials not requiring removal as contemplated in the work, but which, in the opinion of the Engineer, is later to become loose or unstable shall also be promptly and satisfactorily removed as directed by the Engineer.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Engineer.

The rough excavation may be carried up to a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the Engineer.

If the excavation is done to a depth greater than that shown on the drawing, or directed by the Engineer, due to the Contractor's fault, the excess depth shall be filled up to the required level (with cement concrete not leaner than 1:4:8 ordinary concrete or richer) as directed by the Engineer in each individual case.

In formation of rock requiring blasting, those overcuts which are unavoidable will be made up by ordinary cement concrete 1:2:4. All excavated materials such as hard rock, boulders, bricks, dismantled concrete blocks, etc. shall be stacked as directed by the Engineer and shall be the property of the Client.

EXCAVATION IN ORDINARY SOIL, HARD SOIL AND SOFT AND DECOMPOSED ROCK

The excavation in ordinary soil, hard soil soft and decomposed rock will be carried out as per the approved proposal, modified and corrected where necessary by the Engineer. The work will be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines levels and grades, the work will be checked by the Engineer thoroughly and the balance work will be finally checked and approved by the Engineer. In certain cases, where deterioration of the ground, upheaval, slips, etc. are expected, the Engineer may order to suspend the work at any stage and instruct the Contractor to carry out the balance work just before the foundation work of the structure can be started.

EXCAVATION IN HARD ROCK

In case where excavation, both in ordinary soil and hard rock, are involved, the ordinary soil comprising of soft, hard, and dense soils (including laterite formations) and rock including weathered rocks, lateritic rocks, etc. Which can be excavated without blasting, shall be completely stripped off. Further work in hard rock shall be resumed after clearance from the Engineer.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings, or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2.0 metres, steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

In case where blasting, though otherwise required, is prohibited for any reasons, the excavation shall be carried out by chiselling, wedging or any other approved method.

BLASTING

GENERAL

Storage, handling and use of explosives shall be governed by the current explosive rules laid down by the Central and the State Governments. The Contractor shall ensure that these rules are strictly adhered to. The following instruction, wherever found in variance with the above rules, shall be considered as superseded by the above rules.

No child under the age of 16 years and no person who is in a State of intoxication shall be allowed to enter the premises where explosives are stored, or shall they be allowed to handle the explosives.

STORAGE OF EXPLOSIVE

Storage of explosives shall be governed by the current Explosive Rules as per followings: -

- Explosives shall be stored in a clean, dry, well-ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400 m of the actual work site or any source of fire. A space surrounding the magazine shall be fenced in. The ground inside the fence shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be by one gate only and no person shall be allowed inside this fence without permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The mezzanine shall be perfectly well drained.
- Two lightning conductors shall be provided to the magazine, one at each end. The lightning conductors shall be tested once in every year.
- Fuses and detonators shall be stored in separate magazines. However, detonators can be kept in an annex adjoining the magazine provided that their number does not exceed 25,000 and that the annex is so constructed that not less than 60 cm masonry and 100 cm of air space shall intervene between any detonators in such annex and the interior of the main magazine. Cases containing explosives are not to be opened in a magazine. Explosive in open cases is not to be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and destroyed.
- Artificial light is not to be allowed in any magazine. No smoking shall be allowed within 100 metres of a magazine.
- Magazine shoes without nails shall be used while entering the magazine. The mallet, levers, wedges etc. For opening barrels or cases are to be of wood. Inside a magazine the cases of explosives are to be carried by hand and shall not be rolled or dragged. Explosives which have' been issued and returned to the magazine are to be issued first; otherwise, those which have been longest in store are to be issued first.
- Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides, special care is to be taken to keep the floor free from grains of powder or portions of explosive matter fallen on the floors due to leakage of cases etc.
- The magazine shall not be opened during any dust storm or thunderstorm, nor shall any person be allowed in the vicinity of the magazine.
- All magazines shall be officially inspected at definite intervals and a record kept of the results of such inspections.

CARRIAGE OF EXPLOSIVES

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each cage or package is to be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on a vehicle conveying explosives. No carriage or vessel shall be used for transporting explosives unless all iron or steel therein with which a package containing any explosive .is likely to come in contact is effectually covered with lead, leather, wood, cloth, or other suitable material. No lights shall be carried on the vehicle carrying explosives.

No operation connected with the loading, unloading, and handling of explosives shall be conducted after sunset.

USE OF EXPLOSIVES

The Contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with the responsibilities imposed on him.

Holes for charging explosives shall be drilled with Pneumatic drills, the drilling pattern being so planned that the rock pieces after blasting will be suitable for handling.

The hole diameter shall be of such a size that cartridges can easily pass down them and undue force is not required during charging. Charging operations shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from explosive cartridges. Only wooden rods shall be used for loading and stemming shot holes. Only one cartridge at a time shall. be inserted and gently passed home with the wooden tamping rod.

Only such quantities of explosives as are required for work to be done shall be brought to the works. Should any surplus remain when all the holes have been charged, it shall be carefully removed to a point at least 300 m from the firing point.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of several charges the electric detonators shall relate to the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes, or any other path of stray current and to keep the lead wires short circuited until ready to fire. Any kinks in detonator leading wire shall be avoided.

For simultaneous firing of many shot holes, use of cordtex may be done. Cordtex shall be initiated by an electric detonator attached to its side with adhesive tape, connecting wire or string.

All connections shall be made by the authorised shot firer himself. The shot firing cable shall not be dragged along the ground to avoid possible damage to the insulation. The shot firing cable shall be tested for continuity and possible short circuiting before it is used each time.

The shot firer shall always carry the exploder handle on his person until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits.

Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the Engineer.

Before any blasting is carried out, it shall be ensured that all workmen, vehicles, and equipment on the site are cleared from an area of minimum 300 metres radius from the firing point, or as required by statutory regulations, at least ten minutes before the time of firing by sounding a warning siren. The area shall be encircled by red flags.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations the authorised shot firer shall return to the blast area and carefully inspect the work and satisfy himself that all charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole not less than 600 mm from the misfired hole and by exploding a new charge. The authorised shot firer shall be present during removal of the debris liable to contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing. When blasting is conducted in the neighbourhood of roads, structures, buildings etc. controlled blasting must be carried out by drilling shallow shot holes and filling the same with light charge of explosives

Adequate safety precautions as per building byelaws, safety code, statutory regulations etc. shall be taken during blasting operations.

DISPOSAL

The excavated spoils will be disposed of in any or all the following manners:

a. By using it for backfilling straightway.

b. By stacking it temporarily for use in backfilling later during execution of the contract.

   i) By either spreading, or

   ii) Spreading and compacting at designated filing areas and / or disposal areas.

c. By selecting the useful material and stacking it neatly in areas designated by the engineer for use in backfilling by the engineer for use in backfilling by some other agency.

DISPOSAL OF SURPLUS

All surplus material from excavation shall be carried away from the excavation site to designated disposal area selected by the Engineer.

All good and sound rock excavated from the pits and all assorted materials of dismantled structures shall be the property of the Client.

PROTECTION

The Engineer shall be notified by the Contractor as soon as the excavation is expected to be completed within a day so that it may be inspected by him at the earliest. Immediately after approval of the Engineer, the excavation must be covered up with the shortest possible time. But, in no case the excavation shall be covered up or worked on before approval and measurement by the Engineer. Excavated material shall be placed beyond 1.5 metres from the edge of the pit or trench or half the depth of the pit or trench whichever is more or further away if directed by the Engineer.

Excavation shall not be carried out below the foundation level of structure close by until required precautions have been taken. Adequate fencing is to be made enclosing the excavation.

The Contractor shall protect all under-ground services exposed by excavation. The Contractor shall also divert all surface drains, etc. affected by the excavation to maintain the working area neat and clean.

DEALING WITH SURFACE WATER

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

No works shall commence until surface water streams have been properly intercepted, redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems to drain surface water from working areas.

DEWATERING

All excavations shall be kept free of water and slush. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by the Engineer any water inclusive of rainwater and subsoil water accumulated in excavation and keep the trench dewatered until the construction of foundation structure and backfilling are complete ·in all respects. (Except where such dewatering would need installation of well points or deep wells for which separate payment will be made) Sumps made for dewatering must be kept clear of the foundations. Method of pumping shall be approved by the Engineer but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping.

TIMBER SHORING

Timber Shoring made from approved quality of timber shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench and the type of timbering shall be determined by the Engineer. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

CLOSE TIMBERING

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 250 x 40 mm sections as directed by the Engineer. The boards shall generally be placed in position vertically 'In pairs, one board on each side of cutting, and shall be kept apart by horizontal walers of strong wood at maximum 1.2 metres spacing, cross strutted with ballies or as directed by the Engineer. The length of the bally struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the' sides of the excavation and supported by vertical walers, which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed, so that the earth is not liable to slip out.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

OPEN TIMBERING

In the case of open timbering, the entire surface of the side of trench pit is not required to be covered. The vertical board of minimum 250 mm width and minimum 40 mm depth shall be spaced sufficiently apart to leave unsupported strips of maximum 500 mm average width. The detailed arrangement, sizes of the timber and the distances apart shall be subject to the approval of the Engineer. In all other respects, specification for close timbering shall apply to open timbering.

TREATMENT OF SLIPS

The Contractor will take all precaution to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If, however, slips do occur due to causes beyond the control of the Contractor, the same shall be removed by him and payment shall be made to him on appropriate item rate of earthwork. Slips caused due to negligence of the Contractor will be cleared and back-filled later by him.

BACK-FILLING

GENERAL

The material used for backfilling shall consist of material, approved by the Engineer obtained directly from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits from selected areas designated by the Engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials, etc.

In certain locations, the Engineer may direct sand fillings. The sand should be clean, well graded and be of quality normally acceptable for use in concrete.

FILLING AND COMPACTION IN PITS AND TRENCHES AROUND STRUCTURES

As soon as the work in foundations has been accepted and measured, the spaces around the foundation structures in pits and trenches shall be cleared of all debris, brick bats, mortar droppings, etc., and filled with earth in layers not exceeding 250 mm in loose thickness each layer being watered, rammed and properly compacted to achieve a dry density of not less than 95% of proctor's dry density at optimum moisture content as per IS: 2720 - Part VII where backfilling with cohesive soil and sandy silt containing high percentage of silt. For back filling with sand having little or no silt, each layer shall be compacted to a relative density of 75% as per IS: 2720 - Part XIV. Earth shall be rammed with approved mechanised compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the Engineer. The final surface shall be trimmed and levelled to proper profile as shown in the drawing and as desired by the Engineer. Since the degree of compaction depends on the moisture content of the soil, a close watch should be kept on it and corrections done to optimise the moisture content.

PLINTH FILLING

The plinth shall be filled with earth in layers not exceeding 250 mm in loose thickness, watered, and compacted as stated under clause No. 3.7.2 with approved compaction machine or manually, if specifically permitted by the Engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted, to avoid any settlement at a later stage. The finished level of the filling shall be trimmed to the slope intended to be given to the floor.

FILLING IN TRENCHES FOR WATER PIPES AND DRAINS

Earth used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 150 mm size in any direction, mixed with fine material consisting of disintegrated rock, moorum or earth as available, to fill up the voids as far as possible and then the mixture used for filling. The types of bedding and pipe surround material shall be as specified in the drawings.

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed.

Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150 mm, watered, rammed, and compacted taking care that no damage is caused to the pipe below. Filling of trenches shall be carried out simultaneously on both' sides of the pipe in such a manner that unequal pressures do not occur.

In case of excavation of trenches in rock, the filling up to a depth of 300 mm or the diameter of the pipe whichever is more, above the crown of pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash according to the availability at site. The remaining filling shall be done with rock filling of boulders of size not exceeding 150 mm mixed with fine material as available to fill up the voids, watered, rammed, and compacted.

FILLING IN DISPOSAL AREA

Surplus material from excavation which is not required for backfilling will be disposed of in designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250 mm thick when loose and compacted with the help of compacting equipment. In wide areas rollers will be employed and compaction done to the satisfaction of the Engineer at the optimum moisture content which shall be checked and controlled by contractor.

In certain cases, the Engineer may direct disposal without compaction which can be done by tipping the spoils from a high bench neatly always maintaining a proper level and grade of the bench.

APPROACHES AND FENCING

The Contractor should provide and maintain proper approaches for workmen and for inspection. The roads and approaches around the excavated pits should be always kept clear so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the Project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

LIGHTING

Full scale area lighting is to be provided if night work is permitted or directed by the Engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the fill.

TESTING AND ACCEPTANCE CRITERIA

EXCAVATION

On completion of excavation, the dimensions of the pits will be checked as per the drawings after the pits are completely dewatered. the work will be accepted after all undercuts have been set right and all over excavations filled back to required line, levels, and grades by placing ordinary concrete of 1:4:8 proportion and/or richer and/or by compacted earth, as directed by the Engineer. The choice of grade of concrete will be a matter of unfettered discretion of the Engineer. Over excavation of the sides will be made good by the Contractor while carrying out the backfilling. The excavation work will be accepted after the above requirements are fulfilled and all temporary approaches encroaching inside the required dimension of the excavation have been removed.

BACK-FILLING

The degree of compaction shall be sufficient to achieve a dry density of not less than 95% of products dry density at optimum moisture content as per IS: 2720 – Part VII or a relative density of 75% as per IS: 2720 – Part XIV as applicable depending on the nature of back filling material as stated in clause no. 3.7 of this specification. The work of back filling will be accepted after the Engineer is satisfied with the degree of compaction achieved.

RATES

The rates for the items shall include cost of all materials consumed in the works, hire charges of materials, tools and plant, cost of labour, insurance, all transport, taxes, duties and royalties, security and safety arrangements, supervision, profit etc. The rates of excavation shall also include the cost of dewatering installation of piezometers, wherever necessary and stacking the excavated spoils properly up to a lead, unless otherwise mentioned in the Schedule of items.

Excavation shall be measured to the dimensions of the PCC line as shown in the drawings. However minimum working space at the bottom and slope as required to provide safety, stability of the excavation shall be provided. No extra measurements beyond the PCC line shall be payable and the above shall be deemed to be included in the rate for the excavation works.

Where backfilling is to be done with sand, it shall be of good quality from quarries approved by the Engineer. The rate shall include all operations including the cost of sand.

MODE OF MEASUREMENTS

CLEARING AND GRUBBING

No separate measurement shall be done for this item for the purpose of payment in general except for cutting of trees having girth more than 30cm and works connected to this.

EXCAVATION

Excavation shall be measured to the dimensions of the PCC line as shown in the drawings in m3 (Up to two decimal points). No extra measurement beyond the PCC line. No extra shall be paid for keeping the excavations dewatered as required for completion of the structure to come in. Necessary disposal of the spoils as described in the schedule of items shall be included in the quoted rate.

SHORING

Shoring and strutting shall be provided effectively to prevent any collapse of the excavation sides in pits and trenches as required by the Engineer without any extra cost to the Purchaser and shall be deemed to be included in the rates for the excavation works.

BACK-FILLING

- **A.** With Assorted Earth from Excavations for Foundations, Trenches etc.
- **B.** Quantity of consolidated backfill shall be measured in m3 (Up to two decimal points).
- **C.** The cost of lead, lift, etc., shall be as per schedule of items and included in the rate quoted with Earth from borrow pits and stacks
- **D.** Quantity of consolidated backfill shall be measured in m3. The cost of lead, lift, etc. as mentioned in the Schedule of Items shall be included in the rates quoted.

SAND FILLING

Quantity of consolidated sand filling shall be measured in m3 (Up to two decimal points). The rate shall include cost of sand and all necessary works for execution of the items.

LEADS AND LIFTS

The leads for excavation and/or back-filling will be measured between the centroid of the actual disposal area and that of the plan of the pit. The distance between these two points will be measured along the shortest practicable haulage path as decided by the Engineer. Lifts will be measured vertically between the average ground level from where the pit excavation was started and the bottom level of the excavated pit. Level lines corresponding to the stages where lifts become payable will be drawn on the cross section of the pit and the volumes of excavation contained between these horizontal planes will be computed and paid according to the corresponding rates.

DEWATERING

The excavated pits and trenches shall be dewatered and kept dry till backfilling is completed and shall be deemed to be included in the rate for excavation works and no separate payment shall be made. Dewatering requirements shall be assessed by the bidder in his quotation and elaborate scheme shall be developed during construction stage including well point system dewatering scheme, if required.

2. CEMENT CONCRETE

SCOPE

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or Precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

This specification shall also apply to the extent it has been referred to or applicable with the special requirements of structures covered in scope of IS: 456-2000.

Unless permitted otherwise IS: 456-2000 shall form a part of this specification and shall be complied with. For any aspect not covered by this Code, appropriate IS Code, specifications and/or replacement by any International Code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference.

GENERAL

Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified, shall include but not be limited to the following: -

A. Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.

B. The supply of material shall be at one point in the site. It shall be the responsibility of Contractor to store and transport the same up to the construction place and fabrication yard.

C. Design and prepare working drawings of formworks, scaffolds, supports, etc and submit for approval.

D. Submit for approval shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedment, hangers, openings, frames etc.

E. Submit for approval detailed drawings of supports, templates, hangers, etc. required for installation of various embedment's like inserts, anchor bolts, pipe sleeves, frames, joint seals, openings etc.

F. Submit for approval detailed schemes of all operations required for executing the work, e.g., Material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.

G. Design and submit for approval concrete mix designs required to be adopted on the job.

H. Furnish samples and submit for approval results of tests of various properties of the following:

   a. The various ingredients of concrete

   b. Concrete

   c. Embedment's

   d. Joint seals

I. Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings, specifications, and Schedule of Items.

J. For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved Performa for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

K. The Contractor shall prepare and submit bar bending schedule to the Engineer in-charge for approval.

L. The Contractor shall submit Test certificates for all material procured by him to the Engineer for review and acceptance.

M. Fly Ash conforming to IS: 3812- Part 1 may be used, if approved by the Engineer as part replacement of OPC for all grades of concrete as per IS: 456-2000.

N. Fly Ash shall be from approved source and shall be tested. Transportation shall be done in closed containers and storing at site shall be in silos. The entire operation of transportation, storing and handling shall meet all the state and central Pollution Control norms.

Conformity with Design

The Contractor will prepare check lists in approved Performa which will be called 'Pour Cards'. These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance with the drawings and specifications, the Engineer will give written permission on the same 'Pour Card' allowing the Contractor to commence placement of concrete. Details of all instructions issued' by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. These sheets, termed as 'Progress Cards', will be prepared by the Contractor on approved Performa. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete.

One of the mix designs developed by the Contractor as per the IS Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

MATERIALS TO BE USED

General Requirement

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless stated otherwise and be of best approved quality.

Cement

Generally, cement shall be 43 grade ordinary Portland cement conforming to IS: 8112, in special cases any of the following type of cement may be permitted or directed to be used with prior approval by the Engineer:

a) Rapid hardening Portland cement conforming to IS: 8041

b) Portland slag cement conforming, to IS: 455

c) Portland Pozzolana Cement (fly ash based) Conforming to IS: 1489 (Part-1)

d) Portland pozzolana Cement (calcined clay) conforming to IS: 1489 (Part-2)

e) Hydrophobic Cement conforming to IS: 8043

f) Low heat Portland cement conforming to IS: 12600

g) Sulphate Resisting Portland cement conforming to IS: 12330

Aggregates

Aggregates shall be natural or crushed gravel or crushed rock and free from deleterious material. It shall comply with the requirements of IS: 383. All fine and coarse aggregate shall be tested for susceptibility to Alkali Silicate reaction in a laboratory approved by the Engineer.

<u>Coarse Aggregate</u>

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as Coarse Aggregate. Only Coarse Aggregate from approved quarries and conforming to IS: 383 will be allowed to be used on the works. Aggregates shall be washed 10 make it free from deleterious materials, if necessary.

The grading of coarse aggregates by sieve analysis shall be as per IS: 383. If by the analysis the deficiency of a particular grain size is found, which could affect the density of the concrete, the Engineer may ask the contractor to avoid such quantities of aggregate of the particular size or and such quantity of aggregate of any particular size to achieve the required grading as per IS:383.

Fine Aggregate

Aggregate smaller than 4.75mm and within the grading limits and other requirements set in IS: 383 are termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used on works.

In certain cases, there may be two types of sand, one very fine and the other very coarse. In such cases, the two types shall be combined to meet the requirements of a particular zone of IS: 383. In all cases, the preferred zone's Zone -II.

In certain cases, crushed stone sand may be added to natural sand in order to achieve the required grading.

Crushed stone sand alone may be used only with the approval of the Engineer.

Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts, or other impurities. Normally potable water is found to be suitable. Generally, IS: 3550 will be followed for routine tests. Acceptance test for water shall be as per IS: 3025, and Table-I of IS: 456-2000.

In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by compressive strength and initial setting time tests as per method of tests in accordance with the requirements of IS: 516 and IS: 4031 respectively. The pH value of water shall generally be not less than 6.

Admixture

Only admixture of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures which may be used in structural concrete shall necessarily satisfy the design requirement be as per the following Standards:

Table 2-1 Details of Admixture

IS: 9103	Indian standard specification for Admixtures for Concrete
ASTM: C494-10a	American Standard Specification for Chemical Admixtures for Concrete

Integral water proofing compound conforming to IS: 2645 shall only be used in cement mortar/cement screeds and plasters.

However, the Contractor shall furnish following technical information about the admixtures (along with the manufacturer's Catalogue) which he is planning to use in different areas within the scope of work for the approval of the Engineer:

a) Type of admixture

b) Mix proportion and mode of application in concrete/mortar

c) Manufacturer's specification and necessary quality assurance certificates (mainly on chloride and sulphate content, pH value, infra-red analysis, and solid content.)

Type and make of admixture and its doses will be as obtained in approved trial mixes.

Integral water proofing component may be permitted to be used only in mortar / concrete screed and not in any structural concrete.

Reinforcement

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract / Drawing / instructions. All bars shall be of tested quality.

Reinforcement shall be of HYSD TMT steel bars conforming to IS: 1786, Fe 500. If Mild steel bars are used, they shall conform to IS: 432. In the event of presence of alkalinity or corrosive nature of soil, fusion bonded epoxy coated rebar shall be used for all foundations up to plinth level.

In case of Fe500 grade steel bars the minimum elongation shall be 12%.

Coupler

Mechanical reinforcement couplers shall be used for joining reinforcing steel bars in lieu of lap splices wherever indicated in the drawings or as directed by the Engineer. The couplers shall conform to IS 16172:2014 – Mechanical Splices for Reinforcing Bars and shall be suitable for reinforcing bars conforming to IS 1786:2008.

The couplers shall be manufactured from high-strength alloy/carbon steel and shall be capable of developing at least 125% of the specified yield strength of the reinforcing bar, ensuring that failure occurs in the parent bar rather than in the coupler, in accordance with IS 16172:2014. Couplers shall be factory manufactured, free from defects, corrosion, cracks, or damaged threads.

Bar end preparation, threading, installation, and tightening shall be carried out strictly as per the manufacturer's recommendations using approved equipment. Threaded bar ends shall be protected from damage and contamination before installation. Couplers shall be installed in the locations shown on the approved drawings and shall comply with the ductile detailing requirements of IS 13920:2016, where applicable.

Each batch of couplers shall be accompanied by the manufacturer's test certificates and shall be subjected to inspection and testing, including tensile and slip tests, as specified in IS 16172:2014. All reinforcement detailing shall comply with IS 2502:1963, and reinforced concrete works shall conform to IS 456:2000.

Measurement shall be made in Number (Nos.) of approved and installed couplers of the specified diameter. The rate shall include the supply of couplers, bar end preparation, threading, installation, testing, labour, tools, equipment, and all incidental works necessary for the satisfactory completion of the work.

Foundation Bolt Assembly

Foundation bolts shall generally conform to IS: 5624. Mild steel bars used for the fabrication of bolt assembly shall conform to Grade -1 of IS: 432, IS: 2062 or any other material including high carbon / high tensile steel as specified.

Hexagonal nuts and lock nuts shall conform to IS: 1363 and 1364 up to M 36 dia and IS: 3138 for M 42 to M 150 mm dia. Flat plain washers shall be of mild steel and punched / machined type conforming to IS: 5369. Steel pipe sleeves shall conform to medium class of IS: 1161.

STORAGE OF MATERIALS

General

All materials shall be as stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work.

Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete, and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realized from the Contractor's dues.

The Contractor shall maintain up to-date accounts of receipt, issue, and balance (stack wise) of all materials. Storage of construction materials shall conform to IS: 4082.

Cement

Sufficient space for storage with open passages between stacks shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated warehouses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer as soon as it is detected.

Different types of cement shall be clearly marked with the type and different types of cement shall not be intermixed.

Aggregates

Aggregates shall be stored on planks or steel plates or on concrete or masonry surface. Each size shall be kept separated with wooden or steel or concrete or masonry bulkheads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stockpiles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

Reinforcement

Reinforcing steel shall be stored consignment-wise and size wise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease, and distortions. If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust at no extra cost to the Client. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

Quality Control

Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same.

The quality control operation shall include but not be limited to the following items-of work:

Table 2-2 Details of Quality Control Operations

S.No.	Items Of Work	Quality Control Operation
(a)	Admixture	Type, quantity, physical and chemical properties that affect strength, workability, and durability of concrete. For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits.
(b)	Aggregate	Physical, chemical, and mineralogical qualities. Grading, moisture content and impurities.
(c)	Water	Impurities tests
(d)	Cement	Tests to satisfy relevant is specifications
(e)	Formwork	Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, lies, bracing and shoring and coaling
(f)	Reinforcement	Shapes, dimensions, length of splices, clearances, lies and supports. Quality and requirement of welded splices. Material tests or certificates to satisfy relevant is specification.
(g)	Grades of concrete	Usage and mix design, testing of all properties.

(h)	Batching and mixing	Types and capacity of plant, concrete mixers, and transportation equipment.
(i)	Joints	Locations of joints, water slops and filler materials. Dimension of joints, quality and shape of joint material and splices.
(j)	Embedded and anchorage items	Material, shape, location, setting
(k)	Placing	Preparation, rate of pouring, the limitations, time intervals between mixing and placing and between two successive lifts, covering over dry' or wet surfaces, cleaning, and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors
(l)	Compaction	Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding, and tamping
(m)	Setting of bases and beaming plates	Lines, elevations, and bedding mortar
(n)	Concrete finishes	Repairs of surface defects, screening, floating, steel troweling and brooming, special finishes
(o)	Curing	Methods and length of time

Copies of records and tests for the items noted above, as well as records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

Quality Assurance Plan (QAP)

The contractor shall submit and obtain Client's approval of the detailed QAP for workmanship, materials, testing and approval for each item of Concrete work prior to executing the works

QAP should include the tests mentioned in Clause 10.0 of this specification.

CONCRETING

All concreting requirements shall be in accordance with IS: 456-2000 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not cover all the aspects to the full satisfaction of the Engineer.

Washing and Screening of Aggregates

Washing and Screening of coarse aggregate shall be carried out to remove fines, dirt's, or other deleterious materials.

Washing of fine aggregate shall not be allowed, Fine aggregates shall be screened only to remove dirt or other deleterious materials.

However, all washing, and screening of aggregates shall be carried out by approved means to ensure compliance with the aggregate specification.

Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete.

Admixtures may be permitted to be used in accordance with IS: 456-2000 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data, or other satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

Grades of Concrete

Concrete grades for structural concrete shall be as M25 or higher Grades designated in IS: 456-2000. Grade of concrete to be used in different parts of work shall be as shown on the drawing or as per the Engineer's instructions. In case of liquid retaining structures, IS: 3370 will be followed.

M10 grade concrete shall be used only as lean concrete below foundations and for mass filling.

PROPORTIONING AND WORKS CONTROL

General

Proportioning of Ingredients of concrete shall be made by any of the two following methods as directed by the Engineer.

a) With preliminary tests by designing the concrete mix. Such concrete shall be called 'Design Mix Concrete'.

b) Without preliminary tests adopting nominal concrete mix. Such concrete shall be called 'Nominal Mix Concrete'.

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades permitted in accordance with IS: 456-2000 may be used if shown on drawings or approved by the Engineer. In all cases the proportioning of ingredients and works control shall be in accordance with IS: 456-2000 and shall be adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

Mix Design Criteria

Concrete mixes will be designed by the Contractor to achieve the strength, durability, and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations:

a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.

b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.

c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.

d) Chemical admixtures may be used to modify the rate of hardening to improve workability (maintaining low water -cement ratio) or as an aid to control concrete quality.

e) The finished concrete should have adequate durability in all conditions, to withstand satisfactorily the weather and other destructive agencies which it is expected to be subjected to in actual service.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete by the Engineer. The Contractor will strictly abide by the same in his design of concrete mix installation

Notwithstanding anything mentioned in various tables given in IS: 456-2000 giving specific values and degrees of workability for different condition of concrete placing, minimum cement content and maximum water-cement ratio for concrete exposed to sulphate attack and for concrete to ensure durability under different condition of exposure, strength requirement for different grades of concrete, proportion for nominal mix concrete included in the specification. For identical condition if values given in the clause 9.6 below are different from those mentioned in IS: 456-2000, the values as indicated in the clause 9.6 below shall prevail.

Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results. Strength of concrete shall meet the requirements of IS: 456-2000.

Concrete Mix Design and Strength requirements

Concrete mix design shall be as per IS: 10262 and SP: 23. The strength requirements of both design mix and nominal mix concrete where ordinary Portland cement or Portland slag cement is used shall be as per Table-2 of IS: 456-2000. All other relevant clauses of IS: 456-2000 shall also apply.

Minimum Cement Content and water cement ratio

The minimum cement content, slump, and maximum water cement ratio for each grade of concrete shall be as shown below:

a) For Lean Concrete and plinth protection paving, minimum cement content shall be 320 kg/m3 and maximum water cement ratio of 0.55.

b) For structural concrete of all grades including precast concrete the minimum cement content shall be 365 kg/m3 and maximum 450 kg/m3 and maximum water cement ratio of 0.45.

c) For all equipment foundations minimum cement content shall be 400 kg/m3 and the maximum water cement ratio of 0.40.

d) Sufficient number of trial mixes (to be decided by the Engineer) will be taken at the laboratory for the various designs and graphs of w/c ratio Vs crushing strengths at various ages will be plotted.

e) All tests will be done in presence of the Engineer who shall be the final authority to decide upon the adoption of any revised minimum cement content. The Contractor will always be responsible to produce quality concrete of the required grade as per the acceptance criteria of IS: 456-2000.

f) The Engineer will always have the unquestionable right to revise the minimum cement content as decided above, if, in his opinion, there is any chance of deterioration of quality on account of use of lower cement content or any other reason.

In case there is a downward revision of the minimum cement content from that specified in the contract, the particular unit rate of concrete will be reduced by an amount equal to the cost of cement saved, calculated at the issue rate. The relevant cost of wastage and handling on the cement saved, which is inherent in the total cost of structure, will not be deducted from the unit rate and will thus pass on to the Contractor.

Strength Requirement

In case of 'Design Mix Concrete' the water-cement ratio of such value as to give acceptable test results as per IS: 456-2000 will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer.

Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-9 of IS: 456-2000 and no tests are necessary. The acceptance test criteria for nominal mix concrete shall be as per IS: 456-2000.

Durability Requirement

Table-4 of IS:456-2000 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by durability consideration is lower than that required from strength criterion, the former shall be adopted.

However, water-cement ratio, from the point of view of durability as well as from strength consideration, should meet the requirement given in clause 9.6 above, whichever is stringent.

In general, the water cement ratio between 0.4 and 0.45 will be desirable to satisfy the durability requirement and from the consideration of Impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer / super- plasticizer.

However, the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer. It will be preferable to use Melamine based plasticizer.

Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of form work and around the reinforcement and embedment's and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. Slump for manually placed concrete shall be about 80mm and for pumped concrete 100mm to 120mm.

Note: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively, where facilities exist or if required by the Engineer, the compacting factor test in accordance with IS: 1199 and Clause 7 of IS: 456-2000 shall be carried out.

Size of Coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer:

Table 2-3 Size of Coarse Aggregates

Reinforced concrete except foundation	**20mm**
Ordinary Plain concrete and Reinforced concrete foundations	40mm

Grading of coarse aggregates for a particular size shall conform to relevant IS Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles: 40 mm to 20 mm and 20 mm to 5mm.

In certain cases, it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

Mixing of Concrete

The cement and aggregate shall be thoroughly mixed in a batch-type pull mill mixer. The capacity of the mixer shall not be less than (one cubic meter) 1m3 and the total quantity of batching mixing plant shall be such to accommodate the various concrete quantities to be cast in a continuous way and shall comply with the requirements of IS: 456-2000, IS: 1791 and IS: 12119.

The water shall not be added until all the aggregates and cement are in the drum. Mixing shall continue until the concrete is of uniform color and for not less than 2 (two) minutes after all the materials are in the drum. Partly set or excessively wet concrete shall not be used. No concrete shall be mixed by hand.

Conveying Concrete

Immediately after mixing, the concrete shall be conveyed to the place of use as rapidly as possible using methods, which will prevent the segregation, loss, or contamination of materials. The concrete shall be mixed and compacted within 90 minutes of the addition of water to the mix. Any concrete left unplaced after this time shall be rejected and removed from site.

The concrete shall be transported in dumpers or trucks, before using concrete pumps, placer pipelines, chutes or spouts it is necessary to have the written approval of the Engineer.

The Contractor shall obtain permission at least 24 hours in advance of any concrete pour.

Placing and Compacting Concrete

Concrete shall be placed in forms as close as possible to its final position in a single operation to the full thickness of slabs and beams and shall be placed in horizontal layers, (not exceeding 2.5m height in a single pour in walls), columns or similar members.

The Contractor shall organize the pouring of concrete in such a manner that once concreting of a section has started the operation shall be continuous and each operation shall be completed prior to a stoppage.

The temperature of concrete shall not exceed 40 ºC measured at discharge into the works.

The maximum allowable temperature differential between any two points in the same element is 15°C Additional temperature control measures during construction (such as use of insulated formwork) shall be required. Contractor to prepare a process control chart and method statement verifying measures to achieve these requirements.

The temperature monitoring of concrete work is required where:

a) The minimum dimension of any casting is 0.8 m or more, or

b) Where otherwise instructed by the engineer

Where specified in the drawings, construction, expansion, or contraction joints shall be provided and the concrete shall be poured continuously between two such adjacent joints. No other joints than shown in the drawings shall be permitted. Stoppage (cold) joints formed between two concreting operations separated by more than 6 hours' time shall be subject to the same treatment as the construction joints.

Concrete shall not be dropped into place from a height exceeding 1.5 m. Trunking and chutes to Engineer approval shall be used for any concrete to be deposited from a height exceeding 1.5 m.

Concrete which has partially hardened shall not be exposed to injurious vibrations or shock, except for controlled re-vibration where specified. When concreting of a certain large structural element is specified strictly as to be poured continuously, then the concreting operations shall be organized for day and night working, in long shifts, as necessary.

As concrete is being placed it shall be compacted by mechanical vibrators complying with IS: 2505, IS: 2506, IS: 2514 and IS: 4656, to obtain a dense material free from honeycombing, free from water and air holes.

The contractor shall ensure that the vibrators are used in such a manner that the reinforcement is not displaced, the formwork not damaged and no segregation caused, but complete compaction of concrete is achieved.

CONSTRUCTION JOINTS AND COLD JOINTS

Construction Joints

The number of construction joints should be kept as low as possible consistent with reasonable precautions against shrinkage. Concreting should be carried out continuously up to the construction joints. Whenever specified or instructed the while concreting to be done in single pour.

Where it is necessary to introduce construction joints, careful considerations should be given to the exact location, which should be indicated on the drawings. Alternatively, the location of joints should be subject to agreement between the Engineer and the Contractor before any work commences. Construction joints shall be at right angles to the general direction of the member and should take due account of shear and other stresses.

Concrete should not be allowed to run into a feather edge and vertical joints shall be formed against a stop board.

The top surface of a layer of concrete should be level and reasonably flat unless design considerations make this undesirable. Joint lines should be so arranged that they coincide with features of the finished work.

If kicker (i.e., a starter stub) is used, it should be at least 70 mm high and carefully constructed. The kicker should be incorporated with the previous concrete.

Period of 7 (seven) days is to be allowed between adjacent pours except where water stops are provided when this can be reduced with Engineer's approval. Alternately a gap of 600 mm wide shall be left between adjacent pours and filled after 7 (seven) days from the date of formation subject to Engineer's approval.

Immediately prior to recommencement of concreting on a joint, the surface of the concrete against which new concrete will be cast should be free from laitance and should be roughened to the extent that the largest aggregate is exposed but not disturbed.

Care should be taken that the joint surface is clean immediately before the fresh concrete is placed against it.

Particular care should be taken in the placing of the new concrete close to the joint. This concrete should be particularly well compacted,

Where the Engineer considers that special preparation is necessary, i.e., for an in-situ structural connection, preparation should be carried out preferably when the concrete has set but not hardened, by spraying with a fine spray of water or brushing with a stiff brush, which is sufficient to remove the outer mortar skin and expose the larger aggregate. Unhardened concrete is achievable by using surface retarder (paste applied on formwork) on the joint face immediately after pouring of concrete. Where this treatment is impracticable, sand blasting or a needle gun should be used to remove the surface skin and laitance, hacking of hardened surface shall be avoided.

Whenever directed, particularly for water retaining structures old to new concrete bonding agent shall be applied on the old concrete face before pouring fresh concrete as per the direction of the Engineer.

A record shall be kept on site of the time and date of placing the concrete in each section of work, where the locations of the joints are not specified, it will be in accordance with the following:

a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.

b) Concrete in a beam shall preferably be placed without a joint, but if provision of a joint is unavoidable, the joint shall be vertical and within the middle third of the span,

c) A joint in a suspended floor slab shall be vertical and within the middle third of the span and at right angles to the principal reinforcement.

d) Featheredges in concrete shall be avoided while forming a joint.

e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress,

f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.

b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth A rich mortar layer 12 mm in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete

c) In case the concrete at the joint has become so stiff that it cannot be remoulded, and mortar or slurry does not rise despite extensive vibration, the joint will be left to harden for at least 12 -24 hrs.

d) It will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under clause 9.11.

REPAIRS, FINISHES AND TREATMENT OF CONCRETE SURFACES

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed, and replaced by sound concrete at the Contractor's cost. The Engineer may, at his sole discretion, allow retaining concrete with minor defects provided the Contractor is able to repair it by approved methods at no extra cost to the Client. All concrete work shall be inspected by the Contractor immediately after the forms are removed and he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Defective concrete will generally require rectification: -

a) Sack rubbing with mortar and stoning with carborundum stone.

b) Cutting away the defective concrete to the required depth and shape.

c) Cleaning of reinforcement and embedment. It may be necessary to provide an anti-corrosive coating on the reinforcement.

d) Roughening by sand blasting or chipping.

e) Installing additional reinforcement/welded mesh fabric.

f) Dry packing with stiff mortar.

g) Plastering, Guniting, shotcreting etc.

h) Placing and compacting concrete in the void left by cutting out defective concrete.

i) Pressure Grouting with cement sand slurry of 1:1 mix.

j) Repairing with a suitable mortar either cement or resin modified mortar.

k) Polymer modified patching and adhesive repair mortar for beams and columns.

PROTECTION AND CURING OF CONCRETE

Newly placed concrete shall be protected by approved means from rain, sun, and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing.

Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding.

Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, polythene sheet, hessian, canvas, or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor.

If permitted by the Engineer, curing compound like "ANTISOLE (WP)" or approved equivalent may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall comply with ASTM requirements for acceptance.

Curing compound shall be used where the surface is difficult or not easily accessible for water curing. For RCC stack and silos curing compound shall be used.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water sheen from concrete surface. It is important not to apply the curing compound when standing water is still present on concrete. The contractor shall arrange for the manufacturer's supervision at no extra cost to the Client.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final.

In case any lapse on the part of the Contractor is noticed by the Engineer, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the Contractor or pay for the part where adequate curing was noticed at a reduced rate, entirely at the discretion of the Engineer.

3. REINFORCEMENT

Mild steel round bars, cold twisted and deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc., will be used as reinforcement as per drawings and directions.

Bar Bending Schedules

The Contractor shall submit to the Engineer for approval Bar Bending Schedules with working drawings in triplicate, showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, within one month of receipt of the Letter of Intent or of the receipt of the relevant design drawings, whichever is later. Upon receipt of the Engineer's final approval of the Bar Bending Schedule and drawings, the Contractor shall submit 6 (six) prints of the final drawings with one reproducible print after incorporating necessary modifications or corrections, for final record and distribution. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the Contract.

Cleaning

All steer for reinforcement shall be free from loose scales, oil, grease, paint, or other harmful matters immediately before placing the concrete.

Cutting and Bending of Reinforcement

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS: 2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding with the approved Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material.

Re-bending can be done only if approved by the Engineer.

Reinforcing bars above 16 mm diameter shall be bent by machine producing a gradual and even motion. Bars of 16 mm or below may be bent by hand. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845°C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

Reinforcing bars, whether high yield or mild steel shall be cut using either handheld shears, guillotines, or foot operated pneumatic cutters. Cutting bars using cold chisels may be allowed by the Engineer at exceptional cases.

Placing in Position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks irrespective of whether such supports are payable or not. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 Gauge annealed soft iron wire. Tack welding of bars should not be done unless permitted by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held.

The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. they should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

Welding

Normal bond laps in reinforcement shall be placed by lap. Butt welding mild steel reinforcement bars may be done only when permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS: 2751 and IS: 456-2000. Welded mesh fabrics conforming to IS: 1566 may also be used if specified in the Schedule of Items and Drawings.

Welding of high yield twisted bars shall be avoided.

Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS: 456-2000, unless otherwise specified. If the bars in a lap are not of the same diameter, the smaller will guide the lap length. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position does not have to bear extra load and get disturbed.

The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sands (1:2) by volume and cured in a pond for at least 14 (fourteen) days.

The type, shape, size, and location of the concrete blocks shall be as approved by the Engineer.

TEMPERATURE CONTROL OF CONCRETE

Cold Weather Concreting

When conditions are such that any operation of concreting may be expected to be done at 5ºC atmospheric temperatures or below the work shall conform to the requirement of IS: 456-2000 and IS: 7861- Part II.

Hot Weather Concreting

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS: 7861-Part 1 and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 40 ºC while placing. Positive temperature control by precooling, post cooling or any other method, if required, will be specified, and paid for separately.

Temperatures of fresh concrete shall not exceed 23 ºC when placed it.

Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of clause 14 of IS: 456-2000.

4. FORM WORK

General

Formwork shall conform to the shape, grade, lines, levels, and dimension as shown on the drawings. The contractor shall prepare design and working drawings for formwork and temporary support system for important structures and get them approved by the Engineer prior to commencement of actual work.

Materials used for the formwork inclusive of the supports and centering shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service.

All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centering shall be true to vertical, rigid and, thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight of the concrete as a liquid as well as the working load in case the Contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the form work shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel or concrete of adequate strength shall be used.

Alternatively, except in case of water retaining structures through rods and the tie bolts shall be sleeved with PVC conduits to allow retraction of the ties on removal of the shutters. Where required, the annulus of the conduits will be filled with expanding mortar to seal the void. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the form work shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins, and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified free of charge as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are plumb and true and thoroughly cross braced to keep them so. All floor and beam centering shall be crowned not less than 8 mm in all directions for every 5m span. Unless specifically described on the drawings or elsewhere to the contrary, beveled forms 25 mm by 25 mm shall be fixed in the formwork at all corners to provide chamfering of the finished concrete edges without any extra charge. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base of vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, saw dust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/ or water jet along with wire brushes, brooms etc. shall be used for cleaning.

The inside surface of the formwork shall be treated with approved non-staining oil-based shutter release agent like "Separol/Sika form oil/ Siparol Concentrate" or approved equivalent before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the form work.

The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

Design

The formwork and scaffolding shall be so designed and erected that the forms for slabs and the sides of beams, columns and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork. Removing any props or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

The design of form work shall take into account all vertical and lateral loads that the forms will carry or be subjected to during the construction process. Besides weight and pressures of, reinforced concrete and weight of the forms themselves, the design shall consider loading due to unsymmetrical placement of concrete; impact from dumping of concrete; movement of men and construction equipment; wind action and any other imposed load during construction. The contractor shall assess the magnitude of vertical live load to be taken for design of formwork duly considering his method, sequence, and rate of pourer of concrete. However, minimum design vertical live load to be considered shall be 750 kg/m2 excluding weight of concrete.

Inspection of Forms

Casting of Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the form work shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

Removal of Forms

Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if he so desires.

The Contractor shall record on the drawing or in any other approved Banner, the date on which concrete is placed in each part of the work and the date on which the form work is removed there from and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the form work and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him without any extra cost to the Client. The Engineer may, however, instruct to postpone the removal of form work if he considers it necessary. Forms for various types of structural components shall not be removed before the minimum periods specified herein when OPC is used and the removal after the minimum periods shall also be subject to the approval of the Engineer in each case.

Table 4-1 Details of Formwork

Part of Structure	Number of days
Columns and Walls	2
Beam sides and Pile cap footing sides	3
Slabs, 125mm	10
Slabs over 125mm thick and soffit of minor 18 beams	18
Soffit of main beams	24

Wherever exposed surfaces of concrete can be effectively sealed to prevent loss of water, the periods specified for temperature above 40 ºC can be reduced to those of the temperature range of 20 ºC to 40 ºC subject to approval of the Engineer.

Construction joints in beams, if required to be provided, will be located within the middle third of span according to clause 9.12.1(b) of this specification. In such cases, however, entire span of beam shall have to be kept supported by formwork till its removal for the portion of beam, cast at a later date, is due and so approved by the Engineer.

If any type of cement other than ordinary Portland cement and Rapid hardening Portland cement is used the time of removal or forms shall be revised as approved by the Engineer such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form as mentioned above. This has to be supported by regular tests.

Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this Specification or drawings or directed by the Engineer:

For-

a	**Sectional dimension**	**±5mm**
b	Plumb	1 in 1000 of height
c	Levels	±3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in the finished concrete surface and should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified herein before. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer.

Classification

Generally, the ordinary class formwork shall be used unless otherwise directed by the Engineer:

Ordinary

These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.

Plywood

These shall be used in exposed surfaces, where especially a good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit utilization of used plywood for the 'ordinary' class, if it is still in good condition.

Ornamental

These shall be used where ornamental and curved surface are required and shall be made of selected best quality well-seasoned timbers or of plywood, which can be shaped correctly.

OPENING, CHASES, GROOVES, REBATES, BLOCK OUTS ETC.

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

ANCHOR BOLTS, ANCHORS, SLEEVES, INSERTS, HANGERS/CONDUITS/PIPE/

OTHER MISCELLANIES EMBEDDED FIXTURES

The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as directed and secure the same as may be required. The materials, if required to be supplied by the Contractor, shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer.

Exposed surfaces of embedded materials are to be painted with one coat of approved anti-corrosive paint and/or bituminous paint and protected with suitable wrappings without any extra cost to the Client. If welding is to be done subsequently on the exposed surface of embedded material the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Engineer, free of cost to the Client. Items to be embedded:

a) Inserts, hangers, anchors, frames around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.

b) Anchor bolts and plates for machinery, equipment, and tor structural steel work.

c) Steel structural to be left embedded for future extension, special connection etc.

d) Lugs or plugs tor door and window frames occurring in concrete work.

e) Flashing and jointing in concrete work.

f) Any miscellanies embedment and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

5. STAINLESS STEEL

GENERAL

This specification covers the supply, fabrication and erection/launching of structural Stainless steel work in general. Fabrication and approval of Stainless steel structures shall be in compliance with:

- The specifications and relevant standards and codes listed under and related drawings.
- All fabrication drawings and supplementary drawings to be supplied by the Contractor prior to execution of the work and duly approved by the Engineer.
- In case of any conflict between the clauses mentioned hereunder and the Indian Standards, those expressed in the specification shall prevail.

SCOPE

The fabrication and erection/launching of the Stainless steel work consist of accomplishing all jobs herein enumerated including providing all labour, tools, tackle and plant, machinery, all materials and consumables such as welding electrodes, bolts and nuts, oxygen and acetylene gases, oils for cleaning etc of approved quality. The work shall be executed by an approved specialist agency experienced in the work and according to the drawings and specifications.

The contractor will be required to fabricate the structure to the extent possible (in transportable length and volume) in own / approved fabrication shop.

APPLICABLE CODES AND SPECIFICATIONS

The following specifications, standards and codes of latest version at the time of execution shall be made a part of this specification. All standards, specifications, codes of practice referred to herein shall be of latest editions including all applicable official amendments and revisions. Only the codes relevant to present work out of the list mentioned below shall be applicable. Any additional pertinent code, if required shall be used with prior permission of Engineer in charge.

Table 5-1 Stainless Steel Codes & Standards

i)	IS : 6911	Stainless Steel plate, sheet & strip - Specification
ii)	IS : 1364	Hexagonal head bolts, screws (M16 to M64)
iii)	IS : 3757 IS : 6623	Specs for high strength structural bolts nuts
iv)	IS : 2016 IS : 6639	Specs for plain washers Hexagon bolts for steel structures
v)	IS : 800	Code of Practice for General Construction in steel
vi)	IS : 7280	Specs for base wire electrodes for submerged arc welding of structural steels
vii)	IS : 817	Code of practice for training and testing of metal arc welders
viii)	IS : 7318 Part – I	Approval test for welders when welding procedure approval is not required
ix)	IS : 1182	Recommended Practice for Radiographic Examination of fusion Welded Butt Joints in steel Plates

x)	IS : 2595	Code of practice for Radiographic testing
xi)	IS : 4260	Recommended practice for ultra-sonic testing for butt welds in ferritic steels
xii)	IS : 3658	Codes of Practice for Liquid penetrate Flaw Detection
xix)	IS : 1477	Code of Practice for painting of Ferrous (Part 1 & 2) Metals in building
xx)	IS : 2074	Ready Mix Paint, air drying, red oxide zinc chrome, priming specifications
xiii)	IS : 1852	Specifications for Rolling and Cutting Tolerances for Hot rolled steel Products
xiv)	IS : 806	Code of Practice for use of steel tubes in General Building Construction
xv)	IS : 1161	Specifications for Steel Tubes for Structural purposes
xvi)	IS : 7215	Tolerances for fabrication of steel structures
xvii)	IS : 822	Code of procedures for inspection of welding
xviii)	IS : 801	Code of practice for use of cold – formed light gauge steel structural member's in general building construction
xix)	IS : 1599	Method for bend test
xx)	IS : 1608	Mechanical testing of metals: Tensile Test
xxi)	IS : 7205	Safety Code for erection of structural steel
xxii)	IS : 7307	Approval tests for welding procedures –fusion welding of steel
xxiii)	IRC-6	Code of practice for Road bridges-section-II
xxiv)	IRC-21	Code of practice for Road bridges-section-III
xxv)	IRC-24	Code of practice for Road bridges-section-V
xxvi)	IRC-78	Code of practice for Road bridges-section I-V
xxvii)	IRC-83	Code of practice for Bearings- Part-II/III/IV
xxviii)	IRS Steel Bridge Code	For construction of Steel bridges
xxix)	BS-110	Guidelines on fabrication of steel girders for construction/field engineers
xxx)	BS-112	Guidelines for Planning of Road Over Bridges

xxxi)	BS-S-7.5.3.1-9	Specification for Higher strength Martensitic Stainless Steel for bridges and associated structural applications
xxxii)	AWS 1.6	Structural Stainless Steel Welding Code
xxxiii)	ASTM A194	Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
xxxiv)	ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
xxxv)	ASTM A240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
xxxvi)	ASTM A6/A6M	Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
xxxvii)	ASTM A700	Guide for Packaging, Marking, and Loading Methods for Steel Products for Shipment
xxxviii)	ASTM A673/673M	Specification for Sampling Procedure for Impact Testing of Structural Steel
xxxix)	ASTM A370	Test Methods and Definitions for Mechanical Testing of Steel Products
xl)	ASTM A480/A480M	Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip
xli)	ASTM A709/A709M	Standard specification for structural steel for bridges
xlii)	ASTM A1010/A1010M	Standard specification for higher Strength Martensitic Stainless Steel plate, sheet and strip
xliii)	EN 1011-3	Recommendations for welding of metallic materials Part 3: Arc welding of stainless steels
xliv)	EN 1993-1-4	Stainless Steel Eurocode
xlv)	SCI P413	Design Manual for Stainless Steel
xlvi)	Design Guide 27	Design Guide by AISC

GENERAL SPECIFICATIONS

The requirements set forth in Relevant IS / IRC / IRS / International codes for the design, fabrication and erection of structural steel shall govern this work, except as otherwise noted on the drawings or as otherwise specified.

In cases of conflict between clauses of this specification and those in the Indian Standards, this specification shall govern.

Substitutions of sections or modifications of details or both shall be made only when approved, in writing, by the Engineer in charge. The contractor shall be responsible for all errors of fabrication, and for the correct fittings of the structural members shown in the drawings.

Materials

All materials shall be new and shall conform to their respective specifications as specified. The use of equivalent or higher grade or alternative materials will be considered only in very special cases subject to the approval of the Engineer.

Structural Stainless Steel

Structural Stainless steel in Built up / Hollow sections/Girders fabricated from Hot Rolled Annealed Pickled (HRAP) Plates as per requirement of structural design

- Grade 350 (X01Cr11Ni1) as per Indian Standard (IS) 6911 along with its latest amendments (also referred as IRS 350CR as per RDSO specification), having mechanical properties 0.2% proof Stress 350 MPa min, Ultimate Tensile Strength 450 MPa min, % Elongation 20 min.
- Grade 450 (X01Cr11Ni1Mn1) as per Indian Standard (IS) 6911 along with its latest amendments, having mechanical properties 0.2% proof Stress 450 MPa min, Ultimate Tensile Strength 550 MPa min, % Elongation 18 min.

STAINLESS STEEL FOR ARCHITECTURAL OR NON-STRUCTURAL WORKS

Stainless steel (Grade 304/304L/316/316L) as per IS 6911 latest amendment - Non-structural members/ railing made of Hollow tubes, channels, plates etc., including welding, grinding, buffing, polishing and making curvature (wherever required) and fitting the same with necessary stainless steel nuts and bolts complete, including fixing the railing with necessary accessories & stainless steel dash fasteners, stainless steel bolts etc., of required size with suitable arrangement as per approval of Engineer-in-charge

Fasteners

Fasteners shall be in accordance with IS: 1364, 1367, 3757, 6623, 6639, ASTM A193 and 194 as applicable.

Washers

Washers shall confirm IS: 2016 or any other similar codes.

Welding electrodes

For SAW welding, it is recommended to use ER308L, ER309L, ER316L and their higher silicon content counterparts. For FCAW, ER309L, and for GMAW, ER309L/ER309LMo with Gas mixture Ar-98% is recommended. However, any other suitable welding consumable permissible by AWS 1.6 may also be used.

Receipt and Storing of Materials

Approved material conforming to IS and Specification shall be procured by the Contractor as per schedule. Storing yards shall have hard grounds and should be well drained. Stainless Steel shall be stored on raised platform in these yards. Yards shall be maintained clean so as to avoid any contamination due to dust, mud, oil, grease etc. Scrap and full-length steel shall be stacked separately. Further each type / category of steel shall be stacked appropriately.

All sections shall be checked on receipt to ensure that they are free from surface defects as pitting, twists, cracks and laminations. They shall be arranged by grade and quality and by lot. Every section shall be marked to aid identification and the manufacturer's certificate for every lot giving details of chemical analysis and mechanical characteristics shall be kept in record.

Welding wires and electrodes shall be segregated by quality and lots and stored inside a dry, enclosed room as per recommendations of IS: 9595. All care shall be taken to keep the electrodes in perfectly dry condition to ensure weld metal soundness and satisfactory operations manufacturer's certificates for electrodes shall also be made available.

Bolts, nuts and washers shall be sorted out by grade, type and diameter and the manufacturer's quality/ test certificate shall be maintained for record purposes.

Quality Certificate of Materials

he contractor shall produce manufacturer's test certificate of the material. Notwithstanding, the manufacturer's test certificate the EIC may ask for testing of material in approved test labs. The test result shall satisfy the requirement of relevant Indian Standards and Specification.

Whenever quality certificates are missing or incomplete or when material quality differs from standard specifications, the Contractor shall conduct all appropriate tests as directed by the Engineer at his own cost.

Shop / Fabrication Drawings

The Contractor shall prepare all fabrication drawings based on the design and submit four copies to the Engineer – in – Charge, well in advance to commencement if work, for approval and comments of Client / Employer and design consultant, if any on the same. The Contractor shall fabricate all the structural Stainless steel work strictly conforming to the specifications and approved fabrication drawings.

Fabrication drawings shall include the following:

a) Member sizes and details

b) Types and dimensions of welds and bolts.

c) Shapes and sizes of edge preparation for welding

d) Details of shop and field joints included in the assemblies

e) Bill of Materials.

f) Quality of structural Stainless steel, welding electrodes, bolts, nuts and washers, etc. to be used.

g) Erection assemblies, identifying all transportable parts and sub – assemblies, associated with special instructions, if required showing part marks and erection marks.

h) Painting of Stainless steel structures is purely for aesthetic purpose only. Surface preparation shall be carried out by abrasive blasting to Sa 2.5 finish (as per ISO 8501-1 / SSPC-SP10 / NACE No. 2) using non-metallic media to free from oil, grease, dirt, dust and contaminants. The scheme would be one coat epoxy rich primer (30-40 micron DFT) followed by one coat of synthetic enamel finish (40-50 micron DFT) achieving a total dry film thickness of 75-100 micron conforming to IS 2932:2003.

i) Calculations where asked for approval.

j) Method of erection and Special precautions to be taken during erection.

Issue of fabrication and erection drawings by consultants or review of drawings by Client / Employer / Consultant shall in no way relieve the contractor of his responsibilities for correctness in the execution of the work and the contractor shall be required to modify / rectify the structure at any stage of the work to rectify any mistake / omission in the fabrication drawing and the fabrication based on this drawing or that the work does not conform to good engineering practices such modifications / rectification shall be made at no extra cost.

The contractor is required to update the fabrication drawings to include revisions made in design drawings during the course of work at no extra cost. The contractor shall also supply two prints of as built drawings, along with their soft copies and transparencies at no extra cost.

Workmanship

The workmanship shall be equal to the Standard practice followed in modem structural shop. All works shall be adequately supervised and care shall be taken to ensure that the structural members remain in proper position. All similar parts shall be manufactured accurately so that the same could be interchanged with other parts having same identification marks. Accuracy shall be maintained during fabrication to ensure that all parts fit together properly during erection.

Fabrication

- All fabrication shall be preferably done in full – fledged workshop. However, contractor may be allowed to fabricate the structural element at his workshop nearby and transport the same to the site. This is to be done with prior approval of Engineer in Charge.
- All fabrication shall be done as per specifications, IS: 800, IS: 9595, other applicable specifications and drawings approved as “Good for Construction”.
- Fabrication shall also be understood to include building up an element either by welding plates to a rolled section, a combination of rolled sections with plates or a section built up entirely with plates, tubes / pipes / hollow sections.
- The contractor shall prior to starting any fabrication ensure that the fabrication yard is levelled on firm enough to take weight of structures and equipment.
- Any defective fabrication or material pointed out at any stage shall be replaced by the contractor free of cost.
- All the fabricated and delivered items shall be suitably packed and protected from any damage during transportation and handling. Any damage caused at any time shall be made good by the Contractor at his own cost. In general, tolerance for fabrication shall be as per IS : 7215.

Preparation of Materials / Fabrication procedures

Straightening

All materials shall be clean, reasonably straight and free from twists. If straightening or flattening is necessary, it shall be done in a manner that will not damage the material. The specified camber wherever necessary shall be provided.

Marking

Marking of members shall be made on horizontal pads or on appropriate racks or supports in order to ensure horizontal and straight placement of such members.

Clearance

The erection clearance for members having end cleats or plates shall not be more than 2 mm at each end, whereas for other types of end connections it shall not be more than 3 mm at each end. If for any reason a greater end clearance is required, suitable seating shall be provided.

Templates

Templates used shall be of steel. In case where actual parts have been used as templates for drilling similar pieces, the Engineer – in – Charge shall decide whether they are fit to be used.

Cutting

Machine cutting or flame cutting may be allowed to use provided, a mechanically controlled cutting torch is used for the flame-cutting and the resulting edge is reasonably clean and straight. Cut members shall be free from distortion at cut edges. When gas cutting is adopted, the flame cut edges shall be machined to a depth of 3 to 5 mm depending on the thickness of the member.

Chipping of angles, flanges and edges of plates wherever necessary, shall be done without damaging the parent material. Chipped edges shall be grinded to a neat finish and sharp corners and hammered rough faces shall be rounded off.

Edge preparation for welding may be done by machine controlled flame cutting with edges free of burns, clean and straight. The butting surfaces at all joints shall be planned so as to butt in close contact throughout the finished joint. All flame – cut edges shall be planned, unless they are clean, square and true to shape.

Drilling / Holing

Holes for bolts shall be drilled. All holes, except as stated hereunder, shall be drilled to the required size or sub-punched 3mm less in diameter and reamed thereafter to the required size. Thickness of the materials for sub-punching shall not be greater than 16mm. All matching holes for bolts shall register with each other so that a gauge of 0.8mm less in diameter than the diameter of the hole can pass freely through the members assembled for bolting in the direction at right angle to such members. All holes for turned and fitted bolts shall be drilled undersize by one mm and after assembly, reamed to a tolerance of +0.13mm / -0.00mm unless otherwise specified. No holes shall be made by gas cutting process.

Bending

Cold bending of plates, flats, tubes / pipes and sections shall be carried out on bending rolls or in presses. The methodology for bending along with mock up shall be got approved from Engineer – in– Charge. In exceptional cases hot bending may be allowed by EIC for higher diameter pipes provided cold bending is not possible.

Appropriate bending method shall be adopted, so as to avoid wrinkles on surface or distortion of pipe section etc. If required, suitable filler materials shall be used for equitable stress distribution during bending.

Accuracy of bending operations shall be checked by means of templates and the clearance between member and template shall be decided by EIC based on the mock-up and good Engineering practice. Bend member shall not have cracks wrinkles or deep indentations from bending equipment.

Assembly

All parts of bolted and welded members shall be held firmly in position by means of jigs or clamps while bolting or welding. No drifting of holes shall be permitted except to draw the parts together and no drift shall be larger than the nominal diameter of bolt. Drifting carried out during assembly shall not distort the metal or enlarge the holes.

Trial assemblies shall be carried out at the fabrication stage to ensure accuracy of workmanship. These checks shall be witnessed by the Engineer – in – Charge.

Bolting

Bolts shall be grade Class 8.8 /10.9 . All turned and fitted bolts shall be parallel throughout the barrel within the tolerance of 0.125mm unless otherwise specified and faces of heads and nuts bearing on steel work shall be machined.

All such bolts shall be provided with washers not less than 3mm thick, so that when the nut is tightened, it shall not bear the unthreaded body of the bolt and the threaded portion of the bolt should not be within the thickness of the parts bolted together. The threaded portion of each bolt shall project through the nut by at least one thread. Square tapered washers shall be provided for all heads and nuts bearing on levelled surface. Flat washers shall be circular in shape nuts and washers etc. shall be thoroughly cleaned and dipped in linseed oil.

Preparation of Member for Bolting

The member shall be assembled for bolting with proper jigs and fixtures to sustain the assemblies without deformation and bending. Before assembly all sharp edges, , dirt etc. shall be removed. Before assembly the surfaces in contact of the member shall be cleaned.

Welding

General

Welding of steel shall be in accordance with AWS 1.6, IS: 800, IS: 817, IS: 435 and IS: 1223 as applicable. Welds shall be made by qualified welders. A Welder shall produce satisfactory evidence of his ability to do a given type of work and shall prove his ability to product a connection of the strength required. Evidence of welder's qualification tests shall be produced if required by the Engineer – in – Charge. Engineer – in – Charge may reject any welder found not suitable during actual work. In general the welders qualification shall be carried out as per AWS 1.6 / ASME – Section IX / IS: 817.

Welding wire and electrodes shall be stored separately by quantities and lots inside a dry and enclosed room and as per instruction given by the Engineer in Charge. Material shall be perfectly dry and drawn from an electrode oven, if required.

Both the structural members and the welding operators shall be adequately protected from rain, strong winds or snow during welding. The Contractor shall provide necessary supervision to ensure that all welding carried out in conformity with the specification and relevant IS codes. The contractor shall make all necessary infrastructures available such as requisite number of welding sets, cutting and grinding equipment, test equipment and all consumables as required.

Preparation of Members for Welding

Edge preparation of fusion faces for welding shall be carried out as per details given in IS : 9595 or as shown in drawings. All tolerances for such weld shall be as per IS : 9595.

Surfaces to be welded shall be cleared to ensure that they are free from loose scales, slag, grease, paint and other foreign matter, and shall be maintained.

Preheating of members shall be necessary when the base metal temperature (based on ambient temperature) is less than the temperature required for that welding procedure. Preheating shall generally be carried out for members having thickness more than 20mm. The preheating shall be done in such a manner that the part on which weld metal is to be deposited is above the specified temperature shall be measured on the face opposite to the face being heated. In case access is limited to only the face being heated, the Source of heat shall be removed and sufficient time allowed elapsing for heat equalization prior to measurement. (1 minute per 25mm of Plate thickness).

Column splices and butt joints of compression members shall be accurately ground and close butted over the entire section to ensure full contact for load transmission. The tolerance for such work shall be maximum 0.2mm. In the case of column bases and caps the ends of the section along with connected gussets, stiffeners, angles, channels etc. shall be ground so as to ensure a minimum contact area of 90%. The fining of angles and channels should be sufficiently accurate to limit the reduction in thickness on account of grinding to 2mm. The ends of bearing stiffeners shall be ground so as to fit tightly at top and bottom. Slab bases and cap plates shall be accurately ground over bearing surfaces to ensure minimum 90% contact area with columns.

Welding electrodes

For SAW welding, it is recommended to use ER308L, ER309L, ER316L and their higher silicon content counterparts. For FCAW, ER309L, and for GMAW, ER309L/ER309LMo with Gas mixture Ar-98% is recommended. However, any other suitable welding consumable permissible by AWS 1.6 may also be used.

Welding Plant

Welding plant shall be capable of maintaining the voltage and current specified by the manufacturer of the electrodes. The contractor shall supply instruments for verifying the voltage and current as and when required by the Engineer.

When an automatic process of welding is adopted, the deposited metal must have mechanical properties equal to those obtained by the use electrodes complying with AWS 1.6 or any other relevant code.

Manual Welding

Manual welding shall be carried out by qualified welders equipped with plant suitable for the purpose. All welders shall be qualified in accordance with IS : 817 / AWS 1.6 / ASME Section IX and details of such qualification shall be submitted to the Engineer

Welding Processes

Any one or more of the following welding processes may be used.

- Manual Metal Arc Welding process.
- Submerged Arc Welding process.
- Gas Metal Arc Welding process.

The contractor shall submit the welding procedure and the consumables proposed to be used to the Engineer – in – Charge for approval. Combination of processes or electrodes may be permitted only with the specific approval of the Engineer – in – Charge.

Approval and Testing of Welding Procedures

Before welding of any of the permanent works is carried out, the contractor shall furnish details of welding procedure for each welding operation.

Welding trials shall be carried out and completed on representative samples of the materials before the start of fabrication, as directed by the Engineer.

Welding trials are intended to establish welding procedure prior to the commencement of fabrication and for this purpose assemblies shall be made from plate or section cuttings large enough to simulate the joint selected for trial. The trial shall be representative of actual fabrication conditions including:

- Preparation and fit-up.
- Preheat.
- Welding position
- Restraint (so for as is practicable)

Welding trials on material 20mm thick will be taken to include all materials under 20mm thick and trials on materials 50mm thick. The trials shall include specimen weld details from the actual construction which shall be welded in a manner simulating the most unfavorable instances of fit-up and preparation which it is expected will occur in the fabrication.

After welding, the specimen shall be allowed to cool naturally to ambient temperature. It shall be left for 72 hours and thereafter, it shall be sectioned and examined for cracking. Testing shall be carried out in accordance with IS: 7307 (Part – I) / approved specification as directed by the Engineer. Approval of any welding procedure shall not relieve the contractor of his responsibility for correct welding procedure to be followed and for minimizing the distortion in the finished structure.

Sequence of Welding

- The direction of welding shall be horn points relatively fixed with respect to each other towards points having more flexibility.
- Welding shall be carded out continuously to completion with the required number of runs.
- For compound section splices, each component part shall be spliced prior to welding with other component parts.
- Welds shall progress in a sequence that will balance the applied heat so as to reduce distortion.
- Joints having more shrinkage shall be welded prior to joints having less shrinkage.
- The sequence causing minimum distortion or shrinkage shall be chosen.

Welding Technique

The fusion faces shall be properly aligned and the gap set to the distance specified. The root pass of butt joint shall be done such that full penetration is achieved as also complete fusion of root edges. On completing each run the weld and the parent metal shall be cleared by wire brushing and light chipping to remove all slag and splatters. Visible defects, if any such as cracks, cavities etc. shall be removed to sound metal prior to depositing subsequent run of weld.

All full penetration butt weld shall be completed by gouging / chipping the back of the joint and depositing a seal run of weld metal. Alternatively a backing strip shall be provided.

All care shall be taken to prevent any kind of movement, shock or vibration of components during welding to prevent weld cracks. Low hydrogen electrodes shall be used for all welding of girders with thickness of plates equal to or more than 20mm.

Workmanship of welding

The general welding programme for shop and site welds, including particulars of the preparation of fusion faces, pre-heating where required and method of making welds shall be submitted in writing to the Engineer for approval before the work is put in hand. No departure from the welding programme shall be made without the prior approval of the Engineer.

In the fabrication of built up assemblies all butt welds in each component part shall be completed before the final assembly. Wherever practicable, clamps, magnets, holding devices or other setting-up fixtures shall be used in assembling parts of the structures so as to avoid tack welding as far as possible.

In fit-up where clamps cannot be used, spacer strips shall be used to ensure the correct root gap. Where tack welds are used, they shall be of the same quality and size as the first run of main weld. All tack welds shall be cleaned and ground to sound material prior to welding of the root pass. The main weld shall fuse completely with the end of the tack weld to form a regular profile. Where preheat is required for the main welds, the tack welds shall be made under the same heat conditions. The indiscriminate use of tack welds during assembly shall be avoided.

All welds shall be visually inspected. Cracked or badly formed welds shall be cut out to the approval of the Engineer before re-welding them. As far as practicable, all welding shall be carried out in the down hand position. Where structural steelwork is painted before fabrication or erection, the metal surface within 75mm of any weld shall be coated with primer only.

Weld Inspection

All facilities for stage inspection during welding and on completion shall be provided by contractor. All testing shall be as per IS: 822 / AWS 1.6 and the extent of inspection and testing shall be in conformity with the relevant or as directed by Engineer in Charge. The contractor shall extend all facility required to inspect all stages of fabrication and erection including welding procedure qualification. No painting of welds shall be undertaken prior to inspection and approval. All the tests required to be carried out shall be paid for by the contractor.

One or more of the following methods will be applied for the inspection and testing of welds. The various types of tests shall be:

Visual Inspection

100% welds shall be visually inspected to ascertain absence of the following defects. Suitable magnifying glass may be used for inspection.

- Surface cracks in weld or parent metal, or undercut, burning, overheating of parent metal.
- Blow holes, exposed porosity in the weld or infused welds.
- Defects in the profile such as excessive convexity or concavity, unequal leg lengths, incompletely filled grooves excessive penetration beds, root grooves etc.
- Distortion due to welding and misalignment.

Mechanical Tests

Tensile load test, bend test, impact test etc. shall be carried out as per the standards.

Other tests.

- Ultrasonic test for detection of for detection of internal flows in welds shall be carried out as per IS-4260 or as per specification.
- Liquid Penetrant Test (LPI) shall be carried out for inspection of surface defects in the welds per IS 3658 or as per specification.

Repairs of Welds

Welds not meeting the requirements of the specification and IS codes shall be removed and replaced. Repairs to defective welds shall be carried out only after the repair procedure submitted is approved by the Engineer – in – charge.

Splicing

In compound sections, splicing of components shall be staggered with respect to each other by a minimum of 500mm. When two parts of a component are not butt welded to each other, the opposing ends at a joint shall be ground flush for bearing and suitable flange and web splice plates shall be designed to cater for the full strength of the flange / web of the sections.

In case full strength butt weld is used to connect opposing ends at a joint, additional flange and web splice plates shall be provided capable of carrying 20% strength of the flange and web.

Shop Erection

The steel work shall be temporarily erected in the shop to determine the accuracy of the fit. The extent of erection shall be either complete or as directed by Engineer in charge.

General Inspections and Testing of Structures

Materials and workmanship at all times shall be subject to inspection by the Client / Employer. All inspection as far as possible shall be made at the place of fabrication and the contractor shall co- operate with the Client / Employer Inspector and permit access for inspection to all places where work is being done. The contractor shall supply all necessary gauges and templates necessary for inspection. However, such inspection shall not relieve the contractor of his responsibility to furnish satisfactory work.

Materials of workmanship, not conforming to provisions of the specifications, may be rejected at any time when defects are found during the progress of work.

The contractor shall obtain approval from the Engineer – in - charge of all fabricated items prior to commencement of their erection. However, any such approval shall not absolve the contractor from his responsibility of correctness and workmanship of the entire work.

Packaging and Transportation

Loading and transportation shall be done in accordance with transport rules prevailing at that location. Items shall be packed to protect them from damage / distortion. Small parts shall be wired to their main members. Loose item such as bolts, nuts and washers shall be packed in crates / bags.

ERECTIONS/LAUNCHING

General

Erection of structural steel work shall be carried out in accordance with the relevant IS code in conformity with the drawings and specifications in an expeditious manner.

The suitability and capacity of all plant, machinery, equipment etc. used for erection shall be to the satisfaction of the Engineer.

Scope of erection work

The contractor shall provide all construction material and equipment, transport facilities, tools, tackles, consumables, labour, supervision for erection, including carrying out the following: Receiving, unloading, checking and moving into the storage facility at site, as outlined under General Conditions of contract inclusive of attending to all insurance matters in respect of materials arriving at site.

Transporting from site, storage, handling, rigging, assembling, riveting, bolting, welding, and installation of all fabricated materials in proper location according to drawings or as directed by the Engineer.

Checking centre lines, levels of all foundations blocks including checking line and level, position and plumb of all bolts and pockets. Any defects observed in the foundation shall be brought to the notice of the Engineer. The contractor shall satisfy himself regarding the correctness of the foundations before installing the fabricated structures on the foundation blocks. Aligning, levelling, riveting, bolting, welding, fixing in position of fabricated materials shall be done in accordance with drawings or as directed by the Engineer.

Supply of all required consumables, construction and erection materials, including but not limited to gauges, welding / brazing, rods, electrodes and wires, oxygen, acetylene, fuel, bolts, nuts, rivets, shims and temporary supports etc. as required for the incidental works and for the completion of erection.

Erection/Launching shall also include the following work:

a) All minor modifications such as:

- Removal of bends, kinks, twists etc. of parts damaged during transport and handling.
- Cutting, chipping, filling, grinding etc. for preparation and finishing of site connections.
- Reaming of the next higher size of rivet or bolt for holes which do not register, or which are found to be damaged.
- Welding of connections in place of riveting or bolting for which holes are either not drilled or wrongly drilled during fabrication.

b) The following shall be considered as a legitimate part of erection work:

- Re-fabrication work in respect of parts damaged beyond repair during transport and handling or in respect of those that are incorrectly fabricated.
- Fabrication of parts omitted during fabrication due to an error, or subsequently found to be essential.
- Plug-welding and re-drilling of holes which do not register and which cannot be reamed for the use of next size of rivet or bolt.
- Drilling of holes which are either not drilled at all or are drilled in incorrect positions during fabrication.

Erection/Launching scheme and Drawings

The approved erection drawings and any approved arrangement drawings, specifications or instructions accompanying them shall be followed while erecting the structural steelwork. Erection drawings for structural steel work shall be prepared by the contractor and shall consist of line diagrams showing every member in position with the respective erection mark.

Erection marks shall appear on the structural steel members as detailed and all steelwork shall be erected with the marks in the same relative position as shown on the plan or elevation. Any discrepancy between and specifications shall be brought to the attention of the Engineer in Charge for obtaining his decision.

Storing and Handling of Material

The fabricated materials shall be carefully unloaded at site, examined for defects, checked, sorted out and stacked properly above the ground level, to be kept clean and properly drained. The handling and storing of the component parts of a structure shall involve the use of method and alliances not likely to produce injury by twisting, bending or otherwise deforming the metal. No member slightly bent or twisted shall be put in place until the defects are corrected.

All small bends or twists detected in members shall be rectified before such members are put in place. Any serious bends or defects shall be reported at once to the Engineer. The straightening of bent edges of plates, angles and other shapes shall be done by methods not likely to produce fracture or other injury. Following the completion of the straightening of a bend or buckle, the surface of the metal shall be carefully inspected by the contractor for evidence of incipient or any other type of fractures. The contractor shall report to the Engineer about the presence of such evidence and act according to his instructions.

Setting Out

The contractor shall be responsible for checking the alignment and levels of foundations, correctness of foundation-bolt centres, their projected height above the foundation tops, the length of threading provided and the provision and fitment of nuts for the foundation bolts. These shall be checked well in advance of starting the erection work and the contractor shall be responsible for any consequences for non-compliance thereof. Discrepancies, if any, shall immediately be brought to the notice of the Engineer for his advice.

One set of reference axes and one Bench mark level will be furnished to the contractor. These shall be used by him for setting out operation. The contractor shall assume full responsibility for the correct setting out of all Stainless steel work and erecting it correctly as per the alignment and levels shown on the drawings and for the verticality of members. Notwithstanding any assistance rendered to the contractor by the Engineer, if at any time during the progress of the work any error should arise or arise therein, the contractor shall remove and amend the work to the satisfaction of the Engineer, at his own cost.

Assembly and Erection

Before the commencement of structural Stainless steel work, the contractor shall submit a schedule of operations, detailing the erection procedures to be followed. The schedule shall include provisions for any temporary bracing that may be considered necessary during the election.

During the erection of a structure, the steel work shall be securely bolted or otherwise fastened and if necessary temporarily braced, so as to make adequate provision for all erection stresses and conditions, including those due to erection equipment and its operation. Such temporary bracing shall be maintained in position until the erection work is sufficiently advanced and it is ascertained that the bracing provided is no longer required.

Connections for temporary bracing and additional holes, members or cleats used to facilitate handling or erection, shall be provided in a manner which does not weaken the steelwork already erected.

The alignment of each portion of the structure shall be carried out progressively, soon after that portion is erected. Permanent connections shall not be made until proper alignment has been obtained and a sufficiently large portion of the structure has been erected and temporarily connected so as to ensure that the members thus connected shall not be overstressed or displaced during the progressive alignment of the remainder of the structure.

Tolerances

Erection tolerances shall be provided strictly in accordance with the requirements of IS: 7215.

Field Connections

Field Bolting

This shall be carried out with the same care as shop bolting.

Field Welding

Field Welding after field assembly shall follow the same requirements as laid down for shop assembly and stop welding

Grouting

Prior to erecting the steelwork over concrete pedestals, columns or brackets, the top of concrete shall be cleared with wire brushes, chipping and compressed air to remove all laitance and loose material and made thoroughly wet. The structural member shall then be erected aligned and plumbed with the base plates as shoe plates maintained as specified levels using shims / pack plates or wedges.

After the structure is erected, formwork shall be done all around and the joints sealed to be water tight. The Grout under the base plates, including in pockets and sleeves shall be ordinary grout or non-shrink grout as specified in drawings. Non-shrink grout shall be of premix type and shall be prepared as per manufacturer's instruction; Non shrink grout shall be of quality and type approved by Engineer – in – charge.

The grout shall be poured in by grout a pump continuously from one side till the intervening space is filled completely and the grout is carried to the far side of base plate. The grout shall be spread with flexible steel strips and rammed with rods to ensure the gap is filled completed.

After the grout has sufficiently hardened the shims / pack / wedges which are accessible may be removed and anchor bolts tightened. The alignment of the structure shall be rechecked and the voids left by removal of the shims / pack plates / wedges shall be filled with a similar mix of grout. In case the structure is not properly aligned the grout shall be removed the structure re-aligned and grouting operation repeated

6. SHEET PILING

GENERAL

Sheet piling shall be used for the temporary or permanent retention of earth and water during excavation, construction of foundations, cofferdams, riverbank protection works, retaining structures, waterfront developments, bridge abutments, and other civil engineering works as shown on the approved drawings. The work shall include the design (where specified), supply, transportation, handling, storage, installation, driving, cutting, welding, anchoring, corrosion protection, testing, monitoring, extraction (for temporary works), and all incidental works necessary for the satisfactory completion of the sheet piling system.

The Contractor shall carry out the work in accordance with the Tender drawings, Specifications, approved Method Statements, and the instructions of the Engineer. All works shall comply with the latest revisions of relevant Indian Standards, international standards, and statutory regulations.

APPLICABLE STANDARDS

Unless otherwise specified, the sheet piling works shall conform to the latest editions of the following standards:

Table 6-1 Sheet Piling Codes & Standards

Standard	Relevance
IS 9527	Steel Sheet Piles – Covers dimensions, terminology, and material requirements.
IS 800:2007	Design of steel structures, including structural checks for walers, bracing, and connections.
IS 2062	Material specification for structural steel grades (e.g., E250, E350).
IS 2911	Pile foundations; provides guidance where sheet piles are used in foundation works.
IS 875 (Parts 1–5)	Dead, live, wind, and other design loads.
IS 1893 (Part 1):2016	Seismic loading, where applicable.
IS 1200	Measurement of civil engineering works.
IS 816 and IS 9595	Welding procedures and quality requirements.
IS 10289	Geotechnical investigations for foundation design.

MATERIALS

STEEL SHEET PILES

Steel sheet piles shall be hot-rolled or cold-formed interlocking sections manufactured from high-quality structural steel conforming to IS 2062 Grade E350 or equivalent EN 10248 Grade S355GP unless otherwise specified. The steel shall possess adequate strength, ductility, toughness, and weldability suitable for the intended service conditions.

The sheet piles shall be free from defects such as cracks, laminations, excessive corrosion, distortion, twists, bends, damaged interlocks, or other imperfections that may adversely affect structural performance or installation.

The Contractor shall submit the manufacturer's mill certificates indicating the chemical composition, mechanical properties, dimensions, and manufacturing tolerances for approval before delivery to the site.

DIMENSIONS

The section type, thickness, width, depth, moment of inertia, section modulus, weight per metre, and pile length shall conform to the approved design drawings. Any proposed substitution of pile sections shall require prior approval from the Engineer and shall be supported by detailed structural calculations demonstrating equivalent or superior performance.

CORROSION PROTECTION

For permanent works, suitable corrosion protection measures shall be provided based on the environmental exposure conditions and the design life of the structure. Protective measures may include:

- Hot-dip galvanizing
- Fusion-bonded epoxy coating
- Coal tar epoxy coating
- Polyurethane coating systems
- Cathodic protection
- Sacrificial corrosion allowance by increasing steel thickness

Damaged coatings occurring during transportation or installation shall be repaired using compatible approved repair materials before completion of the works.

DESIGN REQUIREMENTS

Where the Contractor is responsible for the design, detailed structural and geotechnical design calculations shall be prepared and submitted for approval.

The design shall consider:

- Active, passive, and at-rest earth pressures
- Hydrostatic and hydrodynamic water pressures
- Live load surcharge
- Traffic loading
- Crane loading
- Construction loading
- Seismic loading as per IS 1893
- Wind loading where applicable
- Uplift forces
- Scour depth
- Differential water levels
- Groundwater fluctuations
- Soil stratification
- Long-term corrosion allowance
- Structural capacity of sheet piles
- Serviceability requirements
- Global stability
- Anchor forces
- Internal bending moments and shear forces
- Lateral deflection

The design shall satisfy both Ultimate Limit State (ULS) and Serviceability Limit State (SLS) requirements.

The maximum lateral deflection shall generally not exceed the limits specified in the project requirements or the applicable design codes.

SITE INVESTIGATION

Prior to commencement of the sheet piling works, the Contractor shall thoroughly review the available geotechnical investigation reports. Additional investigations shall be carried out wherever the available data are insufficient for design or construction.

The investigation shall establish:

- Soil profile
- Groundwater level
- Rock level
- Standard Penetration Test (SPT) values
- Shear strength parameters
- Soil density
- Existing underground utilities
- Nearby buildings and structures
- Existing retaining systems
- Obstructions below ground

The Contractor shall identify all utilities before commencing driving operations to prevent accidental damage.

HANDLING AND STORAGE

Sheet piles shall be transported and stored in a manner that prevents permanent deformation, damage to interlocks, corrosion, or coating deterioration.

Piles shall be stacked on timber sleepers or suitable supports at regular intervals. They shall be protected from mud, standing water, and contaminants. Lifting shall be carried out using approved lifting points and appropriate lifting equipment to avoid distortion of the pile sections.

INSTALLATION

SETTING OUT

The Contractor shall establish the reference grid, alignment, and pile locations using approved survey equipment. Guide frames or templates shall be installed to maintain the required alignment and verticality throughout the driving operation.

DRIVING EQUIPEMENT

The Contractor shall select suitable installation equipment based on the soil conditions and environmental constraints. The equipment may include:

- Vibratory hammers
- Hydraulic impact hammers
- Diesel hammers
- Hydraulic press-in machines
- Silent piling machines
- Jetting equipment (where permitted)

The selected equipment shall be capable of installing the piles to the required depth without causing unacceptable damage to the sheet piles or nearby structures.

DRIVING PROCEDURE

Driving shall commence only after approval of the installation method. Sheet piles shall be pitched and interlocked progressively and driven in a controlled sequence to minimize distortion and maintain proper alignment.

Driving shall be continuous wherever practicable to avoid lock seizure or excessive resistance. Temporary guide frames shall remain in position until sufficient penetration has been achieved.

If excessive refusal is encountered before the design depth is reached, driving shall be stopped immediately, and the Engineer shall be informed. No pile shall be forcibly driven beyond the capacity of the approved equipment without authorization.

ANCHORS AND BRACING

Where tie rods, walers, or internal bracing systems are required, these components shall be installed strictly in accordance with the approved drawings.

Anchor rods shall be pre-tensioned to the specified load using calibrated hydraulic jacks. The Contractor shall maintain records of all anchor installation and proof testing.

Connections shall be fabricated using approved welding procedures or high-strength bolted connections.

QUALITY CONTROL

A comprehensive quality assurance system shall be maintained throughout the construction period.

Quality control activities shall include:

- Verification of material certificates
- Dimensional inspection
- Visual inspection of interlocks
- Survey of pile alignment
- Verification of penetration depth
- Recording driving resistance
- Weld inspection
- Coating inspection
- Installation records
- Daily driving logs

The Contractor shall maintain complete records for each sheet pile installed.

TESTING AND INSPECTION

Where specified, the following tests shall be carried out:

- Ultrasonic Testing (UT) of welds
- Magnetic Particle Testing (MT)
- Coating thickness measurement
- Anchor proof load testing
- Water tightness inspection for cofferdams
- Survey verification
- Vibration monitoring

- Settlement monitoring
- Structural monitoring using inclinometers and piezometers where required

Any defective work identified during inspection shall be repaired or replaced at no additional cost to the Employer.

ENVIRONMENTAL AND SAFETY REQUIREMENTS

The Contractor shall implement all necessary safety and environmental protection measures during the execution of sheet piling works.

Special attention shall be given to:

- Safe lifting operations
- Crane stability
- Noise control during driving
- Vibration monitoring near existing structures
- Dust suppression
- Protection of underground utilities
- Safe working near water bodies
- Fall protection
- Emergency rescue arrangements
- Spill prevention and waste management

Where work is carried out adjacent to occupied buildings or sensitive infrastructure, vibration levels shall be continuously monitored to ensure they remain within permissible limits.

REMOVAL OF TEMPORARY SHEET PILES

Temporary sheet piles shall be extracted after completion of the permanent works unless otherwise directed by the Engineer.

Extraction shall be performed carefully to avoid disturbing adjacent structures, foundations, utilities, or completed works. Any voids created during extraction shall be backfilled with approved material and compacted where required.

Any damage resulting from extraction operations shall be repaired by the Contractor at his own expense.

7. EXPANSION AND ISOLATION JOINTS

General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory free of cost to the Client. Joints shall be formed true to line, level, shape, dimension, and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

Bitumen Board/Expanded Polystyrene Board

The joint filler shall be either (a) or (b) given below as shown in the drawing as directed by the Engineer.

Bitumen Board

Bitumen impregnated fiber board of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof.

It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site.

At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

Expanded Polystyrene Boards

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

Joint Sealing Strips

Joint sealing strips may be provided at the construction, expansion, and isolation joints as a continuous diaphragm to contain their material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be non-metallic like rubber or PVC.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised, if necessary, by the Engineer. The Contractor is to supply all labor and material for installation including the material and tools required for jointing, testing, protection, etc.

If desired by the Engineer, joints in rubber seals may have to be vulcanized.

Non-metallic sealing strips will be normally in Rubber or PVC Rubber, or PVC joint seals can be of shape having any combination of the following features:

- Plain
- Central bulb
- Dumb-bell or flattened ends
- Ribbed and Corrugated Wings
- V- shaped

These types of seals can be easily handled in very large lengths. Transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer.

The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs and the edges accurately.

The Sealing strips shall be either (a) or (b) given below as shown in the drawing as directed by the Engineer.

Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings/schedule of items and/or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion, and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer:

Specific Gravity 1.1 to 1.15, Shore Hardness 65A to 75A, Tensile Strength 25-30 N/mm2, Maximum Safe Continuous Temperature 75ºC, Ultimate Elongation Not less than 350%.

P.V.C. Sealing Strips

The minimum thickness of PVC sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings/schedule of items and/or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly:

Specific Gravity	1.3 to 1.35
Shore Hardness	60A to 80A
Tensile Strength	10 -15 N/Sq.mm
Maximum Safe Continuous Temperature	70 ºC
Ultimate Elongation	Not less than 275%

Joint Sealing Compound

When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.

Alternatively, when directed, the expansion Joints may be filled with joint sealing compound like "Sikalastic" or approved equivalent and shall be applied as per manufacturer's specification.

Isolation Joints

Strong and tough alkathene or PVC sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete, to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

Rubber Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings or as directed by the Engineer. The rubber shall have a unit weight of 1500 kg/m3, a shore hardness of 65A to 70A and be of best quality of approved manufacture, durable, capable, of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

8. GROUTING UNDER MACHINERY OR STRUCTURAL STEEL BASES

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make It flow as required. The areas to be grouted shall be (1:1) cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed - by the Engineer, 6 mm down stone chips may have to be used in the mix.

Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked-up air. Edges shall be finished properly. If desired by the Engineer, admixtures like Aluminum powder, Ironite etc. may have to be added with the grout in proportions to be decided by the Engineer. Admixture, if directed to be added, will be measured, and paid separately.

Alternatively non-shrink, free flow, cementitious grout like "Sika grout 214/ Anchor NSG" or approved equivalent specifically selected for the type of equipment to be located (vibrating, static etc.) may also be used for grouting as per manufacturer's specification with necessary approval of the Engineer.

9. PRE-CAST CONCRETE

The Specification for Precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All Precast work shall be carried out in a yard made for the purpose.

This yard shall be dry, properly levelled and having a hard and even as well as well drained surface to prevent excessive uneven settlement due to softening of soil during casting and curing. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportions) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 10 (Ten) days of curing and can be removed for erection after 28 (twenty-eight) days of curing.

The moulds shall preferably be of steel or of timber lined with G.I. sheet metal and must be rigid enough to prevent distortion during placing and compaction of the concrete.

Other than normal curing by applying water through spray nozzles or perforated hose curing by high pressure steam, steam vapor or other accepted processes may also be employed to accelerate the hardening of the concrete and to reduce the curing time.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

All members shall be indelibly marked with a unique identification mark on a surface which will not be permanently exposed to show on which production line they were manufactured, their type, the class of concrete, the data of casting and if they are of a symmetrical section the face which will be uppermost when the member is in its correct position after erection.

Pre-cast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials, and men to The Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as directed by the Engineer. If centering has to be used for supporting the Precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days.

The joint between Precast roof planks shall be pointed with1:2 cement: sand mortar was called for in the drawings.

10. WATERPROOFING OF CONCRETE STRUCTURE

General

Waterproof concrete must meet the provisions of IS: 3370. Waterproof concrete must be sufficiently dense (impermeable). Water aggressive to concrete should be kept away from fresh protected against direct access of the aggressive substances.

The protection, which is to be laid as protection to all concrete surfaces in contact with the ground, shall consist of an approved water proofing membrane. The membrane shall adhere to the concrete surfaces, including underside of the structures and other surfaces where concrete is cast in contact with the membrane.

Such membranes shall be PVC sheets of minimum 0.35mm thickness with knobs of Maxlock.

The waterproof membranes shall be installed in strict accordance with manufacturer's instructions.

The membranes shall extend 15 cm above ground level.

When setting forms and reinforcing steel caution shall be exercised to avoid damage to the impervious membrane extending outside the forms shall be protected.

Any puncture or damaged areas shall be cleaned and patched according to the manufacturer's

Concrete which is exposed to for a prolonged period to "very severe" chemical attack must be

instructions.

Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be PVC with 250mm wide and 10mm thick. The materials and installation will be as described under Clause 9.20.3. Construction joint should be provided as per clause 9.12.1 with or without water bar / Seal as shown on the drawing. In case of water bars being used at the construction Joint, fixing of the same has to be done carefully so that the water bar is not displaced, folded, distorted, warped during concreting. The construction joint shall also be treated by the following methods:

A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the form work against which previous pour of concreting shall be done.

The retarder may be liquid or paste form depending on the type of formwork. The form work shall be removed within 24 hours after concreting.

Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Alternatively, after hardening the concrete surface will be scrabbled mechanically with chisel so that about half the aggregates are exposed and cleaned. Then a rich cement mortar using cement, sand, and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting in case of walls. The above bonding agent will be mixed with water which will be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification.

In case of floor joint, however, after washing of retarder a solvent free two component epoxy resin bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days:

Compressive strength	**55 to 60 N/ mm^2**
Flexural Strength	25 to30 N/ mm^2
Tensile strength	15 N/ mm2 (approx.)
Bonding strength to concrete	3 N / N/ mm2 (approx.)

Bonding strength to steel	20 N/ mm2 (approx.)

The whole operation shall be done as per manufacturer's specification. The contractor shall provide manufacturer's supervision at no extra cost to the Client.

In the event the construction joint is found to be separated and leaking the same will be rectified by injection grouting using the following methods.

One row of threaded nozzles at regular intervals not exceeding 1.5 m center to center shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 kg/cm2 to 4 kg/cm2. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision. The cost of such manufacturer's supervision shall be borne by the contractor.

WATERPROOFING ADMIXTURES

The waterproofing admixture for non- structural concrete and cement mortar for screeds and plaster shall be described below and shall conform to relevant IS code. The contractor may have to carry out trial mixes with different brands of admixture for selecting the most appropriate one at his own cost.

The admixture shall not cause decrease of strength of concrete / plaster at any stage, and it is free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5 %.

The maximum permissible dosage of admixture will be 3 % (three percent) by weight of cement but a lower dosage will always be preferred. The product shall be stored in strong moisture proof packing.

a) In concrete: The approved admixture shall be based on modified Lignosulphonate like "Plastocrete N/Super" or approved equivalent. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to the Client to supervise the work, if desired by the Engineer.

b) In Plaster: The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly, and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture like "No leek CP/Sika Latex" or approved equivalent and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification.

The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost to the Client. On completion, the plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

Bituminous or Tar Coating on External Surface

The surface to be waterproofed shall be rendered absolutely dry, clean and dust free. The surface shall be sand papered, cleaned and completely coated with hot Bitumen/coal tar pitch of approved manufacturer and quality as per IS: 216 (not heated above 375 º F) using not less than 2 kg/m2 or with hot asphalt i.e., bitumen according to IS: 73 or IS: 702 mixed with 1% of anti-stripping compound as per IS: 6241 using not less than 1.7 kg/m2.

When the first coat has completely dried up and approved by the Engineer, the second coat shall be applied in the same manner using not less than 1.7 kg/m2 in case of coal tar and 1.5 kg/m2 in case of asphalt. Immediately after application of the second coat and before it dried up, sand shall be spread on the surface to cover it completely. Sufficient time shall be allowed after spreading of sand before backfilling is done in order to allow the final coat to dry up completely. In place of hot application by coal tar / asphalt the coating of the outside surfaces of walls may be carried out using a ready to use liquid, bituminous emulsion/ rubber protective coating of approved manufacturer.

Protective Coating on Inside Surface

Two coats or cement based to components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/ floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

Laying of LDPE Film

Protective waterproof treatment shall be done as outlined and as per sequence given hereunder:

a) The concrete surface shall be made smooth with 12 mm cement plaster 1:6.

b) Apply hot bitumen 80/100 grade (IS: 73-1961) the rate of 1 kg/m2 minimum.

c) Lay black polyethylene film 250 micron (IS: 2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a celophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another celophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat sealing, the celophane tape is to be removed and the joints are to be tested for leaks.

a) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen.

b) Lay hot bitumen 80/100 grade (IS: 73-1961) at 1.0 kg/m2 minimum.

c) Lay 250-micron polyethylene film as second layer similar to (b) above.

d) Lay second layer of 100 gm. brown craft paper laminated similar to (d) above

e) Apply hot bitumen (straight run grade) to IS: 73-1961 at 1 kg/m2 dusted with fine sand.

f) Protecting with a layer of 50 mm thick of cement concrete 1:3:6 (1 cement : 3 coarse sand (zone-lll) derived from natural sources : 6 graded stone aggregate 20 mm nominal size derived from natural sources) over 75 mm thick bed of dry brick ballast 40 mm nominal size, well rammed and consolidated and grouted with fine sand, including necessary excavation, levelling & dressing & finishing the top smooth.

PROTECTIVE COATING ON CONCRETE SURFACE

On Foundation

The outside faces of foundation of important structures will be protected from adverse effect of soil and underground water, if shown on drawing or instructed by the Engineer, by using rubber / bitumen emulsion protective coating of approved manufacturer.

Pressure / Grouting for filling of voids, honeycombs, and cracks

Where required, waterproofing for underground concrete structure shall be done by injecting high polymer based non-shrink waterproof grouting compound through nozzle under pressure as per manufacturer's recommendation. The pressure during injection shall not be less than 2.5 kg/m2 and the thickness of epoxy resinous emulsion waterproof paint (to be applied on the external surface of walls/ slabs) shall not be less than 700 microns.

For sealing of cracks, v-groups shall be cut along the cracks and filled with polymer-based component. Nozzles shall be fixed at 300mm to 600mm interval as directed by the engineer for injection grouting. At the pressure grouting the nozzles will be plugged.

11. SAMPLING AND TESTING

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

CEMENT

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths. Soundness Tests may also be required to be carried out if required by the Engineer. The tests shall be carried out by Contractor without any expense to the Client. In case due to any circumstances, the agency of supply is changed in the middle of the Contract, the party who bore the original contractual obligation will carry on with the test, free of charge to the other, till the end of the job. No cement from a particular consignment/ batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Client, Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the Client or the Contractor.

These tests are of great importance as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

AGGREGATES

The Contractor shall carry out any or all the tests aggregates as may be required by the Engineer in accordance with IS: 2386 Parts I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

WATER

Sampling and testing of water being used for concrete works as per IS: 3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The final acceptance criteria in case of doubt will be as per IS: 3025 and IS: 456-2000.

ADMIXTURE

Air Entraining Agents (AEA)

Initially, before starting to use AEA, relationship between the percentage of air entrained and the cube crushing strength vis-a-vis quantity of AEA used for all types of concrete will be established by the Contractor free of charge by carrying out sufficiently large number of tests. After that, at regular intervals and whenever directed by the Engineer, the Contractor will check up free of charge, the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

Other Admixtures

Tests for establishing the various properties of any other admixtures which may be required to be added shall be carried out by the Contractor free of charge to the Client. The contractor may have to carry out mixes with different brands of admixture for selecting the most appropriate one at his own cost.

CONCRETE

The sampling of concrete, making the test specimens, curing, and testing procedure etc. shall be in accordance with IS: 516 and IS: 1199 the size of specimen being 15cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS: 516.

Sampling procedure, frequency of sampling and test specimen shall conform to Clause 15 of IS: 456-2000.

To control the consistency of concrete from every mixing plant, slump tests and/or compacting factor tests in accordance with IS: 1199 and as mentioned in Clause 9.6 of this Specification shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference.

The acceptance criteria of concrete shall be in accordance with Clause 16 of IS: 456-2000.

Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor No payment for the dismantled concrete, the relevant form work and reinforcement, embedded fixtures, etc. wasted in the dismantled portion shall be made.

In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

ACCEPTANCE CRITERIA

STANDARD DEVIATION

Standard deviation shall be based on test results and determination of Standard deviation shall conform to relevant clauses of IS: 456-2000.

ACCEPTANCE CRITERIA

The strength requirements and acceptance criteria shall conform to Clause 15 and 16 of IS: 456-2000

INSPECTION AND CORE TESTS

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to Clause 17 of IS: 456-2000 and IS: 516.

LOAD TEST

Load tests of structural members may be required by the Engineer, when the strength of test specimen results falls below the required strength, as per 'Load Test on Parts of Structures', Clause 17.6 of IS: 456-2000. If load testing is decided by the Engineer, the member under consideration shall be subjected to a test load equal to 1.25 (one and a quarter) times the specified live load used for design and this load shall be maintained for a period of 24 (twenty-four) hours before removal. The detailed procedure of the test is to be decided by the Engineer. Load tests shall not be made until the structure is at least 56 days old.

If the member shows evident failure, such changes as are necessary to make the structure adequately strong shall be made by the Contractor free of cost to the Client. Alternatively, if permitted under Statutory Regulations and at the discretion of the Engineer, the structure under test or a portion thereof may be retained as such without any modification by derating its load bearing capacity, provided the design criteria allows such derating.

A reinforced concrete beam, floor or roof shall be deemed to have passed the test if the maximum deflection at the end of 24 hours does not exceed the deflection given in Clause 17.6 of IS: 456-2000.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification. The entire cost of dismantling, replacement and restoration of the site being borne by the Contractor if, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.

Information to be submitted by the tenderer

WITH TENDER

The following technical information is required with the tender:

a. Source and arrangement of processing of aggregates proposed to be adopted.

b. Type of equipment proposed to be used.

c. Types of form work proposed to be used.

AFTER AWARD

The following technical information and data including samples where necessary shall be submitted by the Contractor progressively during the execution of the contract.

Programme of Execution and Requirement of Materials Within 15 days of the award of contract, the Contractor will submit a Master Programme for completion of the work giving month wise requirements of materials, particularly mentioning in detail the materials which are to be supplied by the Client and for the procurement of which the help of the Client is required as per the terms and conditions of the Contract. In case the Contractor proposes to take on hire any machineries or tools and plants from the Client, the detailed phased out programme of such hire is also to be submitted.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day to day programme of every month is to be submitted by the Contractor before the end of the previous month.

Samples

Samples of the following materials and any other materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities free of cost, for approval. Approved samples will be preserved by the Engineer for future reference. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities:

Coarse and fine aggregates

Admixtures

Formwork (Steel / Sound Timber / Plywood)

Embedded and anchorage materials as may be desired by the Engineer

Joint sealing strips and other waterproofing material

Joint filling compounds

Foundation quality Rubber Pads.

Fly Ash (IS: 3812- Part1)

Design Mix

Design mix as per Clauses 8.1 (f) & 9.4 of this specification giving proportions of the ingredients, sources of aggregates cement, Fly Ash and along with accompanying test results of trial mixes as per relevant IS, is to be submitted to the Engineer for his approval before it can be used on the works.

A) Detailed Drawings and Designs of Formworks to be used. Detailed design data and drawings of standard formworks, props and scaffolding to be used as per clause 8.1 (b).

B) Detailed Drawings for Templates & Temporary Supports for Embedment's As per Clause 8.1 (d).

C) Mill Test Reports for Cement and Reinforcing Steel

D) Inspection Reports

E) Inspection Reports in respect of Formwork and Reinforcement and any other item of work as may be desired by the Engineer in accordance with Clause 8.3 of this specification.

F) Test Reports

G) Reports of tests of various materials and concrete as required under Clause 10.0 of this specification.

H) Any other data, which may be required as per this specification.

RATE

In general, even though it may not be specifically mentioned in the Schedule of Items, the rates for items mentioned in the Schedule of Items shall include cost of all materials consumed in the work or incidental to it, hire charges of tools and plants, cost of labor, insurance, all transport charges including taking delivery of raw steel from Purchaser's Site Stores and transporting the same to the Contractor's fabricating workshop and delivery of finished fabricated materials back to sites, all taxes, royalties" making approaches, security and safety arrangements, power, fuel, lubricant, preparation of all fabrication drawings, material lists, cutting lists, bolt lists, field welding schedule, services, supervision, overheads, profits etc. complete in all respects unless certain items specifically excluded by the terms and conditions of the Contract and as mentioned in the following sub-clauses.

MODE OF MEASUREMENT

The items of work in the Schedule of Items describe the work in brief. For each item in the Schedule of items, the Contractor's rates shall include for the activities covered in the description of the items as well as for all necessary operations described in the specification. The Contractors rates shall include minor details which are obviously and fairly intended, and which may not be included in the description of these documents. Quoted rates shall also include for all safety measures as required by codal provisions, local regulations and for execution to the satisfaction of the Engineer.

Concrete

Concrete shall be measured in cubic meter correct up to second place of decimal. Concrete shall be paid as per dimensions shown in the drawings. Fly Ash used for partial replacement of cement will be supplied by the contractor and should be inclusive in the unit rates quoted for the concrete works.

Whenever in the BOQ the item is in squire meter with specified thickness the same will be measure in squire meter up to two places of decimal.

Reinforcement

Reinforcement shall be measured in metric ton up to third places of decimal as per drawings. No separate payment shall be made for providing chairs and spacers. Only authorized laps, dowels, and chairs of length more than 2 m (for chairs only) shall be measured for and paid as noted in the joint measurement sheets with the Engineer in charge.

Formwork

Formwork shall be measured in Squire meter as per actual surfaces in contact with the concrete or any other material requiring formwork up to two places of decimal as per drawings.

Where formwork is required to be lined with wallboard, hardboard, polyethylene sheet or paper lining or to be coated with mould liquid or lime white, such formwork shall be described and measured separately.

Admixture

Admixture shall be measured by weight or volume up to two places of decimal according to the consumption of cement.

12. LIST OF CODES AND STANDARDS FOR REFERENCE

All work under this specification shall; unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any aspect of work is not specifically covered by Indian Standard Specifications, any other standard practice (ASTM), as may be specified by the Engineer, shall be followed:

Table 12-1 List of Codes & Standards for reference

IS: 73 (2006)	**Indian Standard Specification for Paving Bitumen**
IS: 216 (2006)	Indian Standard Specification for Coal Tar Pitch
IS: 269 (1989)	Specification for 33 grade Ordinary Portland cement
IS: 383 (1970)	Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete
IS: 432 (1982)	Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement - Part 1 and 2
IS: 455 (1989)	Indian Standard Specification for Portland Slag Cement
IS: 456 (2000):	Indian Standard Code of Practice for Plain and Reinforced Concrete
IS: 457 (1957)	Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures
IS: 457 (1957)	Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures
IS: 516 (1959):	Indian Standard Specification for Methods of Test for Strength of Concrete
IS: 702 (1988)	Specification for industrial bitumen
IS: 737 (1986)	Indian standard specification for wrought Aluminium and Aluminium Alloy sheet and strip for general Engineering purpose.
IS: 1199 (1959)	Indian Standard Specification for Methods of Sampling and Analysis of Concrete
IS: 1200 (1974)	Indian Standard Specification for Method of (Part-II) Measurement Cement Concrete Works.
IS: 1200 (1982)	Indian Standard Specification for Method of (Part-V) Measurement of Formwork
IS: 1322 (1993)	Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing

IS: 1489 (1991)	Indian Standard Specification for Portland - Pozzolana Cement - Part 1 and 2
IS: 1566 (1982)	Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement
IS: 1609 (1991)	Code of Practice for Laying Damp- proof Treatment using Bitumen Felts
IS: 1786 (1985):	Indian Standard Specification for high strength deformed Bars and wires for Concrete Reinforcement
IS: 1791 (1985)	Indian Standard Specification for Batch Type Concrete Mixers
IS: 1834 (1984)	Indian standard specification for hot applied sealing compound for joint in concrete.
IS: 2062 (2006)	Steel for general structural purpose.
IS: 2185	Indian Standard Specification for Hollow and solid/ solid
(Part 1 -2005), (Part 2 -1983)	light wt. Cement Concrete Blocks - Part - 1 and 2
IS: 2210 (1988)	Indian Standard Specification for Design of Reinforced Concrete Shell Structures and Folded Plates
IS: 2386(1963)	Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII
IS: 2430 (1986)	Indian standard specification for method of sampling of Aggregate for concrete.
IS: 2502 (1963)	Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
IS: 2505 (1992)	Indian Standard Specification for Concrete Vibrators Immersion Type
IS: 2506 (1985)	Indian Standard Specification for Screed Board Concrete Vibrators
IS: 2514 (1963)	Indian Standard Specification for Concrete Vibrating tables
IS: 2645 (2003)	Integral Cement water proofing compound
IS: 2722 (1964)	Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)
IS: 2751 (1979)	Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction
IS: 2770 (1967)	Indian Standard Specification for Method of Testing Bond in Reinforced Concrete, Part -1: Pull out Test

IS: 3025 (2004)	Indian standard Specification for Methods of Sampling and Test (Physical and Chemical) for Water and wastewater - part -1 to 37
IS: 3201 (1988)	Indian Standard Specification for Design and Construction of Precast Concrete Trusses and Purlins
IS: 3370 **(Part 1, 2 -1965)** **(Part 3, 4 -1967)**	Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids Part 1 to 4
IS: 3384 (1986)	Indian standard specification for Bitumen primer for use in waterproofing and damp proofing
IS: 3414 (1968)	joints in Buildings
IS: 3550 (1965)	Indian Standard Specification for Method of Test for Routine Control for Water used in Industry
IS: 3558 (1983)	Code of Practice for use of Immersion Vibrators for Consolidating Concrete
IS: 3696 **(Part 1 -1987)** **(Part 2 -1991)**	Safety Code for Part-1: Scaffolding and Part 2: Ladders
IS: 3812 (1981)	Indian Standard Specification for Fly Ash for Use as Pozzolana and Admixture
IS: 4031 (1999)	Indian Standard Specification for Method of Tests for Hydraulic Cement - Part - 1 to 14
IS: 4082 (1996)	Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site
IS: 4090 (1967)	Indian Standard Specification for Design of Reinforced Concrete Arches
IS: 4634 (1991)	Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixers
IS: 4656 (1968)	Indian Standard Specification for Form Vibrators for Concrete
IS: 4925 (2004)	Indian Standard Specification for Concrete Batching and Mixing Plant
IS: 4926 (2003)	Indian Standard Specification for Ready Mixed Concrete
IS: 4990 (1993)	Indian Standard Specification for Plywood for Concrete Shuttering work

1S: 4991 (1968)	Indian Standard Specification for Blast Resistant Design of Structure for Explosion above ground
IS: 4995 (1974)	Indian Standard Specification for Design of Reinforced Concrete Bins for the (Part-I and II) Storage of Granular and Powdery Materials
IS: 4998 (1992)	Indian Standard Specification for Design of Reinforced Concrete (Part - 1): Chimneys
IS: 5512 (1983)	Indian Standard Specification for Flow Table for use in Tests of Hydraulic Cement and Pozzolanic Materials
IS: 5513 (1996)	Indian Standard Specification for Vicat Apparatus
IS: 5515 (1983)	Indian Standard Specification for Compaction Factor Apparatus
IS: 5751 (1984)	Indian Standard Specification for Precast Concrete Coping Blocks
IS: 5816 (1999)	Indian Standard Specification for Method of Test for Splitting Tensile Strength of Concrete Cylinders
IS: 5891 (1970)	Indian Standard Specification for Hand Operated Concrete Mixers
IS: 6452 (1989)	Indian Standard Specification for High Alumina Cement for Structural Use
IS: 6909 (1990)	Indian Standard Specification for Super sulphated Cement
IS: 6923 (1973)	Indian Standard Specification for Method of Test for performance of Screed Board Concrete Vibrators
IS: 6925 (1973)	Indian Standard Specification for Method of Test for Determination of Water-Soluble Chloride in Concrete Admixtures
IS: 7242 (1974)	Indian Standard Specification for Concrete Spreaders
IS: 7246 (1974)	Indian Standard Specification for Table Vibrators for Consolidating Concrete
IS: 7251 (1974)	Indian Standard Specification for Concrete Finishers
IS: 7320 (1974)	Indian Standard Specification for Concrete Slump Test Apparatus
IS: 7861 **(Part 1 -1975)** **(Part 2 -1981)**	Indian Standard Specification for Recommended Practice for hot and cold Weather Concreting
IS: 7969 (1975)	Safety Code for Storage and Handling of Building Materials
IS: 8041 (1990)	Indian Standard Specification for Rapid Hardening Portland cement

IS: 8043 (1991)	Indian standard specification for hydrophobic cement
IS: 8112 (1989)	Specification for 43 grade ordinary Portland cement
IS: 8142 (1976)	Indian Standard Specification for Determining Setting time of Concrete by Penetration Resistance
IS: 8989 (1978)	Safety Code for Erection of Concrete Framed Structures
IS: 9013 (1978):	Indian Standard Specification for Method of Making, Curing and Determining Compressive Strength of Accelerated - cured Concrete Test Specimens
IS: 9077(1979)	Code of Practice for Corrosion Protection of Steel Rails in RB and RCC Construction
IS: 9103(1999)	Indian Standard Specification for Admixtures for Concrete.
ASTM: C494/494M	Standard Specification for chemical admixture for Cement

13. STORAGE AND HANDLING OF COMMON BUILDING MATERIALS

SCOPE

The scope of this Section is to specify the storage and handling of common building materials and its properties unless otherwise mentioned in drawings or schedule of items.

MATERIALS

Bricks

Bricks for general masonry work shall conform to IS: 1077-1970 and for face brick work shall conform to the specifications in IS: 2691-1972.

Bricks for general masonry work shall be of first class (Class-A) quality, well burnt, of uniform size, shape and colour free from cracks, flaws or nodules or free lime and omit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps boles etc. Compressive strength shall be 50 Kg / cm^2 minimum for face bricks. Water absorption after 24 hours immersions shall not exceed 15% by weight for common bricks and 12% for face bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for common bricks and 3% for face bricks. All bricks shall have rectangular faces and sharp straight edges. Maximum permissible chippage for face bricks shall be 6 mm at the edges and 10 mm for corners. The bricks shall show no efflorescence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted, and approved sample shall be retained by the Engineer for future comparison and reference. The colour and texture of face bricks shall be up to the specification and defective bricks shall be removed immediately from site at the Contractor's own cost.

Stone

All stones shall be from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks, and sand holes. The surface of a freshly broken stone shall be bright, clean, and sharp and shall show uniformity of texture, without loose grains and free from any dull, chalky, or earthy appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of water after 24 hours immersion. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

Lime

Lime shall be stone lime and conform to the specification Building Limes IS: 712. Lime putty may be prepared from hydrant lime or quick lime. Hydrated lime shall be mixed with water to form putty and stored with reasonable care to prevent evaporation for at least 24 hours before use Quick lime shall be shake with enough water to make a cream, passed through a No. 0 Sieve, and then stored with reasonable care to prevent evaporation for at least 7 days before use.

Cement

Cement used shall be ordinarily Portland Cement conforming to Code for ordinary cement in IS: 269 and shall be fresh when delivered. The Contractor shall be responsible to submit the manufacturer's certificate and necessary test results for each consignment of cement procured to the Engineer with no additional cost to the Client. If at any time, the Engineer feels that the cement being used by the Contractor is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by, the Contractor. The Contractor shall also have no claim for this type of suspension of work.

Cement shall be stored above ground as specified elsewhere.

Coarse Aggregates

Coarse aggregates shall be as per IS:383 latest edition, consisting of hard, strong, and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability, or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS: 383 and shall be such as to produce a dense concrete of the specified proportions and strength and of consistency that will work readily into position without segregation.

Sand

Sand shall be hard, durables, clean and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosions to any metal in contact with such mortar, plaster, or concrete. All sand shall be properly graded. Unless otherwise directed by the Engineer all sand shall pass through IS Sieve No. 240 and 15 to 35% of and for masonry mortar and 5 to 50% of sand for plaster shall pass through IS Sieve No. 30. Sand for concrete shall conform to IS: 383.

Water

Water shall be clean, fresh, and free from organic matters, acids or soluble salts and other deleterious substances which may ·cause corrosion, discolouration, efflorescence etc.

Reinforcement

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings which may impair proper bond.

Structural steel shall conform to IS: 226. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS:432 Cold twisted steel bars shall conform to IS:1786. Hexagonal wire netting shall conform to IS: 3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanized.

STORAGE AND HANDLING OF MATERIALS

Bricks

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded, to minimize breakage and defacement of bricks. Bricks selected (or different situation of use in the work shall be stacked separately.

Stones

Stones shall be stored at site in manner approved by the Engineer. Dressed stone for wall facing, paving etc. shall be stored with special care to avoid defacement of faces and edges or damp and rust stains.

Lime

Lime should be stored in weatherproof sheds.

Cement

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Contractor and shall be removed from the site immediately.

Coarse and Fine Aggregates

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass, or any other injurious substances at any stage. Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

Reinforcement

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

14. DESIGN BASIS

GENERAL

This report generally covers the basis on which structural analysis, design and details will be done. The report covers: -

Structural systems

- Material
- Loading
- Design limit state combinations
- Applicable codes and standards and reference documents.

Type of Structure

RCC special moment resistant frame (SMRF) structure has been adopted based on code provision of IS 13920-2016 for earthquake Zone-III buildings.

MATERIAL USED

A) **Material Properties**

Table 14-1 Material Used

Unit Weight of concrete	25.0 kN/m3
Unit Weight of Steel	78.5 kN/m3
Unit Weight of Soil (Dry)	As per Geotech Report
Unit Weight of Water	10.0 kN/m3
Unit Weight of AAC Block	8.0 kN/m3
Unit Weight of floor finish	24.0 kN/m3
Unit Weight of Brick	20.0 kN/m3
Unit Weight of PCC	24.0 kN/m3
Unit Weight of Glass	25.0 kN/m3
Unit Weight of Plaster	22.0 kN/m3
Unit Weight of ACP	14.7 kN/m3
Unit Weight of Soil (Wet)	As per Geotech Report
Unit Weight of Waterproofing	20 kN/m3

B) **Following are the Grades of Concrete used in design.**

The Concrete grades for different structural elements will be

- M30 (For Beam & Slab),
- M35 (For Foundation, Retaining wall),

- M50 & M40 (Column & Shear wall)

Reinforcement Specification

Grade of Reinforcement Steel= Fe-500

Structural steel grades Fe 250 for rolled steel sections, 310 & 350 for tubular sections & plates respectively, will be used as per the requirements of the structure.

STRUCTURAL SYSTEM

The structural system adopted is the Special Moment Resisting Frame (SMRF) System. The main considerations followed for the design of structural are:

- Structural safety and stability
- To meet the demands of aesthetics conceived by the architect
- Availability of material, equipment and expertise.
- Constructability and ease of maintenance.
- Durability
- Economy

Superstructure -Gravity Load Resisting System

The structural system for first this building comprises of RCC columns & Beams with solid slab to transfer all gravity load to the foundation level. Columns are placed at locations such that the stability and utility are fulfilled.

Superstructure - Lateral Load Resisting System

The stability of building against lateral forces is entirely provided by the SMRF system.

Substructure

As per the recommendations made in the Geo technical report, the foundations for tower and non-tower shall be open/Raft foundation however final confirmation of the foundation system shall be undertaken after Geotechnical recommendation and detailed structural load calculation. The Grade of concrete shall be minimum M30.

Thermal Analysis

Thermal Analysis will be carried out to cater for the thermal stresses. Temperature loads will be considered as per IS 875 Part 5. Maximum temperature = 47.5°C. Minimum temperature= 2.5 °C. Ambient temperature of concrete= 27°C. Difference in temperature in Summer = 20.5°C. Difference in temperature during winters = 24.5 °C. Temperature loads considered shall be + 20.5 °C and -24.5°C. Analysis shall be carried out for temperature stresses in the structure as it expands and contracts. No expansion joint shall be provided.

Expansion Joints

Expansion joints are planned gaps in structures or piping systems designed to safely absorb temperature-induced expansion and contraction, vibrations, or seismic shifts. As per IS 3414: 1968 Code of practice for design and installation of joints in buildings.

TABLE 2 RECOMMENDATIONS FOR SPACING OF EXPANSION JOINTS

(*Clause* 4.4)

Sl. No.	Item and Description	Spacing of Joints
(1)	(2)	(3)
i) *Walls*		
	1) Load bearing walls with cross walls at intervals. Traditional type of one-brick thick or more	30 m intervals
	2) Walls of warehouse type construction (without cross-walls)	Expansion joints in walls at 30 m maximum intervals. (If the walls are panel walls between columns at not more than 9 m centres no joints are necessary.) Control joints over centre of openings may be given at half the spacing of expansion joints.
ii) *Chajjas, balconies and parapets*		6 to 12 m intervals
iii) *Roofs*		
	1) Ordinary roof slabs of RCC protected by layers of mud phuska or other insulating media in unframed construction	20 to 30 m intervals, and at changes in directions as in L,T,H and V shaped structures
	2) Thin unprotected slabs	15 m intervals
iv) *Frames*		
	Joint in structure through slabs, beams, columns, etc, dividing the building into two independent structural units	Corners of L,H,T and C shaped structures and at 30 m intervals in long uniform structures
v) *Coping*		Corresponding to joints in the roof slabs

Nominal Cover

Clear covers to main reinforcement for different structural elements shall be based on 2- hour fire rating which are as follows - As per IS 456:2000, TABLE 16 (Clause 26.4.2) and TABLE 16A (Clauses 21.4 and 26.4.3 & Fig1).

Table 14-2 Nominal cover for different structural elements

Beam	**30 mm**
Slab	25 mm
Column	40 mm
RCC wall	40 mm
Foundation (Isolated & Raft)	75 mm
Pile(if require)	75 mm
Pile Cap(if require)	75 mm

Stiffness Modifiers

Indian code gives a value of stiffness modifiers. Based on that the following modifiers are being used in analysis model for ULS model:

Structural Elements	Modifiers	Equivalent Stiffness modifiers
Beams	0.35 Ig	I22 = I33 = 0.35

Slabs (In plane)	0.25 Ig	f11 = f22 = f12 = 0.25
Slabs (Out of plane)	0.05 Ig	m11 = m22 = m12 = 0.05
Columns	0.7 Ig	I22 = I33 = 0.7
Shear wall (In plane)	0.35 Ig	f11 = f22 = f12 = 0.35
Shear wall (Out of plane)	0.25 Ig	m11 = m22 = m12 = 0.25

Excavation

Excavation shall be done as per structural drawing for excavation.

Crack width

Cracking of concrete will occur whenever the tensile strength of concrete is exceeded. As concrete has relatively low tensile strength as well as low failure strain in tension, cracking is usually inevitable in normal reinforced concrete members. However, the degree of cracking (in terms of width and spacing of cracks) can be controlled through proper design. In order to avoid excessive cracking in the flexural members, maximum diameter and spacing of the reinforcements is restricted as per the building rules indicated in IS: 456:2000.

- 0.3 mm where cracking is not harmful (Super Structure, Structural Fitments)
- 0.2 mm where cracking is harmful (structures below Ground)
- 0.1mm for water retaining structure and sewage treatment plant.

Note: - To control cracking maximum spacing of bars in all structural elements shall not be more than 250 mm centre to centre.

DESIGN PHILOSPHY

Limit state design approach will be considered including limit state of serviceability and collapse so that the structure should sustain all loads and deformations liable to occur during its construction, perform adequately in normal use, and have adequate durability. The design life of structure is 50 years.

Design of all the structural elements shall be based on its 3D analysis-results. Individual member-sections of this space (3D) frame structure shall be designed for the section forces generated under various load combinations. Dynamic Analysis shall be carried out by Response Spectrum Method. The design base shear values obtained shall be enhanced to the calculated base shear value using a fundamental period prescribed in the latest revision of IS 1893-2016.

LOAD AND LOAD COMBINATION

The structure is analysed and designed for all possible Load Combinations of gravity loads (dead and live load), and lateral loads (Earthquake & Wind loads).

LOADING PARAMETERS

1 Dead Loads

Self-Weight- shall be calculated based on material properties. Self- weight of RCC column and beams are automatically considered by software.

Self-weight factor for RCC = 1.0

Self-weight factor for steel structure = 1.1 (Including Connection, welding etc.)

- Slab 200mm thick = 5 kN/m^2,
- Slab 250mm thick = 6.25 kN/m^2,

- Floor Finishes (50 mm) = 1.2 kN/m^2,
- Slab Sunken Load (250mm) = 2.5 kN/m^2
- Services Load = 0.5 kN/m2

Additional Dead / Collateral Load :-

- False Celling :- 0.50 kN/m^2
- Solar Panel :- 0.25 kN/m^2
- Equipment Load :- 10 kN/m^2 /15 kN/m^2
- Lift Machine Rooms :- 25 kN/m^2 & 50 kN/m^2,
- Fire Tender :- 20 kN/m^2

Notes:- Dead Load Calculation as per IS 875 (Part-I)

2 Imposed Load/ Live Load

- Bath &Toilets = 2.0 kN/m^2,
- Staircase = 5.0 kN/m^2,
- Assembly areas = 5.0 kN/m^2,
- Restaurants = 5.0 kN/m^2,
- Offices = 4.0 kN/m^2,
- Corridors = 5.0 kN/m^2,
- Car parking load = 5.0 kN/m^2,
- Terrace = 1.5 kN/m^2 or actual loads etc., as per IS 875 (Part-II) for calculation of Live Load for Building.

3 Earthquake Loads

The structure has been classified as a Special Moment Resisting Frame (SMRF) building and has been designed for the minimum design seismic base shear in accordance with IS 1893 (Part 1): 2016. The seismic analysis and design have been carried out using the following parameters

Table 14-3 Seismic Factors

Seismic Zone	III
Seismic Zone Factor (Z)	0.16
Soil Profile Type	Type I
Seismic Importance Factor (I)	1.5
Response Reduction Factor (R)	5
Damping Ratio	5% (For RCC str.) & 2% (For Steel str.)

Time Period (Ta)	$T_a = \begin{cases} 0.075h^{0.75} & \text{(for RC MRF building)} \\ 0.080h^{0.75} & \text{(for RC-Steel Composite MRF building)} \\ 0.085h^{0.75} & \text{(for steel MRF building)} \end{cases}$
Design Acceleration Spectrum (Ah)	Ah = Z/2 x Sa/g x I/R
Design Acceleration coefficient (Sa/g)	For rocky or hard soil sites $\begin{cases} 1+15T & T<0.10\text{ s} \\ 2.5 & 0.10\text{ s}<T<0.40\text{ s} \\ \frac{1}{T} & 0.40\text{ s}<T<4.00\text{ s} \\ 0.25 & T>4.00\text{ s} \end{cases}$

4 Wind Loads

The structure is designed for the wind load as for basic wind speed of 44 m/s.

Table 14-4 Wind Loads

Basic Wind Speed (V_b)	**44 m/sec**	
Probability Factor (K_1)	1.0	As per IS -875: 2015 (Part-III) Table 1, Cl. 6.3.1
Terrain, Height and Structure Size Factor (K_2)	Varies	As per IS -875: 2015 (Part-III) Table 2, Cl. 6.3.2.2
Topography Factor (K_3)	1.0	As per IS -875: 2015 (Part-III) Cl. 6.3.3
Cyclonic Region (K_4)	1.0	As per IS -875: 2015 (Part-III) Cl. 6.3.4
Design Wind Speed (V_Z)	$K_1*K_2*K_3*K_4*V_b$	
P_z	$0.6*V_z^2$	
Design Wind Pressure (P_d)	$K_d*K_a*K_c*P_z$	

LOAD COMBINATIONS

For reinforced concrete design, the individual loads will be combined in accordance with the loading combinations specified in latest IS 1893 (part 1) : 2016 and IS 456 : 2000 to achieve the applicable limit state.

ULS LOAD COMBINATIONS & SLS LOAD COMBINATIONS

Load Combination	Limit State of Collapse			Limit States of Serviceability		
	DL	IL	WL	DL	IL	WL
(1)	(2)	(3)	(4)	(5)	(6)	(7)
DL + IL	1.5		1.0	1.0	1.0	–
DL + WL	1.5 or 0.9[1]	–	1.5	1.0	–	1.0
DL + IL + WL		1.2		1.0	0.8	0.8

ULS LOAD COMBINATIONS

1 1.5 (DL + LL)
2 1.5 (DL +/- EQ X)
3 1.5 (DL +/- EQ Z)
4 1.5 (DL +/- RS X)
5 1.5 (DL +/- RS Z)
6 0.9 DL +/- 1.5 EQ X
7 0.9 DL +/- 1.5 EQ Z
8 0.9 DL +/- 1.5 RS X
9 0.9 DL +/- 1.5 RS Z
10 1.5 (DL +/- WL X)
11 1.5 (DL +/- WL Z)
12 0.9 DL +/- 1.5 WL X
13 0.9 DL +/- 1.5 WL Z
14 1.2 (DL + LL +/- EQ X)
15 1.2 (DL + LL +/- EQ Z)
16 1.2 (DL + LL +/- RS X)
17 1.2 (DL + LL +/- RS Z)
18 1.2 (DL + LL +/- WL X)
19 1.2 (DL + LL +/- WL Z)
20 1.5DL+1.2FT
21 1.5 (DL + LL) +/- TL
22 1.5 (DL +/- EQ X) +/- TL
23 1.5 (DL +/- EQ Z) +/- TL
24 1.5 (DL +/- RS X) +/- TL
25 1.5 (DL +/- RS Z) +/- TL
26 0.9 DL +/- 1.5 EQ X+/- TL
27 0.9 DL +/- 1.5 EQ Z+/- TL
28 0.9 DL +/- 1.5 RS X +/- TL

29 0.9 DL +/- 1.5 RS Z +/- TL

30 1.5 (DL +/- WL X) +/- TL

31 1.5 (DL +/- WL Z) +/- TL

32 0.9 DL +/- 1.5 WL X+/- TL

33 0.9 DL +/- 1.5 WL Z+/- TL

34 1.2 (DL + LL +/- EQ X) +/- TL

35 1.2 (DL + LL +/- EQ Z) +/- TL

36 1.2 (DL + LL +/- RS X) +/- TL

37 1.2 (DL + LL +/- RS Z) +/- TL

38 1.2 (DL + LL +/- WL X) +/- TL

39 1.2 (DL + LL +/- WL Z) +/- TL

SLS LOAD COMBINATIONS

1 1.0 (DL + LL)

2 1.0 (DL +/- EQ X)

3 1.0 (DL +/- EQ Z)

4 1.0 (DL +/- RS X)

5 1.0 (DL +/- RS Z)

6 1.0 (DL +/- WL X)

7 1.0 (DL +/- WL Z)

8 1.0 (DL + LL +/- EQ X)

9 1.0 (DL + LL +/- EQ Z)

10 1.0 (DL + LL +/- RS X)

11 1.0 (DL + LL +/- RS Z)

12 1.0 (DL + LL +/- WL X)

13 1.0 (DL + LL +/- WL Z)

14 1.0 DL + 0.80 LL +/- 0.8 WL X

15 1.0 DL + 0.80 LL +/- 0.8 WL Z

16 1.0 (DL + LL) +/- TL

17 1.0 (DL +/- EQ X) +/- TL

18 1.0 (DL +/- EQ Z) +/- TL

19 1.0 (DL +/- RS X) +/- TL

20 1.0 (DL +/- RS Z) +/- TL

21 1.0 (DL +/- WL X) +/- TL

22 1.0 (DL +/- WL Z) +/- TL

23 1.0 (DL + LL +/- EQ X) +/- TL

24 1.0 (DL + LL +/- EQ Z) +/- TL

25 1.0 (DL + LL +/- RS X) +/- TL

26 1.0 (DL + LL +/- RS Z) +/- TL

27 1.0 (DL + LL +/- WL X) +/- TL

28 1.0 (DL + LL +/- WL Z) +/- TL

29 1.0 DL + 0.80 LL +/- 0.8 WL X +/- TL

30 1.0 DL + 0.80 LL +/- 0.8 WL Z +/- TL

31 DL+FT

Note:- Temperature load combination as per clause 8.1 - IS 875 (Part 5) – Reaffirmed 2018

DL = Dead Load

LL = Live Load

EQ X = Earthquake load in X – Direction

EQ Z = Earthquake load in Z – Direction

RS X = Response Spectrum load in X – Direction

RS Z = Response Spectrum load in Z – Direction

WL X = Wind load in X – Direction

WL Z = Wind load in Z – Direction

TL = Temperature Load

FT = Fire Tender Load

STEEL STRUCTURE ULS LOAD COMBINATIONS & SLS LOAD COMBINATIONS AS PER IS 800 : 2007 (Table 4)

Table 4 Partial Safety Factors for Loads, γ_f, for Limit States
(*Clauses* 3.5.1 *and* 5.3.3)

Combination	Limit State of Strength					Limit State of Serviceability			
	DL	LL[1]		WL/EL	AL	DL	LL[1]		WL/EL
		Leading	Accompanying				Leading	Accompanying	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
DL+LL+CL	1.5	1.5	1.05	—	—	1.0	1.0	1.0	—
DL+LL+CL+ WL/EL	1.2	1.2	1.05	0.6	—	1.0	0.8	0.8	0.8
	1.2	1.2	0.53	1.2					
DL+WL/EL	1.5 (0.9)[2]	—	—	1.5	—	1.0	—	—	1.0
DL+ER	1.2 (0.9)[2]	1.2	—	—	—	—	—	—	—
DL+LL+AL	1.0	0.35	0.35	—	1.0	—	—	—	—

[1] When action of different live loads is simultaneously considered, the leading live load shall be considered to be the one causing the higher load effects in the member/section.

[2] This value is to be considered when the dead load contributes to stability against overturning is critical or the dead load causes reduction in stress due to other loads.

Abbreviations:

DL = Dead load, LL = Imposed load (Live loads), WL = Wind load, CL = Crane load (Vertical/Horizontal), AL = Accidental load, ER = Erection load, EL = Earthquake load.

NOTE — The effects of actions (loads) in terms of stresses or stress resultants may be obtained from an appropriate method of analysis as in **4**.

FIRE RESISTANCE REQUIREMENTS

Structural elements requiring fire resistance shall be designed to maintain their structural integrity during a fire by resisting flame penetration, limiting heat transfer, and preventing structural failure. The required fire resistance rating shall be specified in hours in accordance with IS 1641.

The fire resistance of reinforced concrete members depends on:

- Member size and dimensions.
- Clear cover provided to reinforcement.
- Reinforcement detailing.
- Type of concrete aggregate used (normal-weight or lightweight aggregate).

General requirements for fire protection shall comply with IS 1642.

Minimum member dimensions and clear cover to reinforcement for achieving the specified fire resistance shall be provided in accordance with the relevant provisions of IS 456:2000 (Clause 21.2 / Clause 26.4.3, as applicable).

Reinforcement shall be detailed to ensure adequate continuity, anchorage, ties, and bond so that the structural member retains its load-carrying capacity during fire exposure.

Where the required nominal cover exceeds 40 mm for beams or 35 mm for slabs, additional fire protection measures such as fire-resistant coatings, fire-rated false ceilings, or other approved protective systems shall be considered to reduce the risk of concrete spalling.

For structural systems or members not specifically covered by the provisions of IS 456, appropriate specialist guidelines or performance-based fire engineering methods may be adopted to demonstrate the required fire resistance.

Fire Resistance h	Minimum Beam Width b	Rib Width of Slabs b_w	Minimum Thickness of Floors D	Column Dimension (b or D)			Minimum Wall Thickness		
				Fully Exposed	50% Exposed	One Face Exposed	$p<0.4\%$	$0.4\% \le p \le 1\%$	$p>1\%$
	mm	mm	mm	mm	mm	mm	mm	mm	mm
0.5	200	125	75	150	125	100	150	100	100
1	200	125	95	200	160	120	150	120	100
1.5	200	125	110	250	200	140	175	140	100
2	200	125	125	300	200	160	-	160	100
3	240	150	150	400	300	200	-	200	150
4	280	175	170	450	350	240	-	240	180

NOTES

1 These minimum dimensions relate specifically to the covers given in Table 16A.

2 p is the percentage of steel reinforcement.

FIG. 1 MINIMUM DIMENSIONS OF REINFORCED CONCRETE MEMBERS FOR FIRE RESISTANCE

FOUNDATION TYPE

Foundation type based on geotechnical report: Raft/ Pile/ Isolated/ Combined foundation (Final selection based on design)

SOFTWARE/MANUAL SHEET USED FOR ANALYSIS

3-D Analysis of the building is carried out using CSI ETABS / Staad Connect Edition Latest Version Software. Dynamic Analysis/design results are to be used for designing/detailing of various structural elements. Manual calculations, Excel sheets or other software will be used for foundation or other structural components as per requirement.

DETAILING OF STRUCTURES

Detailing of all structural members shall be done as per latest IS: 456 and IS: 13920, SP: 34 and SP-6. Detailing shall be done in such a way that it meets minimum & maximum R/F requirements, minimum and maximum spacing of bars.

For Beam

Longitudinal R/F - Minimum 0.25% & max 2.5% of total cross- sectional area at tension face. Shear R/F- Minimum as per IS: 456 & IS: 13920 using stress of Fe 500 steel for design.

For Slab

Minimum R/F - 0.12% of total cross-sectional area. Max Spacing of bars - 3d or 300 mm whichever is less.

For Columns

Min 0.8% of area of column section required to resist direct stress and max 4% of column section. In extreme cases 6% of area of column section maybe provided.

RCC Wall

Min 0.4% of total cross-sectional area in both directions.

PILES

Min 0.4% of total cross-sectional area.

CONTROL OF DEFLECTIONS

The deflections due to service loads should not exceed the following values:

<u>Vertical Deflections</u>

Concrete Structures

As per IS 456, clause no. 23.2, final deflection due to all loads including the effects of temperature, creep and shrinkage and measured from the as-cast level of the supports, floors, roofs and all other horizontal members should not exceed span/250.The deflection including the effects of temperature, creep and shrinkage occurring after the erection of partitions and the application of finishes should not exceed span/350 or 20 mm, whichever is less.

Steel Structure

As per the clause 5.6.1 (Table 6) of IS 800 - 2007, the deflection under serviceability loads of a building or a building component should not impair the strength of the structure or components or cause damage to the finishing. Deflections are to be checked for the most adverse but realistic combination of service loads and their arrangement, by elastic analysis, using a load factor.

Horizontal Deflections

Drift due to EQ : The inter-storey drift should not exceed H/250.

Drift due to WL : The overall drift of the structure under wind load should not exceed H/500.

Concrete Structures

The final deflection due to all loads including the effects of temperature, creep and shrinkage and measured from the as-cast level of the supports, floors, roofs and all other horizontal members should not exceed span/250. The deflection including the effects of temperature, creep and shrinkage occurring after the erection of partitions and the application of finishes should not exceed span/350 or 20 mm, whichever is less.

Table 6 Deflection Limits

Type of Building	Deflection	Design Load	Member	Supporting	Maximum Deflection
(1)	(2)	(3)	(4)	(5)	(6)
Industrial Buildings	Vertical	Live load/ Wind load	Purlins and Girts	Elastic cladding	Span/150
				Brittle cladding	Span/180
		Live load	Simple span	Elastic cladding	Span/240
				Brittle cladding	Span/300
		Live load	Cantilever span	Elastic cladding	Span/120
				Brittle cladding	Span/150
		Live load/ Wind load	Rafter supporting	Profiled Metal Sheeting	Span/180
				Plastered Sheeting	Span/240
		Crane load (Manual operation)	Gantry	Crane	Span/500
		Crane load (Electric operation up to 50 t)	Gantry	Crane	Span/750
		Crane load (Electric operation over 50 t)	Gantry	Crane	Span/1 000
	Lateral	No cranes	Column	Elastic cladding	Height/150
				Masonry/Brittle cladding	Height/240
		Crane + wind	Gantry (lateral)	Crane (absolute)	Span/400
				Relative displacement between rails supporting crane	10 mm
		Crane+ wind	Column/frame	Gantry (Elastic cladding; pendent operated)	Height/200
				Gantry (Brittle cladding; cab operated)	Height/400
Other Buildings	Vertical	Live load	Floor and Roof	Elements not susceptible to cracking	Span/300
				Elements susceptible to cracking	Span/360
		Live load	Cantilever	Elements not susceptible to cracking	Span/150
				Elements susceptible to cracking	Span/180
	Lateral	Wind	Building	Elastic cladding	Height/300
				Brittle cladding	Height/500
		Wind	Inter storey drift	—	Storey height/300

DESIGN STANDARDS

Specific applicable codes and standards will be identified and adopted in the design philosophies as appropriate to the structural elements. The latest editions of the Codes and standards will be used in designs. All design work shall be based on Indian Standards and Codes with latest revision, with amendments if any, as on date.

CODES USED FOR DESIGNING.

- IS 456 : 2000 Code of Practice for plain and reinforced concrete.
- IS 875 (Part 1) : 1987 Code of Practice for design loads (other than earthquake) for Buildings and structure (Dead loads).
- IS 875 (Part 2) : 1987 Code of Practice for design loads (other than earthquake) for Buildings and structure (Imposed loads).
- IS 875 (Part 3) : 2015 Code of Practice for design loads (other than earthquake) for Buildings and structure (Wind loads).

- IS 875 (Part 5) : 1987 Code of Practice for design loads (other than earthquake) for Buildings and structure (Special loads and combinations).
- IS 1893 (Part 1) : 2016 Criteria for earthquake resistant design of structures (General provisions and buildings).
- IS 13920 : 2016 Ductile Detailing of reinforced concrete structures subjected to seismic forces.
- IS 1080 : 1985. Code of Practice for design and construction of shallow foundations on soils (Other than raft, ring and shell).
- IS 1904 : 1986. Code of Practice for design and construction of foundations in soils general requirement.
- IS 2950 (Part 1) : 1981 Code of Practice for design and construction of raft foundations.
- IS 2911 : (Latest Version) Code of Practice for design and construction of pile foundations.
- IS 3370 (Part 3 & 4) : 2009 Code of Practice for concrete structures for the storage of liquids.
- IS 4326 : 1993 Code of Practice for earthquake resistant design and construction of buildings.
- IS 5525 : 1969 Recommendation for detailing of reinforced concrete works.
- IS 1786 : 2008 Specification for high strength deformed steel bars for concrete reinforcement.
- IS 10262 : 1982 Recommended guidelines for concrete mix design.
- IS 800 : 2007 (Reaffirmed 2017) General construction in steel – code of practice.
- IS 18168 : 2023 Earthquake resistant design and detailing of steel buildings – Code of practice.
- IS 3414 : 1968 Code of practice for design and installation of joints in buildings.
- SP – 16 Aids for Reinforced concrete to IS: 456.
- IS: 1893 (part-4) –2024 Criteria for earthquake resistance design of structures, Part 4 Industrial Structures and Stack-like Structures
- IS: 2062 –2011 Steel for General Structural Purposes specification.
- SP16 : Handbook for Structural Engineers
- NBC 2016 National Building Code of India 2016.
- IS 13620 : 1993 Fusion bonded epoxy coated reinforcing bars — Specification

B. TECHNICAL SPECIFICATIONS – ARCHITECTURAL WORKS

1. MASONRY AND ALLIED WORK

SCOPE

This specification covers furnishing, installation, repairing, finishing, curing, protection, maintenance and handing over of masonry and allied works for use in structures and locations covered under the scope of the Contract.

INSTALLATION

Bricks

Bricks for general masonry work shall conform to IS: 1077-1970 and for face brick work shall conform to the specifications in IS: 2691-1972.

Bricks for general masonry work shall be of first class (Class-A) quality, well burnt, of uniform size, shape and colour free from cracks, flaws or nodules or free lime and omit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps boles etc. Compressive strength shall be 50 Kg I cm2 minimum for face bricks. Water absorption after 24 hours immersions shall not exceed 15% by weight for common bricks and 12% for face bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for common bricks and 3% for face bricks. All bricks shall have rectangular faces and sharp straight edges. Maximum permissible chippage for face bricks shall be 6 mm at the edges and 10 mm for corners. The bricks shall show no efflorescence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted, and approved sample shall be retained by the Engineer for future comparison and reference. The colour and texture of face bricks shall be up-to the specification and defective bricks shall be removed immediately from site at the Contractor's own cost.

Stone

All stones shall be from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks, and sand holes. The surface of a freshly broken stone shall be bright, clean, and sharp and shall show uniformity of texture, without loose grains and free from any dull, chalky, or earthy appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5% of its weight of water after 24 hours immersion. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

Cement

Cement used shall be ordinarily Portland Cement conforming to Code for ordinary cement in IS: 269 and shall be fresh when delivered. The Contractor shall be responsible to submit the manufacturer's certificate and necessary test results for each consignment of cement procured to the Engineer with no additional cost to the Client. If at any time, the Engineer feels that the cement being used by the Contractor is not up-to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by, the Contractor. The Contractor shall also have no claim for this type of suspension of work.

Cement shall be stored above ground as specified elsewhere.

Sand

Sand shall be hard, durables, clean and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron particles, alkalis, salts, coal, mica or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosions to any metal in contact with such mortar, plaster, or concrete. All sand shall be properly graded. Unless otherwise directed by the Engineer all sand shall pass through IS Sieve No. 240 and 15% to 35% of and for masonry mortar and 5% to 50% of sand for plaster shall pass through IS Sieve No. 30. Sand for concrete shall conform to IS: 383.

Water

Water shall be clean, fresh, and free from organic matters, acids or soluble salts and other deleterious substances which may ·cause corrosion, discolouration, and efflorescence etc.

SOLING

Brick Soling

The ground shall be dressed, consolidated by ramming or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and· placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken in all direction and bricks cut as required. The pattern of laying and number of layers shall be as per Schedule of Item. Orientation shall be as desired by the Engineer. After laying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

Stone Soling

The stones for soling shall be selected based on thickness of soling specified in the Schedule of Items. The larger stones shall be laid, and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

BRICK EDGING

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

MASONRY

General

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

Mortar

Mix for mortar shall be specified in the Schedule of Items.

When lime is used hydrated lime shall be mixed with water to form putty and stored with care to prevent evaporation for at least 24 hours before use. Quick lime shall be slaked with enough water to make a cream, passed through a No. 1 sieve, and stored avoiding evaporation for seven days before use.

Lime putty and sand in proper proportion shall be mixed on a watertight platform with necessary addition of water and thoroughly ground in a mortar mill. This mix shall be transferred to a mechanical mix, required quantity of cement added and the content mixed for at least 3 minutes. Mixtures of lime putty and sand may be stored avoiding drying out. For cement sand mortar cement and sand in requisite proportions shall be mixed dry in a mechanical mixer and then water added and mixed further. Minimum quantity of water shall be added to achieve working consistency.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

Brick Masonry

Bricks shall be soaked by Submergence in clean water for at least two hours in approved vats before use. Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus, all joints between bricks shall be fully filled with mortar.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

Exposed Brickwork

Brickwork in superstructures, which is not covered by plaster, shall be as shown on drawing, and executed by especially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of windowsills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule, and string. All brickwork shall be cleaned at the end of days' work. If face bricks are specified in the Schedule of Item, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean and pointed as specified. Where face bricks are used carborandum stone shall be used for rubbing down.

Reinforced Brickworks

Reinforcements shall be as specified in the Schedule of Items. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M. S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. Columns or welded to steel stanchions.

Expansion and Separation Joints

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings and specified in the Schedule of Items. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

Mouldings, Cornices, Drip Course

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with carborandum stone.

Curing

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days' work top surface of masonry shall be kept wet by ponding.

Embedding of fixtures

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

Encasing of Structural Steel

This shall be done by building masonry work round flanges, webs etc. and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Engineer.

The minimum lap in chicken wire mesh shall be 50 mm.

DAMP PROOF COURSE

Unless otherwise specified Damp-proof course shall be 40 mm or as per schedule thick 'artificial stone' in proportion 1:1.5:3 cement sandstone chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double Chequered and cured by ponding for (seven) 7 days.

RATES

Rates shall be unit rates for the complete work as detailed out in the Specification unless any portion is specifically excluded in the Schedule of Items.

METHOD OF MEASUREMENT

Soling

Soling of different types as enumerated in the Schedule of Items shall be measured on actual area basis. Deductions shall not be made for areas less than 0.1 m^2.

Brick Edging

Edging shall be measured on running length unless included in other relevant items.

Masonry

a. Thickness of brick walls shall be measured in nominal brick sizes.

b. For masonry work exceeding 150mm in thickness, actual volume of work shall be measured and deductions for openings, lintels, sills, conduit ducts, pipes etc. shall be made. No opening less than 0.1 m2 in area shall however be deducted.

c. No deductions shall be made for embedded fixtures nor any extra be paid for the mortar used for fixing or for necessary cutting of bricks.

d. For encasing of steel beams, columns etc. The sizes as shown on drawings shall be measured and deductions made for the volume of encased steel.

e. No extra payment shall be made for cutting of masonry units.

f. Walls 150 mm in thickness or less shall be measured for actual area of works.

g. Exposed brickwork using selected ordinary brick or face bricks for the exposed face shall be measured in area as an extra over the ordinary brickwork if so, provided in the Schedule of Items. It shall be measured by volume including the composite backing if so, provided in the Schedule.

h. Reinforcements shall be measured and paid separately under relevant items in the schedule unless included in the items for masonry work.

i. Laps in wire mesh reinforcements shall not be measured. Reinforcing mesh shall be measured on actual area basis. Reinforcing bars shall be measured by weight.

j. The weight shall be arrived at based on sectional weights as per I.S. code. No extra shall be paid for necessary modifications of existing dowels, if any, to tie up with the Contractor's work.

k. Exposed Stonework: Exposed Stonework using selected stone for exposed face shall be measured in area as an extra over ordinary stonework if so, provided in the Schedule of Items.

l. Composite Masonry: Composite masonry shall be measured for volume including backing if so, provided in the Schedule of Items. If not, brickwork and stonework shall be measured separately and paid under relevant items.

m. Expansion and Separation Joints: Joints shall be measured for length or area for the complete work as shown on drawings including filler boards, sealant strips, sealing compounds, painting, cover etc. If so, provided in the Schedule of Items, unless any work is specifically excluded from the item.

n. Mouldings, Cornice, Drip Course: Mouldings, cornice, drip course unless indicated specifically under separate items shall be included in masonry items. However, cut in bricks or stone shall be neglected in measurements.

o. Embedded Fixtures:Inserts etc. shall be measured by weight or by number and paid separately under relevant item in the Schedule of Items.

CODES AND STANDARDS

Some of the important relevant codes for this section are: -

Table 1-1Codes & Standards of Masonry

IS: 1127	Recommendations for dimensions and workmanship of natural building stones for masonry work.
IS: 2185	Code Practice for hollow concrete block.
IS: 1597	Code of Practice for Construction of stone Masonry.
IS: 1609	Code of Practice for laying Damp-proof treatment Using bitumen felts.
IS: 2212	Code of Practice for Brickwork.
IS: 2250	Code of Practice for preparation and use of Masonry Mortar.
IS: 5134	Bitumen Impregnated Paper and Board.

2. BRICK MASONRY WORK

GENERAL

This specification establishes the materials, dressing, laying, joining, curing, workmanship etc. for brick masonry works. Brick masonry shall also comply with all the requirements of IS:2212.

MATERIALS

Cement Mortar

Cement mortar shall meet the requirements of IS:2250 and shall be prepared by mixing cement and sand by volume. Proportion of cement and sand shall be 1:6 (1 part of cement and 6 parts of sand), or as directed by the OWNER for brick masonry of one brick thickness or more, while 1:3 cement mortar (1 part of cement and 3 parts of sand) shall be used for brick masonry of half brick thickness. The sand being used for mortar shall be sieved. The mortar shall be used as soon as possible after mixing and before it has begun to set and in any case within initial setting time of cement after water is added to the dry mixture. Mortar unused for more than initial setting time of cement, shall be rejected and removed from the site of work.

Proportioning

The unit of measurement for cement shall be a bag of cement weighing 50 kg and this shall be taken as 0.035 cubic metre. Sand shall be measured in boxes of suitable size on the basis of its dry volume. In case of damp sand, its quantity shall be increased suitably to allow for bulkage.

Mixing

The mixing of mortar shall be done in a mechanical mixer operated manually or by power. The OWNER may, however, permit band-mixing as a special case, taking into account the magnitude, nature and location of work. The CONTRACTOR shall take the prior permission of OWNER, in writing, for using hand-mixing before the commencement of work.

Mixing in Mechanical Mixer

Cement and sand in specified proportions, by volume, shall be thoroughly mixed dry in a mixer. Water shall then be added gradually, and wet mixing continued for at least one minute. Care shall be taken not to add more water than that which shall bring the mortar to the consistency of stiff paste. Wet mix from the mixer shall be unloaded on water-tight masonry platform, made adjacent to the mixer. Platform shall be at least 150 mm above the levelled ground to avoid contact of surrounding earth with the mix. Size of the platform shall be such that it shall extend at least 300mm all-round the loaded wet mix area. Wet mix, so prepared, shall be utilised within initial setting time (thirty (30) minutes for ordinary Portland cement conforming to IS:269 after addition of water. Mixer shall be cleaned with water each time before suspending the work.

Hand Mixing

The measured quantity of sand shall be levelled on a clean water-tight masonry platform and cement bags emptied on top. The cement and sand shall be thoroughly mixed dry by being turned over and over, backward and forward, several times till the mixture is of uniform colour. The quantity of dry mix, which can be consumed within initial setting time of cement shall then be mixed with just sufficient quantity of water to bring the mortar to the consistency of stiff paste.

CONSTRUCTION PROCEDURE

Soaking of Bricks

Bricks shall be soaked in water before use for a period that is sufficient for the water to just penetrate the whole depth of bricks as well as to remove dirt, dust and sand. Proper soaking of bricks shall prevent the suction of water from the wet mortar, as otherwise mortar will dry out soon and crumble before attaining any strength. The bricks shall not be too wet at the time of use as they are likely to slip on mortar bed and there will be difficulty in achieving the plumbness of wall as well as proper adhesion of bricks to mortar. The period of soaking shall be determined at site by a field test by immersing the bricks in water for different periods and then breaking the bricks to find the extent of water penetration. The least period that corresponds to complete soaking, will be the one, to be allowed for in the construction work.

The soaked bricks shall be removed from the tank, sufficient early, so that at the time of laying, they are skin dry. The soaked bricks shall be stacked over a clean place, wooden planks or masonry platforms to avoid earth, dirt being smeared on them.

Laying

Brick Work (one or more brick thickness)

Brick work (one or more brick thickness) shall be laid in English Bond unless otherwise specified. Half or cut bricks shall not be used except when needed to complete the bond. In no case the defective bricks shall be used.

A layer of average thickness of 10mm of cement mortar shall be spread on full width over a suitable length of lower course or the concrete surface. In order to check and achieve uniformity in masonry, the thickness of bed joints shall be such that four courses and three joints taken consecutively shall measure equal to four times the actual thickness of the brick plus 30mm. Each brick with frog upward, shall be properly bedded and set in position by gently tapping will) handle of trowel or wooden mallet. Its inside faces shall be buttered with mortar before the next brick is laid and pressed against it. After completion of the course, all vertical joint shall be filled from top with mortar.

All brick courses shall be taken up truly plumb; if battered, the batter is to be truly maintained. All courses shall be laid truly horizontal and vertical joints shall be truly vertical. The level and verticality of work in walls shall be checked up at every 1 m interval.

The brick work shall not be raised more than fourteen (14) courses per day.

At the junction of any two walls, the bricks shall at each alternate course, be carried into each of the respective walls so as to thoroughly unite the work.

The courses at the top of plinth and sills, at the top of the wall just below the soffit of the roof slab or roof beam and at the top of the parapet, shall be laid with bricks on edge. Brick on edge course shall be so arranged as to tightly fit under the soffit of the roof beam or roof slab, restricting the mortar layer thickness upto 12mm, however, any gap between the finished brick work and soffit of roof slab /beam shall be suitably sealed with the mortar.

Brick Work (half brick thickness)

For brick walls of half brick thickness, all courses shall be laid with stretchers. Wall shall be reinforced with 2 nos. - 6mm diameter mild steel reinforcement bars, placed at every fourth course. The reinforcement bars shall be straightened and thoroughly cleaned. Half the mortar thickness for the bedding joint shall be laid first and mild steel reinforcement, one on each face of the wall, shall be embedded, keeping a side cover of 12mm mortar. Subsequently, the other half of the mortar thickness shall be laid over the reinforcement covering it fully.

The reinforcement bars shall be carried at least 150mm into the adjoining walls or RCC columns. In case the adjoining wall being of half brick thickness, the length of bars shall be achieved by bending the bars in plan. During casting of reinforced concrete columns, 6mm dia. M.S. reinforcing bar shall be placed at every fourth course of brick masonry. At the junction of two walls, the brick shall, at each alternate course, be carried into each of the respective walls so as to thoroughly unite the work. The brick masonry work shall not be raised more than 14 courses per day.

Brick course under the soffit of beam or slab, shall be laid by restricting the mortar thickness to 12mm. However, any gap between the finished brickwork and soffit of slab/beam, shall be suitably sealed with the mortar.

Jointing

Joints shall be restricted to a width of 10mm with brickwork of any classification. All bed joints shall be normal to the pressure upon them i.e. horizontal in vertical walls, radial in circular brick masonry and at right angles to the face in the battered retaining walls. The vertical joints in alternate courses shall come directly one over the other and shall be truly vertical. Care shall be taken that all the joints are full of mortar, well flushed up. In case no pointing is to be done, cement mortar shall be neatly struck as the work proceeds. The joints in faces which are to be plastered or pointed shall be squarely raked out to a depth of 12mm while the mortar is still green. The rake joints shall be brushed to remove loose particles. After the day's work, the faces of the brick work shall be cleaned on the same day with wire brush and all mortar droppings removed.

Curing

Masonary work shall be protected from rain or any other running water or accumulated water from any source, by suitable means. Masonry work, as it progresses, shall be kept thoroughly wet by sprinkling water at regular intervals, on all faces. Curing shall be done after 24 hours of completion of day's work and shall be done for atleast 10 days after completion. Proper watering cans with spray nozzles, rubber or PVC pipes shall be used for this purpose.

Staging / Scaffolding

Staging/scaffolding shall be properly planned and designed by the CONTRACTOR. Use of only steel tubes is permitted for staging/scaffolding. Design of staging/scaffolding shall be submitted for approval of the OWNER, before commencement of work.

Single scaffolding having one set of vertical support, shall be used and other end of the horizontal scaffolding member shall rest in a hole provided in the header course. The support shall be sound and strongly clamped with the horizontal pieces over which the scaffolding planks shall be fixed. The holes left in the masonry work for supporting the scaffolding shall be filled and made good with plain cement concrete of grade 1:3:6 during plastering. Suitable access shall be provided to the working platform area. The scaffolding shall be strong enough to withstand all loads likely to come upon it and shall also meet the requirements specified in IS:2750.

Double scaffolding shall be provided for pillars less than one metre in width or for the first-class masonry or for a building having more than two storeys.

The following measures shall also be considered during erection of the scaffolding/staging.

Sufficient sills or underpinnings, in addition to base plates, shall be provided, particularly, where scaffoldings are erected on soft grounds.

Adjustable bases to compensate for uneven ground shall be used.

Proper anchoring of the scaffolding/staging at reasonable intervals shall be provided in each direction with the main structure wherever available. Horizontal braces shall be provided to prevent the scaffolding from rocking. Diagonal braces shall be provided continuously from bottom to top between two adjacent rows of uprights. The scaffolding/staging shall be checked at every stage for plumb line. Wherever the scaffolding/staging is found to be out of plumb line, it shall be dismantled and re-erected afresh. Efforts shall not be made to bring it in line with a physical force. All nuts and bolts shall be the clamps/couplings are firmly tightened to avoid slippage. Erection work of a scaffolding/staging, under no circumstance shall be left totally to semiskilled or skilled workmen and shall be carried out under the supervision of CONTRACTOR's technically qualified civil OWNER. For smaller works or works in remote areas wooden ballies may be permitted for scaffolding/staging by the OWNER at his sole discretion.

Embedment of Fixtures

All fixtures, pipes, conduits, holdfasts of doors and windows etc. required to be built in walls, shall be embedded in plain cement concrete block of grade 1:3:6, at the required positions, as the work proceeds.

Compressible Joint Fillers

Soft board shall be used where specified at joints requested by the OWNER. Filler shall be cut to exact widths and shall have all edges neatly trimmed. Fixing of filer shall be strictly in accordance with the manufacturer's printed instructions.

Polysulphide Sealant for Joints

Polysulphide joint sealer or other equal and approved shall be used. Application shall be strictly in accordance with the manufacturer's instructions.

BRICKS /BRICK TILES /BRICK BATS /MECHANIZED AUTOCLAVE FLY ASH LIME BRICK

Bricks used in the masonry may be of the following type.

Common Burnt Clay Bricks shall conform to IS:1077 and shall be hand moulded or machine moulded. They shall be free from nodules of free lime, visible cracks, flaws warpage and organic matter, have a frog 100 mm in length 40 mm in width and 10 mm to 20 mm deep on one of its flat sides. Bricks made by extrusion process and brick tiles may not be provided with frogs. Each brick shall be marked (in the frog where provided) with the manufacturer's identification mark or initials.

Fly Ash Lime Bricks (FALG Bricks) : The Fly Ash Lime Bricks (FALG Bricks) shall conform to IS 12894. Visually the bricks shall be sound, compact and uniform in shape free from visible cracks, warpage, flaws and organic matter. The bricks shall be solid and with or without frog on one of its flat side.

Fly Ash*:* Fly ash shall conform to IS 3812.

Note: This item will be operated only for load bearing structure upto 2 storeys and for non load bearing walls 23 cms thick for multi-storeyed building's.

Bottom ash used as replacement of sand shall not have more than 12% loss on ignition when tested.

Sand: Deleterious materials, such as clay and silt in the sand shall preferably be less than 5%. **Lime:** Lime shall conform to class 'C' hydrated lime of IS 712.

Additives: Any suitable additive considered not detrimental to the durability of bricks may be used.

Clay Fly Ash Bricks: The clay fly ash bricks shall conform to IS 13757. The bricks shall be sound, compact and uniform in shape and colour. Bricks shall have smooth rectangular faces with sharp and square corners. The bricks shall be free from visible cracks, flaws, warpage, nodules of free lime and organic matter, the bricks shall be hand or machine moulded. The bricks shall have frog of 100 mm in length 40 mm width and 10 to 20 mm deep on one of its flat sides. If made by extrusion process may not be provided with frogs. Fly Ash shall conform to grade I or grade II of IS 3812.

Calcium Silicate Bricks: The bricks shall conform to IS 4139. The Calcium silicate bricks shall be sound, compact and uniform in shape. Bricks shall be free from visible cracks, warpage, organic matter, large pebbles and nodules of free lime. Bricks shall be solid and with or without frog. The bricks shall be made of finely grounded sand siliceous rock and lime. In addition limited quantity of fly ash conforming to IS 3812 may be used in the mix. These bricks are also known as Fly Ash Sand Lime bricks in the construction industry.

Tile Brick: The bricks of 4 cm height shall be moulded without frogs. Where modular tiles are not freely available in the market, the tile bricks of F.P.S. thickness 44 mm (1-3/4") shall be used unless otherwise specified.

Brick Bats: Brick bats shall be obtained from well burnt bricks.

Mechanized Autoclave Fly Ash Lime Brick: These bricks shall be machine moulded and prepared in plant by appropriate proportion of fly ash and lime. The autoclave fly ash bricks shall conform to IS 12894. Visually, the bricks shall be sound, compact and uniform shape, free from visible cracks, warpage and organic matters. The brick shall be solid with or without frog, and of 100/80 mm in length, 40 mm width and 10 to 20 mm deep one of its flat side as per IS 12894. The brick shall have smooth rectangular faces with sharp corners and shall be uniform in shape and colour. Fly ash shall conform to IS 3812 and lime shall conform to class 'C' hydrated lime of IS 712.

Steel/Aluminium doors, windows and ventilators

GENERAL

This section of the specification includes the requirements necessary to provide in place all steel/Aluminium doors, windows and ventilators.

INDIAN STANDARDS

Table 2-1 Codes & Standards of Brick Masonry

IS 6248	Specification for metal rolling shutters and rolling grill
IS 1081	Code of practice for fixing and glazing of metal (steel and Aluminium) doo windows and ventilators.
IS 4351	Specifications for steel door frames.
IS 1948	Specifications for Aluminium doors, windows and ventilators.
IS 1361	Specifications for steel windows for Industrial buildings
IS 1200 (Part XIV)	Method of measurement of glazing.
IS 3614	Specifications for fire check doors.
IS 7452	Specification for hot rolled steel sections for doors, windows and ventilators.

IS 2835	Flat transparent sheet glass.
IS 5437	Wired and Figured glass.
IS 25583	Safety glass.

3. PLASTERING

General

This section shall cover all plastering (internal/external) and painting works as specified herein. Before commencing the work sample of works shall be made in accordance with the specification and got approved by the OWNER.

MATERIALS

Cement

The cement plaster shall be 16 mm, 12 mm, 6 mm thick as specified in the item.

Sand

Sand for plastering and pointing shall conform to IS 1542. Sand shall be hard, durable, dean and free from adherent coatings and organic matter and shall not contain any appreciable amount of silt, day balls or pellets. Sand should not contain harmful impurities such as iron pyrites, coal particles, lignite, mica shale etc.

Sand grading outside the limits of IS 460 due to excess or deficiency of coarse or fine panicles shall be processed to comply with the standards. Fine sand shall be obtained from riverbeds not affected by tidal water of the sea and shall be clean, sharp and free from excessive deleterious matter. The sand shall not contain more than 8 per cent of mud and silt as determined by field test with a measuring cylinder.

Water

Water for plastering and pointing shall conform to specifications under 'Material'.

Cement mortar

Preparation of cement mortar shall conform to specifications under 'Brick Masonry' unless otherwise mentioned. Hand mixing of cement/sand mortar for use in plastering shall not be allowed. All such mixing shall be done through mechanical mixer only.

PLAIN CEMENT PLASTER

Preparation of mortars

The mortars of specified mix shall be used as per the specifications of "Cement Mortar' described above.

Application of plaster

One Layer Plaster Work

To ensure even, specified thickness, plaster of 150 mm x 150 mm shall be first applied horizontally and vertically at not more than 2 meter interval over the entire surface to serve as gauges. The surface of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall be brought to true surface by working with a wooden straight edge reaching across the gauges with small upward and sideways movements at a time. Finally the surface shall be finished off true with a trowel or wooden float to obtain a smooth texture. Excessive trowelling or overworking the float shall be avoided. All corners, arises, angles and junctions shall be truly vertical/horizontal and shall be carefully finished. Rounding or chamfering of corners, arises, junctions etc., shall be carried out with proper templates to the size required.

In suspending the work, the plaster shall be left, cut clean to line, both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scrapped clean and wetted before plastering the adjoining area. Plastering work shall be closed on the border of the wall and nearer than 150 mm to any corners or arises and shall not be closed on the body of the features such as plaster bands, cornices nor at the comers or arises.

Two Layer Plaster Work

First or under layer

Before the first coat hardens, surface of it shall be beaten up by edges of wooden tapers and close dents shall be made on the surface. The subsequent coat shall be applied after this coat has been allowed to set for 3 to 5 days depending upon weather conditions. The surface shall not be allowed to dry during this period.

Second or finishing layer

The second layer shall be complete to the specified thickness in the same manner as for first layer. Curing

Curing shall be started 24 hours after finishing the plaster. The plaster shall be kept wet for a period of 7 days. During this period the plaster shall be suitably protected from all damages by such means as approved by the OWNER. The date of execution of plastering shall be marked on the plastering to ensure the proper duration of curing.

Primer

The primer for wood work, iron work or plastered surface shall be as specified in the description of item.

Sno.	Surfaces	Primer to be used
1	*Wood work (hard and soft wood)*	*Pink conforming to IS3536*
2	*Resinour wood and plywood*	*Aluminium primer conforming to IS 3585*
3	*Aluminium and light alloys* *Iron, Steel and Galvanized steel*	*Zinc chromate primer conforming to IS 104* *Red Oxide Zinc chromate Primer conforming IS 20*
4	*Cement/Conc/RCC/brick work, Plasteredsurfaces, non-asbestos*	*Cement primer conforming to IS 109* surfaces receive Oil bound distemper or Paint finish.

The primer shall be ready mixed primer of approved brand and manufacture.

Where primer for wood work is specified to be mixed at site, it shall be prepared from a mixture of red lead, white lead and double boiled linseed oil in the ratio of 0.7 kg : 0.7 kg : 1 litre.

Where primer for steel work is specified to be mixed at site, it shall be prepared from a mixture of red lead, raw linseed oil and turpentine in the ratio of 2.8 kg : 1 litre : 1 litre.

The specifications for the base vehicle and thinner for mixed on site primer shall be as follows:

(a) White Lead : The White lead shall be pure and free from adulterants like barium sulphate and whiting. It shall conform to IS 103.

(b) Red Lead : This shall be in powder form and shall be pure and free from adulterants like brick dust etc. It shall conform to IS 102.

(c) Raw Linseed Oil : Raw linseed oil shall be lightly viscous but clear and of yellowish colour with light brown tinge. Its specific gravity at a temperature of 30 degree C shall be between 0.923 and 0.928. Note : The oil shall be mellow and sweet to the taste with very little smell. The oil shall be of sufficiently matured quality. Oil turbid or thick, with acid and bitter taste and rancid odour and which remains sticky for a considerable time shall be rejected. The oil shall conform in all respects to IS 75. The oil shall be of approved brand and manufacture.

(d) Double Boiled Linseed Oil : This shall be more viscous than the raw oil, have a deeper colour and specific gravity between 0.931 and 0.945 at a temperature of 30 degree C. It shall dry with a glossy surface. It shall conform in all respects to IS 77. The oil shall be of approved brand and manufacture. Turpentine : Mineral turpentine i.e. petroleum distillate which has the same rate of evaporation as vegetable turpentine (distillate product of oleeresin of conifers) shall be used. It shall have no grease or other residue when allowed to evaporate. It shall conform to IS 533.

All the above materials shall be of approved manufacture and brought to site in their original packing in sealed condition.

PREPARATION OF SURFACE

Wooden Surface :

The woodwork to be painted shall be dry and free from moisture. The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sandpaper and shall be well dusted. Knots, if any shall be covered with preparation of red lead made by grinding red lead in water and mixing with strong glue sized and used hot. Appropriate filler material conforming to IS 345 with same shade as Paint shall be used where specified. The surface treated for knotting shall be dry before Paint is applied. After obtaining approval of PMC Engineer/Engineer's Representative for woodwork, the priming coat shall be applied before the woodwork is fixed in position. After the priming coat is applied, the holes and indentation on the surface shall be stopped with glazier's putty or wood putty. Stopping shall not be done before the priming coat is applied as the wood will absorb the oil in stopping and the latter is therefore liable to crack.

Iron & Steel Surface:

All rust and scales shall be removed by scrapping or by brushing with steel wire brushes. Hard skin of oxide formed on the surface of wrought iron during rolling which becomes loose by rusting, shall be removed. All dust and dirt shall be thoroughly wiped away from the surface. If the surface is wet, it shall be dried before priming coat is undertaken.

Plastered Surface:

The surface shall ordinarily not be painted until it has dried completely.Trial patches of primer shall be laid at intervals and where drying is satisfactory, painting shall then be taken in hand. Before primer is applied, holes and undulations, shall be filled up with plaster of paris and rubbed smooth.

APPLICATION

The primer shall be applied with brushes, worked well into the surface and spread even and smooth. Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks.

4. PAINTING

General

This section of specifications includes all requirements necessary for the white washing, colour washing, distempering, painting, and polishing of all surfaces specified herein or as may be necessary for the completion of the areas intended. When shop priming, specified under other sections of these specifications is provided, this may serve as the first of the number of coats herein specified.

All materials required for the execution of painting work shall be obtained direct from approved manufacturers and shall be brought to the site in makers drums, kegs etc. with seals unbroken. If in case of ready mixed paints, thinning if necessary, the brand of thinner shall be as per recommendations of the manufacturer.

Paint shall be applied by brushing or spraying. The brushing operations are to be adjusted to the spreading capacity advised by the manufacturer. During painting, every time after the paint has been worked out of the brush bristles, the bristles shall be opened up by striking the brush suitably.

Spray machine used may be of high pressure type or low pressure depending on the nature and location of work. After work, the brushes shall be completely cleaned off paint and shall be hung in a thinner if intended to be used afterwards. The spray guns shall be cleaned thoroughly after every break in work. The paint containers, when not used shall be kept close and free from air.

After the finishing of work, the adjacent surfaces not intended to be washed/ distempered/painted/polished, shall be thoroughly cleaned of all paint patches and shall be finished in accordance with surface finishing of such surfaces.

Reference Indian Standards

IS 712 Specification for building limes.

IS 55 Specification for Ultramarine blue for paints.

IS 63 Specification for whiting for paint and putty.

IS 427 Distemper (dry), colour as required.

IS 428 Distemper (Oil Bound), colour as required.

IS 5410 Cement paint, colour as required.

IS 384 Brushes, paints and varnishes, flat

IS 486 Brushes, sash, tool, for paints and varnishes.

IS 110 Ready mixed paint, brushing, grey filler enamels for use over primers.

IS 426 Paste filter for colour coats.

IS 345 Wood filler, transparent liquid.

IS 3585 Ready mixed paint, aluminium brushing priming water resistant for woodwork.

ACRYLIC EMULSION PAINTING

Workmanship

Scaffolding

Wherever scaffolding is necessary, it shall be erected in such a way that as far as possible no part of scaffolding shall rest against the surface to be painted. For Painting of ceiling, proper stage scaffolding shall be erected.

Preparation of Surface

The surface shall be thoroughly brushed free from dust, dirt, grease, mortar droppings, other foreign matter and shall be made smooth by sand papering. Unevenness shall be made good by applying putty made of plaster of paris mixed with water including filling up the undulation and then sand papering the same after it is dry.

Preparation of Mix

Plastic emulsion paint shall conform to IS 5411 (Part-1) and shall be of approved shade. Preparation of mix shall be as per manufacturer's instructions.

Application of Paint

The paint mix shall be continuously stirred while applying for maintaining uniform consistency. Number of coats shall be as per item description. The painting shall be laid evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard at first, then brushing alternately in opposite direction 2/3 times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks, no hair marks no clogging of paint puddles shall be permitted. The full process of crossing and laying off will constitute one coat.

The paint shall be applied by means of brush or roller. Before starting painting with plastic emulsion paint, the prepared surface shall be treated with two coats of primer consisting of cement, primer, whiting and plastic emulsion paint shall start only after the preceding coat has become sufficiently hard to resist brush marking. Subsequent coats of plastic emulsion paint shall also be started after the preceding coat is dried by evaporation of water content.

The surface on finishing shall present a flat, velvety smooth finish, even and uniform shade without patches, marks, paint drops etc.

Precautions

Brushes shall be quickly washed in water immediately after use and kept immersed in water during break periods to prevent the paint from hardening on the brush. Old brushes, if used shall be completely dried of turpentine/oil paints by washing in warm soap water.

No oil base putties shall be used in filling cracks/holes.

Washing of painted surface shall not be done within 3-4 weeks of application.

PROTECTIVE MEASURES

Surfaces of doors, windows, floors etc. which are not to be painted shall be protected from being splashed upon. Such surfaces shall be cleaned of whitewash splashed if any.

PAINTING TO STEEL AND OTHER METAL SURFACE

General

Items to be Painted

All structural steel work and metals including handrails, brackets and steel inserts shall be painted except if otherwise specified.

Standard

The operations, workmanship, schedules and equipment for painting shall generally comply with the requirements of IS:1477 (Part I & II) “Code of Practice for Painting of Ferrous Metals in Buildings” & IS 2524 except in so far as this Specification modifies it.

General Requirements

All surfaces shall be thoroughly cleaned of all foreign matters adhering to the steel surface to Swedish Standard specification Sa 2½ by means of blasting with sand. Use of scraper wire brush and pig hammer is acceptable wherever blasting with sand is not possible due to lack of access.

Air less spray shall be used for painting of all structural steel. Painting by brush shall only be allowed in places where use of air less spray not possible. The finished coat shall be generally smooth, of a dense and uniform texture and free from sharp protuberances or pinholes. Each coating shall be checked for thickness by “Elcometer”. Areas where the thickness is less than what is specified shall receive additional treatment.

All operations such as handling & transportation etc. shall be carried out in a manner that there is no damage to the coating. Painting shall generally be done immediately after cleaning. The cleaned surface shall not be allowed to stand overnight before painting. Where galvanised surfaces are to be painted, they shall be cleaned and washed with a solution of copper sulphate before the application of the first coat of primer.

No painting shall commence until the cleaned surfaces have been approved by the OWNER.

Schedule

One coat of Organic Zinc Rich Primer (thickness, 60 m DFT).

Strip coat on each weld joint and edge of structure by surface tolerant Epoxy – 75 m DFT by Brush – One Coat

Two coats of High Build Abrasive Epoxy (DFT 100 m for each coat)

Total System Thickness = 250 m DFT without Strip Coat

Strip coat and one coat of high build epoxy should be immediately followed by primer.

It is not permitted to keep organic Zinc Rick Primer exposed to atmosphere for long time.

Painting system shall be guaranteed for 5 (five) years.

After completion of erection and stanchion grouting, all the painted surface shall be carefully examined for any damage to the painting system and shall be rectified as directed by the OWNER.

Preparation of surface

The surface, before painting, shall be cleaned of all rust, scale, dirt and other foreign matter with wire brushes, steel wool, scrappers, sand paper etc. The surface shall then be wiped finally with mineral turpentine, which shall then be removed of grease etc. The surface then shall be allowed to dry.

In case of GI surface, surface so prepared shall be treated with Mordant solution (5 litres for about 100 sqm) by rubbing the solution generously with brush. After about half an hour, the surface if required shall be retouched and washed down thoroughly with clean cold water and allowed to dry.

Application of priming and paints

Approved quality primer and paint in specified no. of coats shall be applied as per manufacturer's recommendations either by brushing or spraying. Each subsequent coat shall be applied only after the preceding coat is dried.

OIL EMULSION (OIL BOUND) WASHABLE DISTEMPERING

Materials

Oil emulsion (Oil Bound) washable distemper (IS 428) of approved brand and manufacture shall be used. The primer where used as on new work shall be cement primer or distemper primer as described in the item. These shall be of the same manufacture as distemper. The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for day's work shall be prepared.

The distemper and primer shall be brought by the contractor in sealed tins in sufficient quantities at a time to suffice for a fortnight's work, and the same shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty tins shall not be removed from the site of work, till this item of work has been completed and passed by the Engineer-in-Charge.

Preparation of the Surface

For new work the surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt etc.

Pitting in plaster shall be made good with plaster of paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

Application

Priming Coat : The priming coat shall be with distemper primer or cement primer, as required in the description of the item. The application of the distemper primer shall be as described above.

Note : If the wall surface plaster has not dried completely, cement primer shall be applied before distempering the walls. But if distempering is done after the wall surface is dried completely, distemper primer shall be applied. Oil bound distemper is not recommended to be applied, within six months of the completion of wall plaster. However, newly plastered surfaces if required to be distempered before a period of six months shall be given a coat of alkali resistant priming Paint conforming to IS 109 and allowed to dry for atleast 48 hours before distempering is commenced.

For old work no primer coat is necessary.

Distemper Coat : For new work, after the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitutes one coat.

The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied over the primer coat to obtain an even shade.

A time interval of at least 24 hours shall be allowed between successive coats to permit proper drying of the preceding coat.For old work the distemper shall be applied over the prepared surface in the same manner as in new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade.15 cm double bristled distemper brushes shall be used. After each days work, brushes shall be thoroughly washed in hot water with soap solution and hung down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work.

The specifications in respect of scaffolding, protective measures and measurements shall be as described above.

Rate

The rate shall include the cost of all labour and materials involved in all the above operations (including priming coat) described above.

Cement Paint

Material

The cement Paint shall be (conforming to IS 5410) of approved brand and manufacture. The cement Paint shall be brought to the site of work by the CONTRACTOR in its original containers is sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the CONTRACTOR and the PMC Engineer/Engineer's Representative. The empty containers shall not be removed from the site of work till the relevant item of the work has been completed and permission obtained from the PMC Engineer/Engineer's Representative.

Preparation of Surface

For New Work, the surface shall be thoroughly cleaned of all mortar dropping, dirt dust, algae, grease and other foreign matter by brushing and washing. Pitting in plaster shall be made good and a coat of waterproof cement Paint shall be applied over patches after wetting them thoroughly.

Preparation of Mix

Cement Paint shall be mixed in such quantities as can be used up within an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish. Cement Paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of cement Paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the cement Paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency.In all cases the manufacturer's instructions shall be followed meticulously.The lids of cement Paint drums shall be kept tightly closed when not in use, as by exposure to atmosphere the cement Paint rapidly becomes air set due to its hygroscopic qualities. In case of cement Paint brought in gunny bags, once the bag is opened, the contents should be consumed in full on the day of its opening. If the same is not likely to be consumed in full, the balance quantity should be transferred and preserved in an airtight container to avoid its exposure to atmosphere.

Application

The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so that the direct heat of the sun on the surface is avoided. The method of application of cement Paint shall be as per manufacturer's specification. The completed surface shall be watered after the day's work. The second coat shall be applied after the first coat has been set for at least 24 hours. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted. For new work, the surface shall be treated with three or more coats of waterproof cement Paint as found necessary to get a uniform shade. For old work, the treatment shall be with one or more coats as found necessary to get a uniform shade.

Precaution

Waterproof cement Paint shall not be applied on surfaces already treated with white wash, colour wash, distemper dry or oil bound, varnishes, Paints etc. It shall not be applied on gypsums, wood and metal surfaces. If water proofing cement is required to be applied on existing surface, previously treated with white wash, colour wash etc., the surface shall be thoroughly cleaned by scrapping off all the white wash, colour wash etc. completely. Thereafter, a coat of cement primer shall be applied followed by two or more coat of waterproof cement.

5. FLOOR FINISHING

General

This section shall cover all flooring and wall tiling work

No work under this section shall be started until specifically allowed by the OWNER and until all other major works such as plastering, embedding of conduits and pipes channels, window fixing etc. have been completed. Samples of basic materials and work of adequate size representing the nature of variation including quality, size, texture after finishing to be used in the flooring work shall be prepared for all work and got approved by the OWNER sufficiently prior to ordering. The approved samples shall be retained upto the end of the project. The works shall be got done by skilled and specialized workmen experienced in the respective trade of work.

Indian Standards

1. IS 269 Specification for 33 grade ordinary portland Cement

2. IS 401 Code of practice for preservation of timber

3. IS 451 Technical supply conditions for wood screws

4. IS 455 Specification for portland slag cement

5. IS 661 Code of practice for thermal insulation of cold storages

6. IS 702 Specification for industrial bitumen

7. IS 1124 Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones

8. IS 1130 Specification for marble (blocks, slabs and tiles)

9. IS 1141 Code of practice for Seasoning of timber

10. IS 1200-(Part XI) Method of measurement of Building and Civil Engineering work (Part 11) paving, floor finishes, dado and skirting

11. IS 1237- Edition 2.3 Specification for cement concrete flooring tiles

12. IS 1322 Specification for bitumen felts for water proofing and dampproofing

13. IS 1443 Code of practice for laying and finishing of cement concrete

flooring tiles

14. IS 1489 (Part-I) Specification for portland pozzolana cement (Part-I) flyash

based

15. IS 1489-(Part II) Specification for Portland pozzolana cement (Part II) calcined clay based

16. IS 1580 Specification for bituminous compounds for water proofing and

caulking purpose

17. IS 2114 Code of practice for laying in-situ terrazzo floor finish

18. IS 2571 Code of practice for laying in-situ cement concrete flooring

19. IS 3622 Specification for sand stone (Slab & Tiles)

20. IS 3670 Code of practice for construction of timber floors

21. IS 4457 Acid and/or alkali Resistant tiles.

22. IS 5318 Code of practice for laying of hard wood parquet and wood

block floors

23. IS 5766 Code of practice for laying of burnt clay brick floor

24. IS 8041 Specification for rapid hardening portland cement

25. IS 8042 Specification for white portland cement

26. IS 8043 Specification for hydrophobic portland cement

27. IS 8112 Specification for 43 grade ordinary portland cement

28. IS 12330 Specification for sulphate resisting portland cement.

29. IS: 13630 (Part-1 to 15) Methods of Testing of ceramic tiles

30. IS 13712 Specification for ceramic tiles; definition, classification

characteristic and marking

31. IS 15622 Specification for pressed ceramic tile

32. IS 13801:1993 Specification for Tactile

PRESSED CERAMIC TILE FLOORING

Pressed Ceramic Tiles

The tiles shall be of approved make and shall generally conform to IS 15622. They shall be flat, and true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tiles shall be tested as per IS 13630.

Classification and Characteristics of pressed ceramic tiles shall be as per IS 13712.

The tiles shall be square or rectangular of nominal size. Table 1,3,5, and 7 of IS 15622 give the modular preferred sizes and table 2,4,6 and 8 give the most common non modular sizes. Thickness shall be specified by the manufacturer. It includes the profiles on the visible face and on the rear side. Manufacturer/supplier and party shall choose the work size of tiles in order to allow a nominal joint width upto 2mm for unrectified floor tiles and upto 1mm for rectified floor tiles. The joint in case of spacer lug tile shall be as per spacer. The tiles shall conform to table10 of IS 15622 with water absorption 3 to 6% (Group BII).

The top surface of the tiles shall be glazed. Glaze shall be either glossy or matt as specified. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be preferably free from glaze. However, any glaze if unavoidable, shall be permissible on only upto 50 per cent of the surface area of the edges. Coloured Tiles

Only the glaze shall be coloured as specified. The sizes and specifications shall be the same as for the white glazed tiles.

Decorative Tiles

The type and size of the decorative tiles shall be as follows :

(i) Decorated white back ground tiles

The size of these tiles shall be as per IS 15622.

(ii) Decorated and having coloured back-ground

The sizes of the tiles hall be as per IS 15622.

Preparation of Surface and Laying

Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tile shall be with cement mortar 1:3 (1 cement: 3 coarse sand) or as specified. The average thickness of the bedding shall be 20 mm or as specified while the thickness under any portion of the tiles shall not be less than 10 mm. Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it. Over this mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per square metre over an area upto one square metre. Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern. The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope. In bath, toilet W.C. kitchen and balcony/verandah flooring, suitable tile drop or as shown in drawing will be given in addition to required slope to avoid spread of water. Further tile drop will also be provided near floor trap.

Where full size tiles cannot be fixed these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints. Tiles which are fixed in the floor adjoining the wall shall enter not less than 10 mm under the plaster, skirting or dado. After tiles have been laid surplus cement slurry shall be cleaned off.

Pointing and Finishing

The joints shall be cleaned off the grey cement slurry with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the colour of tiles. Where spacer lug tiles are provided, the half the depth of joint shall be filled with polysulphide or as specified on top with under filling with cement grout without the lugs remaining exposed. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

Measurements

Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster and the area calculated in square metre correct to two places of decimal. Where coves are used at the junctions, the length and breadth shall be measured between the lower edges of the coves. No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre.

Areas, where glazed tiles or different types of decorative tiles are used will be measured separately.

Rate

The rate for flooring shall include the cost of all materials and labour involved in all the operations described above, For tiles of sizes upto 0.16 sqm. unless otherwise specified in the description of the item. Nothing extra shall be paid for the use of cut (sawn) tiles in the work.

Extra over and above the normal rate for white tiles shall be paid where coloured or any other type of decorative tiles have been used.

Pressed ceramic tile flooring (Vitrified tile flooring)

Operations as described above shall be followed except the tiles shall conform to Table 12 of IS 15622 and the joint thickness in flooring shall not be more than 1mm.

Pressed Ceramic Tiles in skirting and dado

The tiles shall be conforming to IS 15622. The tiles shall be pressed ceramic covered by a glaze thoroughly matured and fitted to the body. The tiles shall be sound, true to shape, flat and free from flaws and other manufacturing defects affecting their utility.The top surface of the tiles shall be glazed. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be free from glaze; however, any glaze if unavoidable shall be permissible on only upto 50% of the surface area of edges.The glaze shall be free from welts, chips, craze, specks, crawling or other imperfections detracting from the appearance when viewed from a distance of one meter. The glaze shall be either glossy or matt, as specified. The glaze shall be white in colour except in the case of coloured tiles when colours shall be specified by the PMC Engineer/Engineer's Representative. There may be more than one colour on a tile.

Dimensions and Tolerances

Glazed pressed ceramic tiles shall be made square or rectangular in sizes Table 1, 3, 5 & 7 of IS 15622 give the modular sizes and table 2, 4, 6 & 8 of IS 15622 gives the sizes of non modular tiles. Half tiles for use as full tiles shall have dimensions which shall be such as to make the half tiles when jointed together (with 1 mm Joint) match with dimensions of full tiles. Tiles may be manufactured in sizes other than those specified above. The thickness of the tiles shall be 5 mm or 6 mm or as specified in description of items. The dimensions of fittings associated with the glazed tiles namely cover base, round edge tile, angles corner cups, ridge and legs, cornices and capping beads shall be of the shape and dimensions as required and the thickness of fittings shall be the same as the thickness of tiles given above.

Preparation of Surfaces

The joints shall be raked out to a depth of at least 15 mm in masonry walls.In case of concrete wall, the surface shall be hacked and roughened with wire brushes. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced.

Laying

20 mm thick plaster of cement mortar 1:4 (1 cement: 4 coarse sand) mix of as specified shall be applied and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonal at closed intervals. The tiles should be soaked in water, washed clean, and a coat of cement slurry applied liberally at the back of tiles and set in the bedding mortar in required partten and jointed . The tiles shall be tamped and corrected to proper plane and lines. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal and joints truly vertical except where otherwise indicated. Odd size/cut size of tile shall be adjusted at bottom to take care of slope of the flooring. Skirting and dado shall rest on the top of the flooring. Where full size tiles cannot be fixed these shall be cut (sawn) to the required size and their edges rubbed smooth. Skirting /dado shall not project from the finished "surface of wall" by more than the tile thickness; undulations if any shall be adjusted in wall.

Curing and Finishing

The joints shall be cleaned off the grey cement grout with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigments if required to match the colour of tiles. The work shall then be kept wet for 7 days.After curing, the surface shall be washed and finished clean. The finished work shall not sound hollow when tapped with a wooden mallet.

Measurements

Length shall be measured correct to a cm, Height shall be measured correct to a cm in the case of dado and 5 mm in the case of riser and skirting. The area shall be calculated in square meter, correct to two places of decimal. Length and height shall be measured along the finished face of the skirting or dado including curves where specials such as coves, internal and external angles and beads are used.Where cornices are used the area of dado shall be measured excluding the cornices. Nothing extra will be paid for cutting (sawn) the tiles to sizes. Areas where coloured tiles or different types of decorative tiles are used will be measured separately to be paid extra over and above the normal rate for white tiles.

Rates

The rate shall include the cost of all material and labour involved in all the operations described above,for tiles of sizes upto 0.14 sqm. Unless otherwise specified in the description of the item. The specials such as coves, internal and external angles and beading shall be measured and paid for separately. The rate shall not include cost of cornices which shall be measured and paid for in running meters separately.

GRANITE STONE FLOORING

Granite Stone

It shall be of any colour and size as directed by PMC Engineer/Engineer's Representative. Granite shall be plain machine cut and mirror polished. The stone shall be smooth and of even surface without holes or pits.

Dressing of Slabs

Every stone shall be cut to the required size and shape, fine chisel dressed on all sides to the full depth so that a straight edge laid along the side of the stone shall be fully in contact with it. The top surface shall also be fine chisel dressed to remove all waviness. In case machine cut slabs are used, fine chisel dressing of machine cut surface need not be done provided a straight edge laid any where along the machine cut surfaces is in contact with every point on it. The sides and top surface of slabs shall be machined rubbed or table rubbed with coarse sand before paving. All angles and edges of the granite slabs shall be true, square and free from chippings and the surface shall be true and plane.The thickness of the slabs shall be 18, 30 or 40 mm as specified in the description of the item. Tolerance of + 3% shall be allowed for the thickness. In respect of length and breadth of slabs a tolerance of ± 2% shall be allowed.

Laying

Base concrete or the RCC slab on which the slabs are to be laid shall be cleaned, wetted and, mopped. The bedding for the slabs shall be with cement mortar 1:3 (1 cement: 3 coarse sand) or as given in the description of the item.

The average thickness of the bedding mortar under the slab shall be 20 mm and the thickness at any place under the slab shall be not less than 12 mm.

The slabs shall be laid in the following manner:

Mortar of the specified mix shall be spread under the area of each slab, roughly to the average thickness specified in the item. The slab shall be washed clean before laying, it shall be laid on top, pressed, tapped with wooden mallet and brought to level with the adjoining slabs. It shall be lifted and laid aside. The top surface of the mortar shall then be corrected by adding fresh mortar at hollows. The mortar is allowed to harden a bit and cement slurry of honey like consistency shall be spread over the same at the rate of 4.4 kg of cement per sqm. The edges of the slab already paved shall be buttered with grey or white cement with or without admixture of pigment to match the shade of the granite slabs as given in the description of the item. The slab to be paved shall then be lowered gently back in position and tapped with wooden mallet till it is properly bedded in level with and close to the adjoining slabs with as fine a joint as possible. Subsequent slabs shall be laid in the same manner. After each slab has been laid, surplus cement on the surface of the slabs shall be cleaned off. The flooring shall be cured for a minimum period of seven days. The surface of the flooring as laid shall be true to levels, and, slopes as instructed by the PMC Engineer/Engineer's Representative. Joint thickness shall not be more than 1 mm. Due care shall be taken to match the grains of slabs which shall be selected judiciously having uniform pattern of Veins/streaks or as directed by the PMC Engineer/Engineer's Representative. The slabs shall be matched as shown in drawings or as instructed by the PMC Engineer/Engineer's Representative. Slabs which are fixed in the floor adjoining the wall shall enter not less than 12 mm under the plaster skirting or dado. The junction between wall plaster and floor shall be finished neatly and without waviness. Granite slabs flooring shall also be laid in combination with other stones and/or in simple regular pattern/design as described in item of work and/or drawing.

6. POLISHING AND FINISHING

The day after the tiles are laid all joints shall be cleaned of the grey cement grout with a wire brush or trowel to a depth of 5 mm and all dust and loose mortar removed and cleaned. Joints shall then be grouted with grey or white cement mixed with or without pigment to match the shape of the topping of the wearing layer of the tiles. The same cement slurry shall be applied to the entire surface of the tiles in a thin coat with a view to protect the surface from abrasive damage and fill the pin holes that may exist on the surface. The floor shall then be kept wet for a minimum period of 7 days. The surface shall thereafter be grounded evenly with machine fitted with coarse grade grit block (No. 60) . Water shall be used profusely during grinding. After grinding the surface shall be thoroughly washed to remove all grinding mud, cleaned and mopped. It shall then be covered with a thin coat of grey or white cement, mixed with or without pigment to match the colour of the topping of the wearing surface in order to fill any pin hole that appear. The surface shall be again cured. The second grinding shall then be carried out with machine fitted with fine grade grit block (No. 120). The final grinding with machine fitted with the finest grade grit blocks (No. 320) shall be carried out the day after the second grinding described in the preceding para or before handing over the floor, as ordered by the Engineer-in-Charge.For small areas or where circumstances so require, hand grinding/polishing with hand grinder may be permitted in lieu of machine polishing after laying. For hand polishing the following carborundum stones, shall be used:

1st grinding — coarse grade stone (No. 60)

Second grinding — medium grade (No. 80)

Final grinding — fine grade (No. 120)

In all other respects, the process shall be similar as for machine polishing.

After the final polish, oxalic acid shall be dusted over the surface at the rate of 33 gm per square metre sprinkled with water and rubbed hard with a ‘namdah’ block (pad of woollen rags) .The following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.If any tile is disturbed or damaged, it shall be refitted or replaced, properly jointed and polished. The finished floor shall not sound hollow when tapped with a wooden mallet. The specifications shall be as described in above except that (a) first polishing with coarse grade carborundum stone shall not be done, (b) cement slurry with or without pigment shall not be applied on the surface before polishing.

Measurements

Length shall be measured along the finished face of riser or skirting, correct to a cm. Height shall be measured from the finished level of tread or floor, to the top (the underside of tread, in the case of steps) correct to 0.5 cm. The areas shall be calculated in square metre correct to two places of decimal. Dado and lining of pillars etc. shall be measured as ‘Marble work in wall lining. If the thickness is upto 25 mm or as “Marble Work” in Jambs, walls, columns and other plain work’ if the thickness is more.

Rates

The rate shall include the cost of all materials and labour involved in all the operations described above.

Miscellaneous Items

Gypsum Partition Panels

The material shall conform to IS:2849, having minimum compressive strength of 9.3 kg/cm.

Laying

i Panels are stored in a dry place and water should not come in contact with panels during or after construction. If the panels get wet, they should be dried before use.

ii The floor should be perfectly level before laying the first course. All panels must be properly aligned to the plumb. Successive layer of panels must be alternatively staggered so that vertical joints are not in the same line.

iii The recommended quantity of Gypsum Bonding Plaster must be used for joints and filling the grooves made for conduits, pipelines, etc. Excess Bonding Plaster must be scooped and removed, so that the joints and the places where the grooves are filled in are flush and even.

iv The walls should be dry and sanding done properly especially at joints before the primer is applied so that the surface is even and joints will not be visible after painting. Avoid chasing with chisel and hammer. Use electrical saw or grooving tools for conduiting etc.

v The recommended span of walls is maximum 6 meters and maximum height is 4.5 meters.

vi Gypsum panel can easily be cut with coarse tooth hand saw, electric jigsaw, etc. The panels can be cut, sawn, drilled, milled or dowelled on the job. For concealed piping and conduit, the depth of groove should not exceed 50 mm. Hammer and chisel techniques to form chases must be avoided.

vii Sanding: This application is to make the surface level without undulations. To make the gypsum wall surface level (in particular at joints, where there is excess bonding plaster), do sanding with sand paper at joints and other places, wherever you find uneven surface, otherwise joints will be visible after painting. It is important to sand all joints uniformly.

viii Primer Application: The purpose of the primer is to give a better adhesion to the paint and also to reduce consumption of paint on the wall. Water thinable primers shall be used only.

Measurements

The length and height shall be measured correct to a cm. Area shall be calculated in square meters correct to two place of decimal. No deduction shall be made for ducts, opening made from the standard size of panel.

Rate

The rate shall include the cost of materials and labour involved in all the operations described above.

Aluminium Composite Panel

Providing and fixing of Aluminium Composite Panel (ACP) 4 sided having 50 x 25 x 1.50mm frame work vertical and horizontals out of specially designed extruded sections withstand wind pressure of 180 Kg/sq.m and fabricated fixed at all level elevation and heights. The extruded section cutting and fixing required space extruded section shall be of 6063 and alloy of BSH 9 confirming T is – 63400 rate shall included to fix the main frame with necessary clamps, fasteners, bolt nuts etc. The main frame of extruded section shall be of 22843 & 22739 (H9) grade conforming to BS 4174 (or) IS 8147. Rate shall included 4mm thick ACP sheet (0.25 + 3.5 + 0.25) alstrong or equivalent fixing with spacer tape and the ACP sheet bounded with special type structural sealant of dow corning 789 or equivalent in dust free conditions the gaps between ACP sheet to be filed with whether sealant and backer rod or 12mm foam sheet to ensure water and air tightness in all complete complying with standard specification as directed by the departmental officer.

DRY STONE CLADDING (Khondolite Stone Cladding)

Material

Stone shall be of the type as specified in the item. It shall be hard, sound durable and tough free from cracks, decay and weathering and defects like cavities cracks, flaws, holes, veins, patches of soft or loose materials etc. Thickness of stone shall be as specified

Stone shall be cut with the gang saw to the required size and shape on all beds and joints so as to free from any waviness and to give truly vertical horizontal surface as required. The exposed face and sides of stones forming joints shall be such that the straight edge laid along the face of the stone is in contact with every point on it. All the visible angle and edges shall be square and free from chipping. The dressed stone shall be of the thickness specified with permissible tolerance of + 2 mm.

Before starting the work, the contractor shall get the samples of stone approved by Engineer-Incharge. Approved sample shall be kept in custody of Engineer-in-Charge and stones supplied and used on the work shall conform to sample with regard to soundness, colour, veining and general texture. The stone shall be cut by gang saw into slabs of required thickness along the places parallel to the natural bed. When necessary double scaffolding for fixing the stone at greater heights, jib crane or other mechanical appliances shall be used to hoist the heavy pieces of stone and placed them into correct positions. Care shall have to be taken that corners of the stone are not damaged. Stone shall be covered with gunny bags before tying chain or rope is passed over and it shall be handled carefully. No pieces which has been damaged shall be used that work

Stacking and Storing

Stone slabs are thin and brittle and should never be stacked flat across timber supports. They

should therefore, be stacked on edge on timber or like runners. Packing pieces inserted between the slabs may be rope or timb

Scaffolding

Double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

Fixing

The size & shape of the cramps shall be as per drawing and as per directions of Engineer-in-

charge. The samples of steel cramps should be approved in advance before starting the stone cladding work. The cramp shall be attached to top and bottom of the stone. The cramps shall have inbuilt adjustment for vertical and horizontal alignment. The cramps used to hold support and transfer the load of stone unit to the supporting structured steel shall be designed by the manufacturer and approval of the same shall be obtained from the Engineer-in-Charge.

The minimum number of clamps required shall be as per requirement of design to carry the load of individual stone slabs. The cramps shall be spaced not more than 60 cm horizontally and vertically along the stone side for insertion of pins / bolt attached with the steel cramps. Adequate cutting in stone shall be made with precision instrument to hold the cramps pins at the joints.

Stone shall be secured with clamps with high quality workmanship. The walls shall be carried up truly plumb. All the courses shall be laid truly horizontal and all the vertical joints truly vertical. The sequence of execution for cladding work shall be approved by the Engineer-in-Charge.

Jointing: Joints horizontal and vertical shall be filled with weather sealant of make as approved by Engineer -in-charge with the help of pouring gun for filling the sealant. Before filling the joint with sealant, masking tape are required to be fixed on stones surface on both edges of joints of the stones, so that sealant may not spoil the surface of the stone. When all the joints are filled and sealant has dried, the masking tape may be removed.

Protection: Work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage and rain during construction.

Measurement: The length and breadth shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. Any opening of area 0.01 sqm. or less shall not be deducted.

Rate: The rate includes the cost of materials and labour involved in all operations described above including cost of support scaffolding staging, sealant, pouring guns but excluding the cost of steel cramps drilling holes / making recesses in stones which shall be paid for separately.

STRUCTURAL STEEL FRAME WORK FOR DRY STONE CLADDING

Specification for structural frame work for dry stone cladding are same specifications as for steel work in built up sections (welded or bolted).

Fixing of Frame

The properly designed structural frame for withstanding the weight of stone slab are fixed/

supported on wall surface with the help of M.S. brackets/lugs of angle iron/flat etc. which is welded at each junctions of member of frame and also embedded in cement concrete block 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) of size 300 x 230 x 300 mm. The concrete block can be made by cutting the hole of size as mentioned in brick wall and filling the hole with cement concrete including provision of necessary centring/shuttering for holding of concrete. The frame can also be supported on RCC surface with the help of approved expansion hold fastener by drilling the holes in RCC surface.

Steel cramps are either welded or bolted to the frame (by making necessary holes in frame work) for holding of stone.

Measurement

The mode of measurement shall be the same, as specified for steel work in built up section

except that the weight of welding material shall not be added in weight of members for payment and nothing extra shall be paid for making holes for temporary fastening of members during erection before welding, which also includes cost of cement concrete block, centring and shuttering and making holes in walls, but excluding the cost of expansion fastener, steel clamps which shall be paid for separately.

Rate

The rate shall include the cost of all labour and material involved in all the operation described

above.

ADJUSTABLE STAINLESS STEEL CRAMPS

The cramps shall be stainless steel of make approved by the Engineer-in-charge.

The weight of the stainless steel clamp (including weight of nut and washer) shall not be less than 260 gms.

Necessary holes at suitable locations are to be done on steel frame work for dry stone cladding to be fixed.

Necessary recessed are required to be done in stone slab which is required to be supported by clamps.

The one end of steel clamp is fixed on frame with nut and bolt and other end is inserted into recesses/hole for fixing the dry cladding stone on frame.

The rate includes cost of materials and other operations mentioned as above.

FIBRE REINFORCED ELASTOMERIC LIQUID WATER PROOFING MEMBRANE WITH RESILIENT ACRYLIC POLYMERS

Material

Fibre reinforced elastomeric liquid water proofing membrane is a ready-to-use waterproofing, white product, with high solar reflectance and Sun Reflectivity Index (SRI) of 105, for external applications. This is made from resilient acrylic polymers and synthetic resins in water dispersion, and when dry forms a continuous, flexible waterproofing membrane. This is resistant to all atmospheric conditions and UV rays, and guarantees long-lasting protection for the substrate.

Technical Specification/ Parameters:

1. Fibre reinforced elastomeric liquid water proofing membrane with fibers in water emulsion with high

   reflectance and emissivity with a solar reflectance index SRI of 105 should comply with the requirements of EN 1504-9 (“Products and systems for protecting and repairing concrete structures: definitions, requirements, quality control and conformity assessment. General principles for the use of products and systems”) EN 1504-2 coating (C) principles PI, MC and IR (“Concrete surface protection systems”).

2. This should posses a paste like consistency having highly reflective white colour.

3. This should have density of 1.35 with dry solid content of 61.4%.

4. This should have minimum tensile strength of 1.0N/mm² as per ISO 37 or ASTM D-412.
5. This should confirm to results after testing as per EN1062-11 for exposure to artificial weather conditions.
6. The Sun Reflectivity Index when tested as per ASTM E1980 should be 105 minimum.
7. Elongation at break (% age) of 150 % minimum as per ASTM D-412.
8. Adhesion strength is more than 1.0 N/mm2 as per ASTM D-4541.

Applications

It is to be applied using a long-haired roller, brush or spray on any horizontal, sloping or vertical surfaces

to form a string, flexible, tack-free dry surface, suitable for occasional light foot traffic. This can with stand normal expansion and contraction stresses caused by temperature variations due to its flexibility. This also helps lower the working temperature of roofs and guarantees good energy performance properties of all the layers of the roof.

Preparation of Surface

All the substrates, whether they are new or old, must be sound, clean, dry and free of all traces of oil,

grease, old paint, rust, mould and nay other material which could compromise the bond. Application temperature may be from 70C to 400C.

Concrete and in general mineral substrates must be sound and dry with no rising damp. Any loose parts must be removed with wire brushes. All wax, water-repellent treatments, etc. must be removed from the surface of ceramic substrates with a suitable detergent and/ or by sanding. Any hollows and gaps in the surface must be repaired properly with appropriate material as described and instructed by the manufacturer of this product. The tools to be used must be properly cleaned.

Application Procedure

All the area of operation shall be thoroughly cleaned as described in para above. Mix the content in such a manner that they are perfectly blended into a homogenous state of liquid which can be applied by long haired roller or airless spray. The fibre reinforced elastomeric liquid water proofing membrane with resilient acrylic polymers shall be applied on top of concrete roof in three coats @ 10.76 litre/10 sqm or more as recommended by manufacturer specification. One coat i.e. first coat of self priming elastomeric water proofing liquid. The material shall be diluted with water in the ratio of 3:1 (3 parts of elastomeric water proofing liquid and 1 part of water). Wait until the first coat is completely dry and becomes slightly darker in colour. After the first coat has dried completely apply second coat with undiluted elastomeric water proofing liquid in a cross direction to the previous coat. After the drying of second coat completely apply the final coat of undiluted elastomeric water proofing liquid in a direction perpendicular to previous coat. The overall dry film thickness should not be less than 500 microns or more as specified in manufacturer specification. Protect the membrane from rain unless it is completely dry. The overall consumption of the material should be as per nomenclature of the item and should also adhere to the specifications detailed in the approved schedule of the manufacturer.

Measurement

The length and breadth/ height shall be measured in running metre correct to two places of decimal and the area of applications should be measured in sqm correct to two places of decimal.

Rate

The rate shall be include the cost of all the labour and material involved in all the operations described above.

7. ALUMINIUM DOORS/WINDOWS/VENTILATORS AND PARTITION FRAMES

Framework

First of all the shop drawings for each type of doors/windows/ventilators etc. shall be prepared by using suitable sections based on architectural drawings, adequate to meet the requirement/specifications and by taking into consideration varying profiles of aluminium sections being extruded by approved manufacturers. The shop drawings shall show full size sections of glazed doors, windows, ventilators etc. The shop drawings shall also show the details of fittings and joints. Before start of the work, all the shop drawings shall be got approved from the PMC Engineer/Engineer's Representative. Actual measurement of openings left at site for different type of door/window etc. shall be taken. The fabrication of the individual door/windows/ventilators etc. shall be done as per the actual sizes of the opening left at site. The frames shall be truly rectangular and flat with regular shape corners fabricated to true right angles. The frames shall be fabricated out of section which have been cut to length, mitered and jointed mechanically using appropriate machines. Mitered joints shall be corner crimped or fixed with self-tapping stainless steel screws using extruded aluminium cleats of required length and profile. All aluminium work shall provide for replacing damaged/broken glass panes without having to remove or damage any member of exterior finishing material.

Fixing of Frames

The holes in concrete/masonry/wood/any other members for fixing anchor bolts/fasteners/screws shall be drilled with an appropriate electric drill. Windows/doors/ventilators etc. shall be placed in correct final position in the opening and fixed to Sal wood backing using stainless steel screws of star headed, counter sunk and matching size groove. of required size at spacing not more than 250 mm c/c or dash fastener. All joints shall be sealed with approved silicone sealants.In the case of composite windows and doors, the different units are to be assembled first. The assembled composite units shall be checked for line, level and plumb before final fixing is done. PMC Engineer/Engineer's Representative in his sole discretion may allow the units to be assembled in their final location if the situation so warrants. Snap beadings and EPDM gasket shall be fixed as per the detail shown in the shop drawings. Where aluminium comes into contact with stone masonry, brick work, concrete, plaster or dissimilar metal, it shall be coated with an approved insulation lacquer, paint or plastic tape to ensure that electrochemical corrosion is avoided. Insulation material shall be trimmed off to a clean flush line on completion. The CONTRACTOR shall be responsible for the doors, windows etc. being set straight, plumb, level and for their satisfactory operation after fixing is complete.

Measurements

All the aluminium sections including snap beadings fixed in place shall be measured in running meter along the outer periphery of composite section correct to a millimeter. The weight calculated on the basis of actual average (average of five samples) weight of composite section in kilogram correct to the second place of decimal shall be taken for payment (weight shall be taken after anodizing). The weight of cleat shall be added for payment. Neither any deduction nor anything extra shall be paid for skew cuts.

RATE

The rate shall include the cost of all the materials, labour involved in all the operations as described in nomenclature of item and particular specification.

ALUMINIUM GLAZED DOORS/WINDOWS/VENTILATORS

General

Aluminium glazed doors/windows/ventilators shall be of specified sectional size, dimension and profile as per CONTRACTOR's drawing.

Materials

All Aluminium sections shall be extruded sections of INDAL aluminium alloy as per IS:733 and 18:1285. Aluminium sections shall be anodised as per IS : 7088 to min. 25 microns. Glass used for glazing shall be of following type in accordance with item description.

Workmanship

Frames shall be square and flat; the comer of the frame being fabricated to true right angles. Details of construction of frames. Shutters etc. shall be as per drawings.

Side hung window shutters shall either be fixed to the frame with pivots, or aluminium alloy hinges. For fixing the hinges, slots shall be cut in the fixed frames and the hinges inserted inside may be riveted to the frame. The hinges shall normally be of the projecting type conforming to IS designation A-5-M of IS 617, IS 733. In which case Peg stay of 300 mm long complete with Locking bracket and conforming to IS codes same as for hinges shall be provided. Friction hinges may also be provided in which case peg stays are not required.

The handles for side hung shutters shall be of cast aluminium conforming to IS designation A-5-M of IS 617 and shall be mounted on a handle plate rivetted to the opening frames. The handle shall have anodised finish with minimum anodic film thickness of 25 micron or electro colour finish. The handle shall have a two-point nose which shall engage with an aluminium striking plate on the fixed frame. The striking plate shall be finished in the same manner as for the handle.

In case of top hung shutters, aluminium alloy cast hinges and peg stays (same as per side hung shutters) shall be provided.

Centre hung shutters shall be hung on the two pairs of cup pivots of aluminium alloy of IS designation NS-4 of IS 737 and IS designation A-5-M of IS 617 or chromium/cadmium plated brass/bronze cup pivots riveted to the outer and inner frames to permit to swing through an angle of 85°. Cast aluminium (conforming to IS designation A-5-M of IS 617) or chromium/cadmium plated bronze spring catches shall be fitted in the centre of the top bar of the shutter. The spring catch shall be secured to the frame by screwing/riveting to the frame and shall close into an aluminium catch plate riveted/welded to the outside of the outer shutter frame bar. Aluminium or cadmium plated brass chord pulley wheel in an aluminium bracket shall be fitted at the sill of the shutter with Aluminium or galvanized/cadmium plated steel screws.

The door shutters shall be fitted with pivots as specified. The handle for doors shall be of Aluminium and as per design. The door shutters shall be provided with locking device, floor spring. 0/H door closer and any other hardwares, specified in item.

In case of composite Door/window/ventilator units, the units shall be coupled. Weather bar shall be provided whenever a couping member is fitted over an external opening shutter.

Glazing shall be fixed to the extruded sections by means of extruded aluminium beading. Glass panes shall be provided with rubber lining before fixing.

The aluminium frames shall be fixed to the masonry by means of aluminum lugs fixed to the frame (by counter sunk galvanized machine screws) and grouted with M-15 grade concrete in the hole in the masonry. In case of concrete wall, the frames shall be fixed by 96 mm long,12 mm dia metallic dash fasteners. Any steel material coming in contact with aluminium shall be galvanised.

The windows/ventilators/doors shall be checked to ensure smooth operation, perfect level and plumb.

8. WPC WORK

WPC FRAME

Providing and fixing factory made single extruded WPC (Wood Polymer Composite) solid door/window/Clerestory windows & other Frames/ Chowkhat (Frame size 50 x 100 mm)comprising of virgin PVC polymer of K value 58-60 (Suspension Grade), calcium carbonate and natural fibers (wood powder/ rice husk/ wheat husk) and non toxic additives (maximum toxicity index of 12 for 100 gms) fabricated with miter joints after applying PVC solvent cement and screwed with full body threaded star headed SS screws having minimum frame density of 750 kg/cum, screw withdrawal strength of 2200 N (Face) & 1100 N (Edge), minimum compressive strength of 58 N/mm2, modulus of elasticity 900 N/mm2 and resistance to spread of flame of Class A category with property of being termite/borer proof, water/moisture proof and fire retardant and fixed in position with M.S hold fast/lugs/SS dash fasteners of required dia and length complete as per direction of Engineer-In- Charge. (M.S hold fast/lugs or SS dash fasteners shall be paid for separately).

Note: For WPC solid door/window frames, minus 5 mm tolerance in dimensions i.e depth and width of profile shall be acceptable. Variation in profile dimensions on plus side shall be acceptable but no extra payment on this account shall be made.

WPC SHUTTER

Providing and fixing factory made single extruded WPC (Wood Polymer Composite) solid plain flush door shutter of required (size35 mm thick) comprising of virgin polymer of K value 58-60 (Suspension Grade), calcium carbonate and natural fibers (wood powder/ rice husk/wheat husk) and non toxic additives (maximum toxicity index of 12 for 100 gms) having minimum density of 650 kg/cum and screw withdrawal strength of 1800 N (Face) & 900 N (Edge), minimum compressive strength 50 N/mm2, modulus of elasticity 850 N/mm2 and resistance to spread of flame of Class A category with property of being termite/borer proof, water/moisture proof and fire retardant and fixing with stainless steel butt hinges of required size with necessary full body threaded star headed counter sunk S.S screws, all as per direction of Engineer-In- Charge. (Note: stainless steel butt hinges and necessary S.S screws shall be paid separately).

9. 12MM THICK FRAMELESS TOUGHENED GLASS DOOR SHUTTER

Material

This is a clear 12mm toughened safety glass frameless shutter having a consulate top and bottom self-closer mechanism with a pivot connecting to a discrete metal patch fitting at the top and bottom corners to the door.

Application

The 12mm thick clear toughened safety glass frameless shutter is fixed with the help of corner patch

fittings. The corner patch fittings are simply a bolt through glass metal fitting requiring a corner cut out and hole in the glass. These discrete corner patch fittings provide a sleek and clean frameless look. The lock body patch fitting can also be installed where there is a necessity to provide locking arrangements for frameless shutter. The maximum size of frameless doors shutters using corner patch fittings should not exceed from 1000mm X 2400mm. Bigger size doors should not be fixed with these fittings. The figure 21.18.1 shows the fixing of frameless door shutters with top and bottom corner patch fittings.

Installation

The frameless toughened glass door shutters of required thickness as specified in the item

should be installed with the help of 304 grade stainless steel patch fittings of approved brand and manufacturer. These fittings should be complete in all respect with top and bottom pivots and double action hydraulic floor spring types fixing arrangement. These fittings should be based on a modular system, consisting of a base unit, functional inserts, and clip-on covers in a wide range of finishes. The fittings should be suitable to support the weight of the complete glass door in such a way that the movement of the door is smooth and free. The fittings should be got approved from the engineer-incharge and all the fixings etc. shall be done as per manufacturer specification and corresponding codes described in the description of the fitting.

Measurement

The finished final length/ height and width of the glass door should be measured correct to two places of decimal and overall area in sqm correct to two places of decimal should be calculated for payment.

Rate

The rate shall include the cost of all the materials, labours involved in all the operations above and as described in the nomenclature of item and particular specification.

Schedule of Finishes
The below specifications are minimum specifications and only indicative and not exhaustive and shall be correlated with the specific details and architectural, structural and other drawings as approved. The contractor has to plan and execute all the missing fittings, fixtures, items to make premises to the full use and functional. Nothing extra shall be paid on this account. Superior/ stringent specifications shall be followed in case of any ambiguity in specifications given herein, particular specifications, drawings or any other part of this tender document. Also if the Statutory requirements are for higher specifications than specified here; the same to be provided by the Contractor without any additional cost. Decision of the Owner'/PMC in this regard shall be final, binding and not arbitral.

Applicable to interior areas unless otherwise mentioned

S. No.	Area Type	Flooring	Walls	Ceiling	Equipment & fittings
1	Building Areas				
1.1	Reception /Waiting, Entrance Foyer	Minimum 18 MM thick Italian Marble Flooring	Minimum 18 MM thick Italian Marble cladding on in combination with with Low VOC acrylic Emulsion /Texture paint /lacquered glass, feature wall finish	False Ceiling- combination of Moisture resistance Gypsum board/ Acoustic grid tile Ceiling, Wooden Laminated/ veneer Decorative Ceiling/ Coves	All LED lighting fixtures, chandeliers, decorative lighting, Toilet fittings, fixtures complete
1.2	Lift Lobby	Minimum 18 MM thick Italian Marble Flooring	Minimum 18 MM thick Italian Marble cladding in combination with Low VOC acrylic Emulsion /Texture paint /lacquered glass, feature wall finish	False Ceiling- combination of Moisture resistance Gypsum board/ Acoustics grid tile Ceiling/ Decorative ceiling/ Coves	All LED lighting fixtures, decorative ligting

S. No.	Area Type	Flooring	Walls	Ceiling	Equipment & fittings
1.3	Corridors	Minimum 18 MM thick Polished Granite Stone Flooring	Wooden paneling upto minimum 1000 MM height finished with minimum 4 MM thick imported veneer and PU polish. Low VOC acrylic Emulsion /Texture paint on walls	False Ceiling- combination of Moisture resistance Gypsum board/ Acoustics grid tile Ceiling	All LED lighting fixtures
1.4	Staircases	Minimum 18 MM thick Granite Stone Flooring (single stone for Risers and treads) with 150 mm high skirting; Antiskid minimum 2 grooves to be provided on treads, nosing	Low VOC acrylic Emulsion /Texture paint	Low VOC Oil bound distemper	All LED lighting fixtures
1.5	Common Toilets/ Wash- room	600X600 MM Anti-skid double charged vitrified tile flooring minimum 12mm thick	600X600 MM double charged Vitrified tiles Tiles cladding upto bottom of false ceiling all around. Modular cubicle partitions of 2100 MM high with Stainless Steel Hardware system as per the Owner requirement.	Metallic false Ceiling /Low VOC Oil bound distemper	Stainless Steel Accessories, Push Type Low Flow Taps, Full length Mirror, Granite Counter Top, All Chinaware, Exhaust Fans with Louvers as required. All LED lighting fixtures

S. No.	Area Type	Flooring	Walls	Ceiling	Equipment & fittings
1.6	Common Kitchen / Pantry	600X600 MM Anti-skid double charged vitrified tile flooring minimum 12mm thick	00X600 MM double charged Vitrified tiles cladding upto 2100 MM height all around. Low VOC Oil bound distemper above upto ceiling.	Low VOC Oil bound distemper	SS double sink over granite counter top with mixer & SS accessories. Provision of Hot water, Exhaust fan with louvers. All LED lighting fixtures
1.7	Store/Service Areas/ Electrical Room	Minimum 30 MM thick Kota Stone Flooring with skirting 100 mm high/ Access floors as required	Low VOC Oil Bound Distemper	Low VOC Oil Bound Distemper	Exhaust Fans with Louvers as required. All LED lighting fixtures
1.8	Toilet Doors	Minimum 40 mm thick wooden Flush door with minimum 1.0 mm thick laminated finish, minimum 125X75 MM wooden chawkhat and Stainless Steel accessories, door closers, stoppers, handles, locks etc			
1.9	Railing	1000 MM high Stainless Steel glass railing of Grade 304/316, 10 MM thick toughened glass with SS Balusters & Accessories as per approved drawings and finishing.			
1.10	Entry Steps & Platform	Minimum 18 MM thick Granite Stone Flooring (single stone for Risers and treads) with 150 mm high skirting; Antiskid minimum 2 grooves to be provided on treads, nosing			
1.11	Ramps at entrance for DAP	Minimum 18 MM thick-flamed granite finish with stainless steel railings and handrails on both sides arranged in anti-skid strips.			

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DOCUMENT:
ARCHITECTURAL - INTERIOR
TECHNICAL SPECIFICATION

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1. General

All materials shall conform to the latest edition of the Indian Standard Specifications. Standards issued elsewhere may be used only if approved by the Owner/PMC and for those materials only for which appropriate Indian Standards do not exist.

If specification for any material/work is not available in these Technical Specifications, the material/work shall conform to the latest CPWD Specifications, with up to date correction slips, amendments and additions. The work shall be carried out in general as per the latest Central Public Works Department (CPWD) specifications with up to date correction slips, amendments and additions/IS CODES/Manufacturers specifications/as per drawings/as per instructions of Owner/PMC/Employer.

CPWD BOQ items should be complied with its CPWD specification. Deviating that should be brought into notice of owner, PMC, Architect, consultant for approval before executing.

All items should comply IGBC Gold rating to attain maximum points. Irrespective of that should be considered as out of scope work would not considered as certified item.

2. Scope

This specification applies to the Civil, Finishing of Buildings and scope under External Area Development Works to be executed by the Contractor. It is to be read in conjunction with and subject to the general conditions of contract and in conjunction with the drawings, and such other documents as may from time to time be agreed upon as comprising part of this contract. Where these specifications are not clear, relevant codes and specifications shall be followed with prior permission of Owner/PMC.

The Project is to conform to green building and targeted for LEED Gold rating all the methods of construction and measures adopted during construction and materials and specifications have to be in accordance of the LEED Gold rating requirements. Any make / material specified but not conforming to LEED Goldrating shall be replaced under approval of Consultant / Owner/PMC and nothing extra shall be payable to the Contractor in this regard.

1. Clearing

   The contractor shall clear the site of all rubbish and temporary structures, remove all grass and low vegetation and remove all bush wood, trees, stumps of trees, and other vegetation only after consultation with the Owner/PMC as to which bushes and trees shall be saved. All disused foundations, drains or other obstructions met with during excavation shall be dug out and cleared

2. Site Levels

   The contractor shall carry out the survey of the site and shall establish sufficient number of grids and level marks to the satisfaction of the Owner/PMC, who shall decide on the basis of this information, the general level of the plot and the plinth.

3. Bench-Marks

   The contractor shall inspect the site, If desired so, prior to commencement of construction, the contractor shall in consultation with the Owner/PMC, establish additional site datum bench-marks, upto his satisfaction. Nothing extra for any of the above shall be paid to the Contractor and the rates quoted by Contractor will deemed to have included the above costs.

4. Site Investigation

   The contractor has to carry out the “Geo Technical Investigation” for completeness and adequacy for the design works. The contractor shall perform the investigations on his own as per the design requirements at no extra cost payable and shall carry out geotechnical investigation with bore hole drilled upto 30m or such a depth as given in IS 1893 Part 1. Also the same shall be vetted by specialist Geo Consultants and any additional investigations required for the same shall be done by the Contractor at no additional cost to the Employer.

5. Setting out the Work

   The contractor shall set out the works and during the progress of the building shall amend at his own cost any errors arising from inaccurate setting out.

   During the execution of the work contractor must cross check his work with the drawings. The contractor shall be responsible for all the errors in this connection and shall have to rectify all

defects and/or errors at his own cost, failing which the Owner/PMC reserves the right to get the same rectified at the risk and cost of the contractor.

6. Cleaning Up and Handing Over

Upon completion of the work all the areas should be cleaned. All floors, doors, windows, surface, etc. shall be cleaned down in a manner which will render the work acceptable to the Owner/PMC. All rubbish due to any reason, shall be removed daily from the site and an area of up to ten metres on the outer boundaries of the premises will be cleaned by the contractor as a part of the contract.

7. Samples

The contractor shall submit to the Owner/PMC samples of all materials for approval and no work shall commence before such samples are duly approved. Samples of, masonry units, building insulation, finished hardware, metal window, door frames and shutters, flooring tiles, stone, marble, granite, all finishing materials, glass, concrete pavers, paver tiles, etc. and every other work requiring samples in the opinion of the Consultant/ Owner/PMC shall be supplied to the Owner/PMC, and these samples will be retained as standards of materials and workmanship. The cost of the samples shall be borne by the contractor.

Throughout this specification, types of material may be specified by manufacturers' name in order to establish standard of quality, price and performance and not for the purpose of limiting competition. Unless specifically stated otherwise, the tenderers may assume the price of 'approved equivalent' except that the burden is upon the contractor to prove such equality, in writing.

A detailed programme shall be submitted by the Contractor for the material approvals, within stipulated timeframe finalised by Owner/PMC. The same shall be reviewed and approved by Consultant / Owner/PMC. The detailed programme shall include but not limited to:

i) Date/s of submitting the various material samples.

ii) Date/s by which the Owner/PMC approval is required.

iii) Date/s of placing orders on the Manufacturers/Suppliers.

iv) Date/s of arrival of the approved material/s on to the site.

v) Date/s of the completion of the `Mock-ups', wherever required, and the Date/s by which the Consultant /Owner/PMC/ Employers inspection of such `Mock-ups' should be completed and the Date/s by which the Owner/PMC should fully approve the said Mock ups.

vi) All the above shall be linked with the project master construction program and procurement schedule.

8. Tests

A Quality Assurance Plan(QAP) shall be finalise by Owner/PMC/ Employer & Contractor before start of the work. QAP shall be based upon IS codes/CPWD specification/BS/ Section 7-Volume -II of the Tender document and good engineering practice to decide various material for testing/ method of testing and their frequency and various format for quality control to be adopted. Once QAP is finalise, all the materials need to be tested accordingly and if results are not as per the desired result than such materials shall be rejected. All the test shall be done at govt approved testing facilities and cost shall be borne by contractor. The testing facilities shall be approved by Consultant / Owner/PMC before any sample is being sent for testing.

9. Making Good

The contractor shall cut, leave or form holes, recesses, chases etc., in concrete, MASONRY work, walls, ceilings, floors and in any other situations as required or as directed by the Owner/PMC and make good in cement and sand mortar (1:3)/PCC (1:2:4) as decided by Owner/PMC and finish to match the adjoining surfaces. No extra payment shall be admissible in this regard.

3. Drip Course

Drip course in PCC cills/ Projections etc. shall be provided at all places irrespective of as shown in drawings.

4. Plinth Protection

The width of plinth protection shall be as shown on drawings. If width is not shown, it shall be 900/1000mm. Plinth protection shall be 75mm thick in cement concrete (1:3:6) over 75 mm thick hard core of 40 mm graded stone aggregate and well compacted over rammed earth and shall be finished with granite. Plinth protection shall be laid to a slope of 1 in 24. The toe of plinth protection of size 75 mm deep and 75 mm wide shall also be of PCC 1:3:6 type C2 and shall be provided in building irrespective of whether shown on drawings or not. Plinth protection shall be provided to all buildings irrespective of whether shown on drawings or not.

5. Damp Proof Course

Damp proof course with 40 mm thick pcc (1:2:4) shall be provided on all masonry walls and masonry pillars for their full length and width at the ground floor where there is no basement underneath and at the basement floor. Damp proof course shall also be provided under openings/door opening at depressed level including vertical faces of depressed level and including vertical faces of depressed portion of opening as per requirement of IS codes. However damp proof course shall not be provided over dwarf walls / rcc columns.

6. Splash Stone

It shall be provided for each stack of rain water pipes and shall consist of 75mm thick PCC M20 nominal mix using 20mm aggregate over 75mm thick well compacted hard core all as specified and shown on drawings. The top surface shall be prepared even and smooth using extra cement.

7. Mirror Finish Granite Stone Over PCC Sill

PCC sill (1:2:4) shall be provided at places where shown on drawings all as per typical details given in drawings. However, irrespective of being indicated on drawings or not, the top of window sills inside portion shall be provided with 18 mm thick polished Granite stone slab with mirror finish in one piece. Granite stone slab shall be provided over 20 mm thick screed of cm (1:6). Top of Granite stone sills shall be flush with external portion of P.C.C. sills and shall finished half round as shown in the drawing.

8. PCC Coping

PCC coping (1:2:4), 50 mm thick, using 20 mm graded stone aggregate shall be provided on all walls / column tops.

9. Plinth Band/Beam

RCC band/beam as specified/ shown on structural drawings shall be provided at plinth level throughout including doors and other openings and in locations shown on drawings. The concrete mix shall be mixed with the integral water proofing admixture of make as specified in respective appendix attached to these specifications in the proportion as recommended by the manufacturer with a coat of bitumen grade 85/25 conforming to IS codes @ 1.5 Kg per Sqm on top. Thickness and reinforcement of plinth band shall be as shown on drawings. Where these have not been shown on drawings thickness shall be 80mm and longitudinal bars shall be 2 Nos of 12 mm TMT bars and links shall be 8mm bars @ 150mm C/C.

10. Expansion Joints

Horizontal & Vertical

Following procedure shall be followed to treating the expansion joints of roof and walls.

The expansion joints shall be thoroughly cleaned including chipping of existing mortar, thermocol / shalitex board etc. up to a depth of 200 mm. The expansion joint shall be treated up to a depth of 200 mm filled with polysulphide sealant (gun grade) with polystyrene board (thermocol sheet) of 50 mm thick and width of expansion joint as a backing material. Polysulphide sealant (gun grade) Shaliseal PS GG of STP ltd shall be applied over the thermocol sheet to have a watertight surface.

Place 1 mm thick aluminium sheet over the expansion joint with minimum 75 mm on either side of the expansion joint.

One side of the aluminium sheet shall be screwed to the concrete surface and the other side of the aluminium sheet shall be free to move.

One layer of EPDM membrane shall be fixed on the surface of the aluminium sheet and concrete with minimum 75 mm width of sheet glued to the concrete surface.

A compressible tube (Polyurethane rod) of diameter equal to the width of the expansion joint shall be placed in position. The PU rod is placed to allow for excess length of the membrane across the expansion joint. The expansion joint is then covered with second layer of EPDM membrane / Tarfelt APP membrane of approved make over the PU rod with minimum 75 mm width of sheet glued to the concrete surface. Enough extra length of membrane is ensured to accommodate building movement. ·Necessary Waterproofing shall be carried out over this treatment. 25 mm thick cement mortar screed shall be provided over the EPDM membrane / Tarfelt APP membrane of approved make. To prevent shrinkage cracks in mortar, polyester fibers shall be added in the cement mortar screed with a dosage of 0.25 % of weight of cement used. A geo textile polyester membrane (200 gsm) shall be provided between EPDM membrane / Tarfelt APP membrane of approved make and cement mortar screed for the protection of water proofing membrane.

The top of the finished surface shall match with the top surface of the slab for easy movement of rainwater / movement of vehicles.

11. Road Works

Cement Concrete Pavement Under Controlled Conditions

Materials- Cement

(a) Cement used on work shall be as per sub head cement concrete of CPWD specifications- 2019 (Vol. – I).

(b) Water: Water used on work shall conform to SH: cement concrete of CPWD, Specification 2019- Vol. I.

(c) Coarse Aggregate: These shall be crushed or broken from hard stones obtained from approved quarry. These shall be clean strong, durable of fairly cubical shape and free from soft, friable, thin elongated and laminated disintegrated pieces. These shall also be free from dirt, organic deleterious and any other foreign matter and adherent coatings and shall satisfy the physical requirements laid down in para 16.37.19 under quality control conforming to CPWD Specification 2019 Vol. II

This shall be coarse sand conforming to CPWD Specification 2019 Vol. I.

(d) Grading of Mixed Aggregates: The grading of all aggregates (coarse and fine aggregates) to be used in the work shall be determined in the laboratory. The coarse and fine aggregates shall be mixed in suitable proportions so that the grading of the mixed aggregates shall be in the range indicated in Table below.

Table 16.32

I.S. Sieve Size (IS 460) % age passing by weight

45 mm 100

22.4 mm 55 - 60

11.2 mm 45 - 50

5.6 mm 35 - 40

2.8 mm 30 - 35

1.4 mm 20 – 25

710 microns 15 - 20

355 microns 10 - 14

180 microns 2 - 5

Mix Design

The mix shall be approved by Engineer-in- Charge so as to obtain the following mean strength that exceeds the minimum specified flexural strength by 1.64 times the designed standard deviation.

Minimum works beam flexural strength at 28 days = 300 kg/sqm. for M-30 or specified in item

Designed standard deviation = 60 kg/sqm. for M-30 or for specified grade(s)

Design flexural strength at 28 days = 300+60x1.64

Water cement ratio by weight = 398.4 kg/sqm. (f + 1.64 s) says 400 kg.

Water cement ratio by weight = 0.5

Minimum slump not more than 25 mm

For the purpose of tendering the contractor shall base his rate on the assumption that the quantity of cement used for one cum. of finished concrete shall be 340 kg. or M - 30. If the actual quantity of cement required to be used as a result of the laboratory test is different from that assumed above, necessary adjustment in the cost due to short cement used shall be made on the basis of issue rate of cement including storage charges plus 2.5% for handling charges. However, under no circumstances the quantity of cement to be used shall either exceed 350 kg./cum or fall below 330 kg. per cum of finished concrete.

Statistical Field Check

Samples of concrete shall be taken at the mixer and works beams, made, cured and tested in accordance with IS 1199 and IS 516.

When a mix is used for the first time, it is important to get a large number of results, as soon as possible, in order to establish the level of control and then suitability of the mix proportions.

A sample of concrete shall be taken at random on eight separate occasions during each of the first five days of using that mix. From each sample two beams shall be made one for test at 7 days and the other for test at 28 days.

The work beam results shall be examined both individually and in consecutive (but not overlapping) sets of four, for which the average and the range of each set is calculated. The mix proportions shall be modified to increase the strength, if in the first ten consecutive (but not overlapping) sets any of the following conditions are not satisfied.

(I) Each sample has test strength not less than the minimum specified strength i.e. 30 kg/sq.cm. (or otherwise specified in item).

OR

(II) (a) Not more than two individual results (Not more than one of first twenty) of the 40 beams tests shall fall below the minimum work beam strength but they shall not be less than

80% of the specified beam strength of 30 kg./sq. cm (or otherwise specified in item) or the minimum specified strength minus 1.35 times the standard deviation whichever is greater.

(b) No value of the range in any set shall exceed 3 times the designed standard deviation.

(c) The average for all samples (10 sets) shall not be less than the minimum specified strength i.e. 30 kg/sq. cm (or otherwise specified in item) plus 1.64 times the designed standard deviation 60 kg./sq.cm M-30.

If either of these conditions as above are not satisfied, the mix shall be modified and the procedure described above shall be repeated till results satisfying the above criterias are obtained.

Slump Test

The test shall be carried out as per IS 1199. A slump test shall be carried out at each mixer at least one in fifty batches mixed or more frequently if directed by the Engineerin-Charge. Any batch from which slump test is being made shall not be transferred to the place of laying till the slump test has been completed. Not only the batch which gives a slumps in excess of that specified shall be rejected but the concrete already laid immediately preceding the batch tested upto the nearest last ransverse joint may be rejected by the Engineer-in-Charge or his subordinate, if he is satisfied that such preceding batches were substandard in this respect. The decision of the Engineer-in-Charge in this respect shall be final and binding on the contractor. Such rejected concrete shall be removed by the contractor immediately and replaced with proper slump concrete at his cost and expense.

Batching and Mixing

As detailed in SH: 5 of reinforced cement concrete work of CPWD specifications 2019.

Placing of Concrete

As detailed in SH: 5 of reinforced cement concrete work of CPWD specifications 2019.

Compaction of Concrete

Compaction shall be carried out by electrically (or) diesel operated needle and screed vibrators as stipulated hereafter. Needle vibrator should be used all over the area for obtaining initial compaction of concrete. These should be of diameter not less than 4.5 cm. If the vibrators are pneumatic the pressure must not be below 4 kg/sq.cm. If electrically operated, they should have a minimum frequency of 3500 impulses per minute.

There should be at least three needle vibrators working in any bay. A vibrating screed consisting of a steel or timber section weighing not less than 15 kg. per metre with a tamping edge of not less than 7 cm width and having a vibrator mounted thereon shall follow needle vibrators to obtain full compaction. The face of the wooden tamping edge of the screed shall be lined with M.S. Plate rigidly fixed by means of counter sunk screw. Where screed vibrators are used for compaction, a standby unit shall always be maintained ready for use, should the other one go out of order. Where electrically driven vibrators are employed, a standby diesel pneumatic unit shall be kept ready for use in case of power failure. At the discretion of the Engineer-in-Charge, for compaction at edges and joints, vibrators may be supplemented by hand tamping and rodding for securing satisfactory results. Under no circumstances, honey combing of concrete at joints or elsewhere shall be permitted.

When using screed vibrator for compaction it should not be dragged over the concrete.

During the initial passes it shall be lifted to the adjacent forward position in short steps, subsequently, it shall be slowly slided over the surface with its axis slightly tilted away from the direction of sliding and the operation repeated until a close, dense surface is obtained.

Concreting shall be carried out in one operation between the expansion joints and construction joints without any break at the dummy joints.

Concrete shall be deposited on the base as near the joints as possible without touching them. It shall then be shoveled against the sides, maintaining equal pressure and deposited approx. 50 mm higher than the depth of the joints, care being taken that it is worked well around the joints.

The concrete shall not be dumped from the bucket directly upon or against the joints.

Workmen shall not be allowed to walk on freshly laid concrete and proper cat walk shall be provided with independent supports beyond concreting bays.

Finishing of Concrete

During compaction, any low or high spots shall be made up by adding or removing concrete.

After longitudinal floating has been completed but while concrete is still plastic, the slab surface shall be tested for trueness with a 3 m straight edge. Any depressions or high spots showing departure from the true surface shall be immediately rectified. High spots shall be cut down and refinished.

Depressions shall be enlarged to about 8-10 cm and filled up with fresh concrete, compacted and finished.

The straight edge testing the refloating is to continue until the entire surface:

a) is free from observable departure from the straight edge,

b) conforms to the required levels and across section, and

c) shall conform to the specified surface when the concrete has hardened.

The foregoing work is to be carried out while the concrete is still plastic and workable.

Brooming

After belting and as soon as the surplus water, if any, has risen to the surface, the pavement shall be given a broom finish with an approved steel or fiber broom not less than 45 cm wide. The broom shall be pulled gently over the surface of the pavement from edge to edge. Adjacent strokes shall be slightly overlapped. Brooming shall be perpendicular to the centre line of the pavementand so executed that the corrugations formed shall be uniform in character and width and not more than 1.5 mm deep.

Brooming shall be completed before the concrete reaches such a stage that the surface is likely to be torn or unduly roughened by the operation. The broomed surface shall be free from porous or rough spots, irregularities, depressions, and small pockets such as may be caused by accidental disturbing of particles of coars.

Surface Accuracy

After the concrete has sufficiently hardened after about 12 hours and not later than 24 hours, the surface shall be tested again for high spots. All high spots shall be marked and those exceeding 3 mm shall be ground down immediately. Care shall be taken to see that the grinding does not in any way damage the concrete surface.

The final surface finish is to be such that when tested with a profilograh /roughness indicator/or a 3 metre long straight edge or an equivalent mechanical unevenness indicator placed anywhere within the same or adjoining slab in any direction on the surface, there shall be no variation greater than 3 mm.

If the surface irregularity exceeding 3 mm still remains despite grinding as per para 16.37.13.2 the concrete shall be removed to its full depth. The area of concrete to be removed shall be complete slab between the nearest joints, where the defective slab is less than 4.5 metres from the expansion joint, the whole area upto the expansion joint shall be removed to the full depth. The concrete so removed shall not be reused in the work. Fresh concrete shall be laid in the manner already de-scribed in above paras and shall again be subject to test for surface accuracy and other quality control measures. Nothing extra shall be paid on this account.

Construction Joints

Construction joints shall be provided as shown in the drawing and also at places where concreting is stopped due to unforeseen circumstances. The joints shall be straight and vertical through the full thickness of the slab. While concrete in adjacent bay is still green, flats of suitable size shall be drawn along the edge and a groove of size 10 mm × 25 mm deep shall be neatly formed and finished. The edges of the groove shall be full nosed. After curing of concrete is complete, this groove shall be thoroughly cleaned of all sand dust and shall be perfectly dried and filled with hot poured sealing compound conforming to grade B of IS 1834. Before filling with sealing compound the faces of concrete of the joint shall be coated with primer of approved brand to a depth of 25 mm at the rate of 2.6 liters per 10 square meters. Bitumen emulsion shall not be used as primer.

Dummy Joints

The joints shall be 10 mm wide and shall extend vertically from the surface of the slab to a depth equal to 1/3rd of the thickness of the slab but not less than 4 cm in any case. The joint may be formed by depressing into the soft but compacted concrete a high tensile M.S. or other approved.

Tee of flat bar of depth not less than required depth of the joint plus 25 mm. The bar used for forming the groove shall be coated with soft soap or other suitable lubricant to facilitate its removal when the steel Tee or flat is removed joints shall be neatly formed with proper tools and mortar/fine material from the slab itself. No additional cement mortar (rich or otherwise) shall be used.

Cutting or sawing by a saw mounted on a movable frame and driven mechanically shall also be permitted as a method for making the joint. In this case the width may be reduced to 6 mm. any other method for making joints can be followed with the prior approval of the Engineer-in-Charge.

In all cases, except where cutting is done with saw, the joint edges shall be bullnosed.

Care should be taken to see that the edges of the grooves are not damaged.

The grooves shall be filled with hot poured sealing compound conforming to Grade B of

IS: 1834. Prior to filling with sealing compound, the joints shall be cleaned by compressed air and primed with Shalijet primer or equivalent at the rate specified in Para 16.37.16.1

All joints shall be sealed as soon as practicable after 28 days of casting of cc pavement.

Joints shall be sealed flush with the adjacent pavement surface in summer and 3-4 mm below finished concrete surface in winter. The pavement shall be opened to traffic only after joint sealing over the entire pavement. To prevent tackiness or pickup under traffic, the exposed surfaces of the sealing compound shall be dusted with hydrated lime, if directed by Engineer-in-Charge, for which nothing extra shall be paid to the contractor.

In case of sudden rain or storm, the work can be concluded at the dummy joints but these will then be formed as construction joints.

Before sealing of joints, it may be ensured that the groove extends fully across the bay between consecutive longitudinal joints, in the case of transverse joints and is continuous in the case of longitudinal joints. Any concrete or other foreign matter must be removed from the groove.

Expansion Joint

Premoulded Joint Filler in Expansion Joint: It shall conform to IS 1838 (Pt. I). The thickness shall be 25 mm with tolerance 1.5 mm. and shall be of the maximum available standard length not less than one lane width. The filler board shall be positioned vertically with the prefabricated joint assemblies along the line of the joint within tolerance of + 10 mm from the intended line of the joint. The depth of board shall be 25 mm less than thickness of slab within a tolerance of ± 3mm so that the top of the board shall be below the surface or will not impead the passage of the finishing straight edge or oscillating beam of the paving machine.

Bitumine Hot Sealing Compound: The joint sealing compound shall be fuel and heat resistant type complying to grade B of IS 1834. It shall be capable of adhering to the concrete without cracking, spalling and disintegration.

Construction Procedure

Expansion joints shall be provided as shown in the drawing and as per directions of Engineerin- Charge. All joints shall be constructed true to line with their faces perpendicular to the surface of the pavement. The joint shall be 20 mm wide. The depth of the non-extruding filler pad shall be 25 mm less than the depth of the concrete slab.

Before the provision of expansion joint, the face of the already laid concrete slab shall be painted with primer at the rate of 2.6 liters per 10 square metres. The expansion pad shall be properly cut to shape and shall then be placed in position abutting the painted face of the already laid concrete slab. The adjacent slab shall then be concreted. The face of the pad against which the new concrete slab is to be laid shall also be painted with primer before laying the concrete, while concreting a neat groove of size 20 mm x 25 mm as per drawing shall be formed on top of the pad taking care that the edges are absolutely straight and that the groove so made does not get filled with any material like concrete, mortar and other rubbish.

Before the curing process is started, the top of expansion joint shall be filled with bitumen sand mixture in order to ensure that no foreign material used in curing enters into the joint. This filling shall be removed before filling the joints with sealing compound.

For sealing the joints following operations shall be carried out:—

(a) The joints are cleared of any foreign matter to the full depth upto the top of expansion pad with steel spatula.

(b) The joints are blown with compressed air.

(c) Cleaning is done with Kerosene oil.

(d) Priming is done with spray gun @ 2.6 liters per 10 sqm of the surface to be primed.

(e) The primer is allowed to dry completely before pouring the sealing compound.

(f) The sealing compound grade ‘A’ is heated to the required temperature ranging between 155 deg. C to 165 deg. C or to the temperature range specified by the manufacturer. Overheating shall be avoided. Pouring shall be done from vessel with spout in such a manner that the material will not get spilled on the exposed surface of the concrete, any excess filler on the surface of the pavement shall be removed immediately and the pavement surface cleaned.

(g) The filling shall be worked into the joints with hot flats to ensure escape of trapped air.

(h) The filling is then ironed with hot iron. It is recommended that while in summer the joints may be sealed flush with the adjacent pavement surface, in winter the sealing compound may be filled to a depth 3-4 mm below the surface.

(i) The edges of the joints are then cut and trimmed to ensure neat and straight line finish.

(j) To prevent tackiness or pick up under traffic, the exposed surfaces of the sealing compound shall be dusted with hydrated lime, if directed by Engineer-in-Charge (Nothing extra shall be paid for the same).

Painting Road/ Runways Markings

Special Ready Mix Road marking paint of approved brand and manufacture shall be used.

The paint shall conform to IS 164. Ready mixed paint as received from the manufacturer shall be used without adding any admixture. During work, if the consistency of the paint gets thick and thinning becomes necessary it shall be done by use of thinner of the approved brand of paint recommended by the manufacturer and with the approval of the Engineer-in-Charge.

The paint shall be brought to the site of work by the contractor in original sealed containers.

The material shall be brought in one lot in adequate quantity to suffice for the entire work. The material shall be kept in the joint custody of the contractor and the Engineer-in- Charge. The empty container shall not be removed from the site of work, till the work has been completed and permission obtained from the Engineer-in-Charge.

Preparation of Surface

The surface shall be thoroughly cleaned and free from dust. All the dirt, scales, oil and grease shall be thoroughly removed before painting is started. The prepared surface shall be inspected and approved by the Engineer-in-Charge before painting is commenced.

Application

Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its original container. The paint shall be continuously stirred in the smaller container while applying to runway surface so that its consistency is kept uniform.

The painting shall be applied evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area over with paint, brushing the surface hard for the first time over and then brushing alternatively in opposite direction, two or three times and then finally brushing lightly in a direction at right angle to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

Each coat shall be allowed to dry out thoroughly before the next coat is applied.

Earlier applied coat shall be cleaned off dust before the next coat is laid.

No left over paint shall be put back into the stock tins. When not in use, the containers shall be kept properly closed.

No hair marks from the brush or clogging of paint puddles shall be left on the work.

The surface shall ordinarily not be painted until it has dried up completely. Trial patches of paint shall be laid at intervals to check if drying is satisfactory.

The runway marking shall be done in accordance with the drawing unless otherwise instructed by the Engineer-in-Charge.

Brushes and Containers

After work, the brushes shall be completely cleaned of paint by rinsing with turpentine. A brush in which paint has dried up is spoiled and shall on no account be reused for painting work. On no account kerosene oil shall be used for washing the brush.

When the paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth so that they are clean, and can be used again.

12. Precast Concrete Paver Tiles

Providing and laying 60 mm thick factory-made cement concrete interlocking paver blocks of M-30 grade, manufactured using hydraulic pressure and strong vibratory compaction in an automatic block making machine, conforming to relevant IS standards. The paver blocks shall be of approved size, shape, colour and pattern, free from cracks, chips and other defects, and shall be laid over a 50 mm thick compacted coarse sand bedding layer prepared to the required line, level and slope. The coarse sand shall be spread uniformly, properly compacted and screeded to receive the paver blocks. The blocks shall be laid manually in the approved pattern with close joints and proper alignment. After laying,

the joints shall be filled with fine dry sand and vibrated using a plate compactor fitted with a suitable neoprene/rubber pad to ensure proper interlocking and seating of the blocks. Additional sand shall be brushed into the joints wherever required until the joints are completely filled. The finished surface shall be true to line and level, smooth, even, and free from depressions, undulations or loose blocks. The rate shall include the cost of all materials, labour, sand bedding, joint filling, cutting of blocks, laying, compaction, transportation, tools and plants, wastage and all incidental works required for completion of the work as per specifications and directions of the Engineer-in-Charge. Measurement shall be taken on the finished plan area in square metres. There shall be no hollows left. The joints shall be of uniform thickness and in straight line as per the pattern.

The surface of flooring shall be checked frequently with a straight edge at least two meters long so as to obtain a true surface with required slope.

While laying, any chiselling which may be required for making the skirting or dado flush with the plaster (and/or other finishes shall be done. Necessary grooves of required size in cm, between plaster and/or (other finishes, dado or skirting (if required) shall be provided. Forming machine-cut/rounded edges gutters, sills, platforms, channels, curbing, etc. if any, if required, shall be provided as per the drawing and design.

In places where full tiles cannot be fixed, the tiles shall be cut to the size and smoothened at edge to give straight and true joints.

After the tiles have been laid, the surplus cement slurry and the joints shall be cleaned and washed fairly deep before the cement hardens.

The day after tiles have been laid, the joints shall be cleaned of all grey cement grout with a wire brush to a depth of about 5 mm. and then grouted with white cement, with or without pigment to match the shade of the topping of tiles. The same cement slurry shall then be spread over the whole surface, laid in a thin coat to protect the surface from abrasive damage and to fill pin holes that may exist on the surface.

All necessary slopes, gradients and levels shall be truly maintained as required and directed by the Owner/PMC

Curing -The flooring shall be kept wet with damp sand or water for seven days. It shall be kept undisturbed at least for 14 days. The grinding shall normally be, commenced after 14 days.

Finishing - Polishing of the tiles and the chequer grooves, after laying, may be done by hand as directed by Owner/PMC. Special care shall be taken to polish the grooves in such a manner as to get a uniform section and that their finish shall match with the finish of flat portion except that the of the tiles. The finished floor shall not sound hollow when tapped with a mallet. If any tile is disturbed or damaged it shall be refitted or replaced, properly jointed and polished.

Testing of the tiles shall be carried out by the Contractor at his own cost as per I.S. requirement.

13. Kerb Stone (Precast)

1. Laying

Trenches shall first be made along the edge of the wearing course of the road to receive the kerb stones of cement concrete of specified grade. The bed of the trenches shall be compacted manually with steel rammers to a firm and even surface and then the stones shall be set in cement mortar of specified proportion.

The kerb stones with top 20 cm. wide shall be laid with their length running parallel to the road edge, true in line and gradient at a distance of 30 cm. from the road edge to allow for the channel and shall project about 12.5 cm. above the latter. The channel stones with top 30 cm. wide shall be laid in position in chamber with finished road surface and with sufficient slope towards the road gully chamber. The joints of kerb and channel stones shall be staggered and shall be not more than 10 mm. Wherever specified all joints shall be filled with mortar 1:3 (1 cement : 3 coarse sand) and pointed with mortar 1:2 (1 cement: 2 fine sand) which shall be cured for 7 days. The necessary drainage openings of specified sizes shall be made through the kerb as per drawings or as directed by the Owner/PMC for connecting to storm water drains.

2. Finishing

Berms and road edges shall be restored and all surplus earth including rubbish etc. disposed off as directed by the Owner/PMC. Nothing extra shall be paid for this.

14. HDPE Grass Pavers

Providing and laying 40 mm thick High-density polyethylene (HDPE) grass pavers on 150 mm thick sub grade of compacted bed of 20 mm thick nominal size stone aggregate and base course and filling with 150 mm thick sand, including spreading, well ramming, consolidating and finishing smooth etc. all complete as per direction of Owner/PMC.

The high strength plastic modules shall be designed to provide permeable surface on ground with at least 90% porosity and shall contain and stabilize grass or decorative gravel with the ability to withstand heavy loads imposed by emergency vehicles such as fire tender. These modules shall be with Snap on connectors allowing each module to interlock with each other ensuring that they remain in place during & after installation. The modules shall be planted with grass / ground cover enabling these areas to blend into the aesthetics of their surroundings. The modules shall be made of 100% recycled materials and support LEED GOLD /Green Building Certification.

The minimum specifications shall be:

Material : Polyethylene / Polypropylene

Dimensions: : 500 mm x 500 mm

Height: : 40 mm

Cell Size (diagonal): : 70 mm

Weight : ~4.3 kg/m2

Compressive Strength (unfilled) : ~150 t/m2

Compressive Strength (sand filled) : ~3000 t/m2

Service Temperature : -30 °C to 80 °C

Biological Resistance : Unaffected by moulds and algae

Chemical Resistance : Resistant to rot, oils, acids, alkalis, bitumen and naturally occurring soil chemicals

15. AAC Masonry Work

1. Materials

MASONRY to be used in the Building works shall be Autoclaved Aerated Concrete Blocks of size 600mm x 200mm x 200 mm with 55-60% Fly ash, 2-3% Gypsum, 10 - 12% cement, Lime 12-14%, Aluminium powder and balance slurry solids generated during process. Length and height can vary as per availability; however the thickness of blocks shall be 200mm and 100mm as per requirements. Fly ash to be used in the manufacturer of fly ash cement masonry shall conform to Grade 1 or 2 of IS-3812-1981or latest version Minimum percentage of fly ash to be used in the AAC masonry shall not be less than 40%. Manufacturers and test certificate and independent testing conforming chemical and physical requirement / characteristics and proportion of fly ash shall be produced by the contractor to the Owner/PMC for approval. Fly ash shall be procured from coal / lignite based thermal power plants. Water absorption for the AAC masonry shall not be more than 20% of weight.

Efflorescence when tested according to IS-3495 (Part III) 1976 or latest version shall have the rating of efflorescence not more then 12.5%.

The Compressive strength of AAC blocks shall not be less than 4.0 N/sqm and shall conform to IS 2185 or latest version

The normal dry density shall be 550-650 kg/cum, sound absorption upto 42 dB, fire resistance of minimum 4 hours, thermal conductivity “K’0.16 W/sqmK, thermal resistance 0.46 K-sqm/W, heat transmission coefficient 2.17 w/sqmK and drying shrinkage not less than 0.02% (length of the block).

The AAC Blocks shall conform IS 2185 (Part III) or latest version and the masonry shall be carried out as per IS 6041 (1995) or latest version and IS 1905 (1987) or latest version.

2. Workmanship

All masonry work shall be built in CM (1:6). / CM (1:4). Masonry work in panels shall be jointed with RCC columns by means of wall ties of MS flat 30mm x 3mm at every fourth course. The bonding length of reinforcement and MS flat shall be as under unless otherwise shown on drawings: -

a) Junction of 200 mm thick wall and RCC column etc.- 20cm

Faces of masonry walls indicated to be pointed on external faces of masonry work or where shown to be provided with pointing shall be faced with specially selected facing masonry. Masonry shall be uniform in colour, texture and shall have arises so that true horizontal and vertical joints are formed in the facing.

3. Thickness of Masonry Wall/Pillar & Concrete Members

Width of concrete lintels, beams, sills, columns and the like coming in conjunction with masonry walls/pillars shall be kept to the actual width of masonry work unless off sets have been specifically shown, in that case width as shown on drawings shall be maintained.

Centreline dimensions of rooms, verandahs etc as shown in drawings shall be maintained. Internal and overall dimensions if at variance from whatever is shown in drawings shall be deemed to have been amended accordingly. The dimensions of various heights shall be maintained as shown on the drawings

Mortar bed joints shall be such that four courses of masonry work and three joints taken consecutively shall measure 3 to 4cm in addition to the combined height of the masonry, themselves.

4. Half Brick Work

Masonry work in half brick walls shall be done in the same manner as described above that the bricks shall be laid in stretcher bond. When the half brick work is to be reinforced, 2 Nos. M.S. bars of 6 mm dia. shall be embedded in every third course as given in the item (the dia of bars shall not exceed 8 mm). These shall be securely anchored at their end where the partitions end. The free ends of the reinforcement shall be keyed into the mortar of the main brick work to which the half brick work is joined. The mortar used for reinforced brick work shall be rich dense cement mortar of mix 1:4 (1cement: 4 coarse sand). Lime mortar shall not be used. Over laps in reinforcement if any shall not be less than 30 cm.

16. Water Proofing

As per Annexure attached for waterproofing.

17. Plastering Works

Ready Mix plaster:

Providing and applying factory manufactured ready-mix cement plaster using Godrej TUFF Ready Mix Plaster or approved equivalent, consisting of graded sand, cement, polymers and performance-enhancing additives, suitable for internal/external wall plastering. The plaster shall be machine mixed with water as per manufacturer's recommendations and applied in a uniform thickness of 12 mm to 20 mm on prepared masonry or RCC surfaces, including surface preparation, hacking of concrete surfaces where required, application of bonding agent, screeding, trowel finishing, curing, scaffolding, labour, tools and all incidental works complete as per manufacturer's specifications and Engineer-in-Charge's approval. The finished surface shall be smooth, crack-resistant, shrinkage-controlled and ready to receive putty/paint finish. Complete in all respects.

Approved Make

- Godrej TUFF Ready Mix Plaster
- Magicrete Ready Mix Plaster
- Ultratech Super Stucco
- Walplast HomeSure / Homeshield

- Trimurti Ready Mix Plaster
- Saint-Gobain Weber Plaster

Technical Requirements

Parameter	Requirement
Application Thickness	12-20 mm
Compressive Strength (28 Days)	≥ 5 N/mm²
Coverage	Approx. 1.6-1.8 kg/m²/mm thickness
Water Requirement	As per manufacturer's recommendation
Surface Finish	Smooth and level
Curing	Minimum 7 days

18. Granite Flooring

1. The granite stone should be factory processed, pre polished (mirror and diamond polished), surface calibrated, four side trimmed with the reinforcement of epoxy resin and fiber glass backing. The fixing of stone shall be done as per approved pattern and design with smooth and even surface without holes or pits. The top surface of full slab should be treated with epoxy resin (under vacuum & controlled temperature) with slab size not less than 1200 x 800 mm (or as approved) in combination of approved shades & colour, laid in 20 mm thick cement mortar 1:3 (1cement: 3 coarse sand) including finishing the joint joint filler of approved make of approved shade etc to match the colour of Granite stone including edge polishing wherever required all complete as per directions & instructions of Owner/PMC.

2. The type, quality and thickness of granite slabs for flooring skirting and dado shall be of the best quality as described and approved by the Engineer and shall be hard, dense, uniform homogenous in texture, have even crystallizing gains and be free from cracks and other defects. 3. The Contractor shall provide the Engineer with samples for approval and only approved slabs shall be brought on to the site.

4. Before laying sub-.surfaces shall be thoroughly cleaned and washed of all loose materials, dirt, laitance and the like and then well wetted without forming water pools on the surface.

5. Slabs shall be laid in cement slurry over a cement mortar bed approximately 18mm thick (one part of cement four parts of sand) or as required at site evenly spread over sub-surfaces Slabs shall be gently tapped with a wooden mallet until properly bedded and level with adjoining slabs. Joints not exceeding 1 mm wide shall be perfectly straight and uniform in thickness. Slabs shall be laid perfectly level unless otherwise specified or directed by the Engineer. After laying, joints shall be finished with grout of approved make. Slabs laid adjoining walls shall project at least 12mm under plaster or under skirting or dados. After laying, flooring shall be allowed to cure undisturbed for 10 (ten) days and the surplus cement slurry shall be cleaned off.

6. Design traffic shall not be allowed on the floor for at least 14 (fourteen) days after laying slabs. Following curing, slabs shall be lightly tapped with a small wooden mallet. Should this give a hollow sound such slabs, together with any cracked or broken slabs, shall be removed and replaced with new slabs to proper lines and levels.

a. The above procedure shall be followed again after slabs are polished. To ensure that such replaced slabs match those laid earlier the Contractor shall order sufficient extra slabs to meet this requirement.

7. Pointing and Finishing- The joints shall be cleaned off the grey cement slurry with

wire/coir brush or towel to a depth of 2mm to 3mm and all dust and loose mortar removed. Joints shall then be flush pointed with coloured epoxy grout as approved to match the colour of stone. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

8. After joints have developed sufficient strength floors shall be machine polished to the desired finish to the satisfaction of the Engineer. Sufficient quantities of water shall always be used during polishing to prevent scratching,

9. For skirting and dado vertical surfaces shall be thoroughly cleaned and wetted and evenly and uniformly covered with approximately a 12mim thick coat of cement mortar (1:2), Backs of cut slabs for skirting and dados shall be covered with a thin layer of

neat cement paste and files gently tapped against the wall with a wooden mallet. Joints shall be as close as possible and the work shall be truly vertical and flush. At the top of dado work borders shall be provided, if specified. Once work has set skirting and dado shall be hand polished with Carborundum stone to produce a high glossy finish.

Corners and junctions shall be finished true. Dado shall be secured by means of stainless steel crawyers / fasteners as required.

19. Kota Stone Flooring

1. Stones as described shall be of pre polished , approved quality, free of defects, hard, sound, durable and uniform thickness and approved by the Owner/PMC.

Edges shall be chisel dressed and the top surface shall be machine polished with joints running true and parallel from side to side. 2. The Contractor shall provide the Owner/PMC with samples for approval and only approved stones shall be brought on to the Site. 3. Before laying stones, sub-surfaces shall be thoroughly cleaned and washed of all loose materials, dirt, laitance and the like and then well wetted without forming water pools on the surface.

4. Thoroughly wetted stones shall be laid on concrete mortar bedding not less than

12mrn and not more than 25mm thick in the proportions of one part of cement, two parts lime and six parts sand.

5. Mortar shall be evenly spread over sub-surfaces and covered with bed of cement at the rate of 5kg per square metre over areas that can be covered with stones within half an hour. Stones shall be laid on cement beds one after another, each stone being gently tapped with a wooden mallet until properly bedded and level with adjoining stones level unless otherwise specified or directed by the Owner/PMC.

After laying, joints of stones shall be struck smooth. Floor stones laid adjoining walls shall project at least 12mm under plaster or render, skirting or dado. Cut pieces shall be avoided as far as possible. After laying flooring shall be covered with a layer of damp sand and allowed to cure undisturbed for 7 (seven) days. 6. Design traffic shall not be allowed on the floor for at least 14 (fourteen) days after laying stones. Following curing each and every stone shall be lightly tapped with a small wooden mallet. Should this give a hollow sound such stones, together with any cracked or broken stones, shall be removed and replaced with new stones to proper lines and levels. To ensure that such replaced stones match those laid earlier laid the Contractor shall order sufficient extra tiles to meet this requirement.

7. For skirting and dado vertical surfaces shall be thoroughly cleaned and wetted and evenly and uniformly covered with approximately a 12mm thick coat of cement mortar.

8. Backs of stones for skirting and dado shall be covered with a thin layer of neat cement paste and flies gently tapped against walls with a wooden mallet. Work

shall be done from the bottom of the surface proceeding upwards. Joints shall be as close as possible and the work shall be truly vertical and flush.

20. IPS Flooring

Providing and laying 40 mm thick IPS flooring in cement concrete using 1:2:4 mix (1 cement : 2 coarse

sand : 4 graded stone aggregate of 10 mm nominal size) over prepared base, including surface preparation, laying, compaction, leveling, finishing with steel trowel, forming panels with glass/aluminium/PVC dividing strips wherever specified, curing for minimum 14 days, and finishing to a smooth, dense, hard-wearing surface complete as per drawings and specifications. Cement used shall be OPC/PPC of approved make such as UltraTech, ACC, Ambuja, JK Cement or equivalent. The flooring shall be laid to required slopes, levels and lines and finished free from cracks, undulations and surface defects, complete in all respects.

Approved Makes

- Cement: UltraTech, ACC, Ambuja, JK Cement
- Concrete Hardener (if specified): Fosroc Conplast, Sika Chapdur, MYK, Master Builders
- Dividing Strips: Hindalco Aluminium, Saint-Gobain, Approved Equivalent

Technical Requirements

Parameter	Specification
Flooring Thickness	40 mm
Concrete Grade	Equivalent to M15-M20
Aggregate Size	10 mm nominal
Surface Finish	Steel trowel finish
Panel Size	Maximum 2.0 m × 2.0 m or as specified
Curing Period	Minimum 14 days
Tolerance	±3 mm under 3 m straight edge

21. Vacuum Dewatered Flooring

Portland cement of 43 Grade conforming to IS:8112 of normal grinding fineness, which corresponds to a specific surface of 2600-3500 cm2/g is required. Cement of higher grinding fineness, e.g. rapid-hardening Portland cement of larger specific surface shall be avoided especially in concrete mixes with cement content 0.3 t/m3 recommended content is 0.2 - 0.3 t/m3. If stipulated in work specification; VDF Recron 3s synthetic fibres (manufactured by RIL or equivalent) may be used. Minimum dosage shall be 900 gms / m^3 or as recommended by the manufacturer of the fibre. The fibre shall be as per the following specification:

a) Cut length – 12mm

b) Shape of fibre – unique triangular cross section for improved bonding aggregates in concrete.

c) Tensile strength – 4000 to 6000 kg/cm^2

d) Melting point - > 250°C

e) Batching, Mixing, Transporting, placing, compaction finishing and curing shall be as per relevant clause.

If stipulated in work specification, floor hardener (Nitofloor hard top or equivalent) shall be laid as per manufacturer's specifications with concrete as per intended use.

The Contractor shall be responsible for achieving the quality of concrete specified by controlling the concrete mixes, placing, vacuum process, finishing and curing. The concrete technician in charge must be present at the site when work is in progress.

The Contractor shall be required to maintain control charts showing individual test results for aggregate gradation, slump, air content, cement content and compressive strength. Data for slump, eventual air content and compressive strength shall be supplied to the MMCI/HPCL Engineer In-charge.

The Contractor shall be responsible for mix adjustments, performing necessary tests, correcting deficiencies and trouble shooting in general.

Equipment

The following equipment shall be provided by the Contractor;

Poker vibrator with high frequency preferably 335 hz, dia 25 to 38 cm.

Floating

Upon removal of the suction mats and filter pads the concrete surface shall be powerfloated without delay until all imprints from the vacuum process are removed.

Finishing

The waiting time after the floating operation depends on concrete temperature and humidity and varies from 10 minutes to 2 hours.

The trowelling operation cannot take place before the concrete has hardened enough to

carry the machine i.e. the trowelling blades shall not leave any marks on the concrete. Repeated trowelling, with intervals between the passes, which are adapted to the setting of the concrete, greatly improves the surface characteristics. At least two passes shall made for floors which are not to be covered.

Curing

Vacuum dewatered concrete shall be cured like any other quality concrete in order to achieve a good final result. Curing compounds or plastic sheets shall be used.

Acceptance Criteria

In general, the following shall be checked for acceptance:

Concrete cube strength as specified in the drawing

General level of finish of the floor shall not vary by + 5 mm in 10 metres Finished floor shall not exhibit cracks, creases and crustiness. It shall be sound at edges and corners.

Floor shall not have laitance and shall not generate dust on movement of traffic. It should not give hollow

sound on tapping.

During Inspection if any of the above defects are observed, Contractor shall be informed of non-acceptance and the Contractor shall in workman like manner take all necessary corrective action without undue delay at his cost so that the installation meets all acceptance criteria.

22. Stone Cladding Works

1. Granite / Italian marble Cladding

The Contractor shall be responsible for the design, supply of clamps for fixing, fabrication and installation of all items specified in the drawings and bill of quantities.

Scope of work- The work as described include providing of clamps for fixing, designing

and installing of interior stone wall cladding as shown in the drawings, and specifications.

Granite cladding hereinafter shall be deemed to include internal granite dry wall claddings, wet granite fixing, sealing of joints and gaps between granite panels.

Preparation of dimensioned shop drawings including full detailed designs, including fixing etc.

a) Co-ordination with Contractors of other trades

b) Preparation of sample mock-ups and necessary testing

c) Cutting of stones at site as may be required for fitment and polishing of side edges as may be required

d) Matching of stones for shades, grains etc. before installation

e) Silicone sealant between two joints

Contractor shall submit shop drawings which should also show the panel sizes, type and

brand of clamps etc. and co-ordination with works of all other trades as may be required, prior to fabrication.

Contractor shall fabricate, cut, finish and install each type of stone in accordance with

approved shop drawings. Contractor shall furnish and install stone supporting system, anchors, plates, bolts, inserts, washers and all other fastening or hanging devices or accessories necessary for complete installation of stone work.

Contractor shall provide mortar bedding to stone work wherever required, perform cleaning of all stone after installation and prior to acceptance, protect stone work as required, perform all testing as required and apply silicone sealant as required.

All cladding material shall be subject to Owner/PMC in charge review as well as testing in any laboratory specified by the Employer. Any granite panels rejected/ changed form confirmed shop drawings shall be removed from the site and replaced with material meeting the Owner/PMC in charge requirement at no additional cost or time.

The Contractor shall ensure that the stone edges at all such joints are in true line and level.

2. Edge treatment

Each panel of granite shall be accurately cut square, polished around its edges and holes drilled on edges to take up the anchor pins to the satisfaction of the Consultant / Employer /Owner/PMC. The holes, notches or grooves shall be pre-dressed with silicon sealant as per approval. All this preparation of the granite slabs must happen before they

are fixed in position and the accuracy of right angles, dimensional stability and sizes of holes shall have to be tested on site using a mould and other measuring instruments as decided by the Owner/PMC or edges to be 23 mm beveled and polished.

3. Stone support and anchorage

All elements of the support system should never rust or corrode under exposed condition. All metal components like anchors, bolts etc shall be in stainless steel of AISI 304, which shall be tested frequently by the Owner.

4. Cutting, drilling and fitting

Scope includes all cutting, drilling and fitting of stone work required to accommodate the work of other trades in cutting and fitting, carefully cut and grinding edges to a neat, tight fit, cutting in such a manner so as not to impair strength, appearance or architectural design of stone work use physical templates and accurate site measurements for all cutting and drilling. Contractor shall obtain required templates from proper trades.

5. Workmanship

Surface to receive granite cladding shall be examined in detail and site measurement shall be taken. Responsibility for the following shall be on the Contractor.

a) Line and Level

b) Verticality

c) Structural Support

d) Provisions for Expansion and Contraction

e) Water Tightness

f) Finished Appearance

The Contractor shall verify all measurements and dimensions, co-ordinate and supervise the installation of inserts for this work, Co-ordinate and schedule this work with the work of other trades giving particular attention to the location and size of cut-outs required to accommodate mechanical, electrical, and other works or adjoining constructions in

accordance with the reviewed shop drawings for such trade.

6. Preparation for Stone Cladding Work

During the preparation for the stone cladding work the Contractor shall consider the building as a whole while planning, detailing etc. and not treat any face or part thereof in

isolation.

7. Matching Grains and Colour

All stone shall be sorted for colour and grains before laying. The matching of grains/colour shall be carried out as approved by the Owner/PMC. No variation of type of grain or colour shall be allowed in any one area.

8. Design and Pattern

All work shall be laid as per design, detail, pattern, colours, sizes and dimensions given on the drawings. Any modifications and variations at site shall be reflected in adjustment in design as per the approval of the Owner/PMC. All junctions, rebates, nosing's, corners shall have square, curved or shaped mounting as desired and as shown on the drawings

9. Service and Other Outlets

Before any work is to be taken up, the sizes and the pattern of stones shall be laid out,

together with the location of electrical, sanitary outlets and those of all other services and approval sought from the Owner/PMC. Thereafter the stones shall be laid out on the floor showing pattern of grain, etc. and work shall only be carried out after obtaining approval of the Owner/PMC.

10. Setting out

The Contractor shall set out the stone cladding work so as to achieve the following:

a) Establish a benchmark or datum at each floor level for setting out.

b) Establish a vertical centre line in each plain area.

c) Establish the positions of movement joints.

d) Avoid or minimize unsightly cutting.

e) Obtain truly horizontal joint lines.

f) Where openings and other features occur the work shall be done as per the detailed

g) drawings or as directed by the Owner/PMC.

h) Preliminary

The Contractor shall undertake everything necessary to obtain a satisfactory bond between the backgrounds, backings and finishing / cladding. Such work shall include but not be limited to the following:

Withholding application until curing and drying shrinkage of the structural backgrounds

are achieved.

a) Fungicidal wash as approved to remove any organic growth.

b) Removal of any greasy deposits by scrubbing with water and approved detergent.

c) Final brushing to remove laitance, efflorescence or loose material.

d) Wetting to reduce suction or to obtain uniformity of suction.

e) On hard smooth surfaces (such as high grade concrete) or other surfaces

presenting an inadequate key, an adhesive of approved make and brand shall be applied. The adhesive shall be applied by spraying a thin coat of rendering done while the adhesive is still tacky. The provision of the bonding coat shall be deemed to be included in the rate for stonework.

11. Laying

The stone cladding shall be conducted as follows:

a) All stones and all jointing surfaces shall be made perfectly clean and free of dirt, dust, grease or other deleterious material.

b) The stones shall be soaked in clean water for at least 30 minutes.

c) The rendering shall be damped just sufficiently to prevent excessive water absorption from stones.

d) The bedding surfaces of small units shall be well wetted and the units stood on a full bed of mortar and tapped home.

e) For every large or heavy unit, a mortar bed shall be screed level and full but kept back 20mm from the face, before the stone is lowered into place. All joints

shall be as completely filled as possible.

f) Only sufficient mortar shall be spread to bed each stone.

g) It shall be ensured that there are no hard lumps in the mortar that could prevent even bedding.

h) Spacer dabs: Spacer dabs of appropriate mortar, or, for linings only, Plaster of Paris, can be used to achieve resistance against inward movement of the

stones and shall be of such consistency and size that they will be in permanent contact with the back of the stone cladding and the structure. It is essential that they do not bridge movement joints.

i) It shall be ensured that stones are flat and true by means of a straightedge. Adjustments if necessary shall be made within 10 minutes of fixing.

12. Jointing

The stone shall be fixed with consistent joint width by correct use of spacer lugs so as to provide hairline (maximum 1 mm thick) joints. All joints shall be filled solid with

1:2 mortar (1 white cement with pigment: 2 sand) except for projecting members of overhanging cornices, which may be provided with hollow bedding where approved by the Owner/PMC. Excess mortar shall be cleaned off immediately so that no mortar is visible on the face of the stone cladding. The stone cladding shall be properly cured for at least 7 days.

All stones shall be secured to the backing by means of stainless steel cramps, pins, anchors, fasteners and expansion bolts as shown on the approved shop drawings and as directed by the Owner/PMC.

All cramps, dowels etc. shall be fitted and grouted solid as the work proceeds. The fixings shall be secured to concrete backings using expansion fasteners and bolts. No stone shall bridge the expansion / separation gap provided in the structure.

13. Grouting

The stone joints shall be grouted as follows using epoxy grout of approved make in matching colour of stone in the proportion as recommended by the manufacturer / as instructed by the Owner/PMC.

a) Grouting shall be done at any time after the stones are firmly fixed but before any dirt or contamination can enter the joints.

b) Grouting materials shall be mixed to correct consistency and applied to as large an area as can be worked before hardening commences.

c) The grout shall be worked well into the joints / gaps between the stone and the backing until they are completely filled.

d) When the grout has set, the surplus material shall be removed and the joints tooled to required profile. When the grout has hardened the stones shall be washed down with water and finally rubbed with a gunny cloth. If any hollow grounding is detected by tapping the stones, these shall be taken out and re-laid.

14. Polishing

The stone cladding shall be polished to the desired finish.

15. Attachments/Fixings

The Contractor shall ensure that the number of fixings is in accordance with the specifications, drawings and directions of the Owner/PMC, and that the fixings are properly made. Over tightening and bending of fixings to accommodate inaccuracies shall not be allowed.

Each vertical unit shall be secured with two supports cum restraint purpose fixings and two restraint purpose fixings plus two pins. Each soffit unit shall be secured with four supports cum restraint fixings or as approved.

The accidental size of a cramp shall not be less than 25mm x 6mm and the pins used for securing

adjacent stones shall not be less than 75mm long and 6mm diameter or as approved.

The minimum thickness of stone behind a cramp mortise shall be 18mm and the minimum depth of slot for a corbel plate shall also be 18mm or as approved.

The minimum depth of the expansion bolt to be considered for effective penetration shall be as given in Table below:

Type of Fixing	Structural Backing Material	
	Concrete	Brickwork
Load Bearing	75 mm	100 mm
Sofia	75 mm	100 mm
Restraint	75 mm	100 mm

16. Movement Joints

A clear 10mm wide horizontal joint may be provided at every floor level as approved the shop drawings. The joints shall be formed using a shelf type stainless steel channel shaped or Z-shaped load bearing fixing. An approved sealant shall be provided in the movement joints. The joint for sealants shall be clean, dry rectangular and formed by means of a removable fillet (such as pre-molded joint filler) for the depth of the stone cladding and backing. The joint shall be later duly sealed after cleaning, drying and placing backing material. The treatment for the horizontal and vertical separation/expansion joints shall be done in a similar manner.

17. Ancillary Work

General

The Contractor shall:

a) Form shall chases and fixings, etc. as the work proceeds.

b) Temporary support or brace items liable to distortion.

c) Cut into masonry subject to the followings:

- Delay cutting until the mortar has hardened.
- Perform cuttings in a manner that involves minimal vibration to the wall.

i) Circular Columns, Circular Walls

Stone facing to circular column/walls shall be provided to match the profile of the columns/walls as specified. The height of the stone shall match that of the course shown in the drawings.

ii) Scaffolding

All scaffolding as required shall be provided till the completion of work.

iii) Tolerance for Finished Work

The finished work shall conform to the following tolerance.

a) All the hairline joints shall be in perfect lines and levels.

b) Plumb.

i. In any 3m ± 5mm

ii. Maximum per floor ± 10mm

iii. Maximum for total height ± 15mm

c) Horizontal :

i. In any 3m ± 5mm

ii. Maximum for total length ± 10mm

iv) Cleaning, Completion and Mock-up

On completion of the first area of stone cladding, once it is duly cured and dried the Owner/PMC shall examine the same to ascertain whether the quality of workmanship and finish is as desired. If the quality is accepted by the Owner/PMC as the desired finish the same area shall be cleaned of all dust and other deposits by washing together with detergent or other admixtures, with the approval of the Owner/PMC.

Upon completely drying, it shall be finished with an application of silicone water repellent solution to seal the surface. This area of stone work shall be retained as a sample of finished stonework, wherein the effects of weather, movement and other conditions shall be reviewed over a period not exceeding one month and the effects if found leading to unsatisfactory work, shall be remedied by the Contractor, until a satisfactory sample of finished work is accepted.

All subsequent work shall thereafter be completed to the standard and quality as approved for the above mock-up. In case any portion is not done to the desired quality the same shall be deemed to be rejected and shall be removed and replaced at no extra cost.

18. Protection

The Contractor shall:

Create adequate facilities to protect work adjacent to stone surfaces from damage.

Protect exposed flat and corner surfaces of stone work from damage or defacement

Prevent materials used for installing work of this section from staining the exposed surfaces of stone work or the exposed surfaces of the adjoining construction. Immediately remove sealant, mortar grout or other detrimental materials from exposed surfaces of stone cladding or adjoining construction.

After installation, protect stone work from damage during subsequent construction activities. Provide whatever means, methods, and/or materials required protecting all in-place stone work from any damage whatsoever resulting from the work of other trades. Be responsible to remove and replace any damaged or defaced stone work. Remove protection when no longer required.

19. Completion cleaning and commissioning

Before declaring the installation “Completed and Commissioned”, the Contractor shall clean exposed surfaces of all stone work with clean water and stiff fiber brushes until all dirt, stains, efflorescence, and mortar other defacements are removed using cleaners and procedures recommended by the stone quarry and fabricator. Use of wire brushes, metal scrapers or acids shall not be permitted. Protection of adjacent surfaces from damage during cleaning operations shall be the responsibility of the Contractor.

Before handing over, all the stone surfaces shall be thoroughly checked and inspected to ensure that no spots or external marks remain. Wherever such spots or marks are detected, they should be brought back to their true natural colour, shade, grains, polish, luster etc.

23. Vitrified and Ceramic Tile Work

i. Tile shall be of approved make and they shall be flat and true to shape and free from blisters, crazing, chips, welts, crawling or other imperfections detracting from their appearance. Tile shall be ISO 9002 approved.

ii. The tiles shall be square or rectangular of nominal size such as 300 x 300 mm, 600 x 600mm, 800mm x 800mm as directed by the Owner/PMC. The thickness of the tiles shall be 10 mm as specified. The length of all four sides shall be measured correct to 0.1 mm and average length breadth shall not vary more than + 0.1% mm from specified dimension. The variation of individual dimension from average value of length/breadth shall not exceed + 0.5 mm. Tolerance in thickness shall be + 1%.

iii. The top surface of the tiles shall be unpolished /polished/rustic/matt finished as per drawing. Technical data for Vitrified tile

Technical	Norms	STANDARDS
Chemical Resistance	EN 106	No Damage
Color Resistance to Light	DIN 51094	No noticeable colour changes must take place
Breaking Strength	ASTM C – 648	>1113N
Resistance to Thermal Shock	EN 104	No Damage
Skid Resistance (Industrial Application	DIN 51130 ZH 1/571	>R9
Skid Resistance (Bare – footed traffic)	DIN 51097	
Technical	Norms	STANDARDS
Determination of Dimension	EN 98	-
Sides	EN 98	+0.5%
Thickness	EN 98	+5%
Straightness of sides	EN 98	+0.5%
Rectangular	EN 98	+0.6%
Surface Flatness	EN 98	+0.5%
Water Absorption	EN 98	<0.5%
Flexlon Resistance	EN 99	>27 N/MM2
Abrasion Resistance	EN 100	<204 MM3

Frost Resistance	EN 202	>6MOHS
Coefficient of Linear Thermal Extension	EN 101	@<9x10 C1

iv. The type, quality, size thickness and colour of tiles for flooring, skirting and dados shall be of the best quality as described and approved by the Owner/PMC.

v. The Contractor shall provide the Owner/PMC with samples for approval and only approved tiles, skirting and dados shall be brought on to the Site. vi. Before laying tiles, sub-surfaces shall be thoroughly cleaned and washed of all loose materials, dirt, laitance and the like and then well wetted without forming water pools on the surface.

vii. Tiles shall be laid on cement concrete mortar bedding 12mm thick in the proportions of one part of cement, and four parts sand. Tiles shall be laid on mortar beds one after another. Each tile being gently tapped with a wooden mallet until properly bedded and level with adjoining tiles. Joints shall be perfectly straight and uniform in thickness. Tiles shall be laid perfectly level unless otherwise specified of directed by the Owner/PMC. After laying joints of tiles shall be finished with epoxy based grout of matching shade and colour as described.

viii. Floor tiles laid adjoining walls shall project at least, 12mm under plaster or render, skirting or dados. Half tiles and cut pieces shall be avoided as far as possible.

ix. After laying, flooring shall be allowed to cure undisturbed for 7 (seven) days. x. Design traffic shall not be allowed on the floor for at least 14 (fourteen) days after laying tiles.

xi. Following curing each and every tile shall be lightly tapped with a small wooden mallet. Should this give a hollow sound such tiles, together with any cracked or broken tiles, shall be removed and replaced with new tiles to proper lines and levels.

xii. For skirting and dado vertical surfaces shall be thoroughly cleaned and wetted and evenly and uniformly covered with a 12mm thick coat of cement mortar (1:2). Backs of tiles for skirting and dados shall be covered with a thin layer of neat cement paste and tiles gently tapped against the wall with a wooden mallet.

xiii. Work shall be done from the bottom of the surface proceeding upwards. Joints shall be as close as possible and the work shall be truly vertical and flush corners and junctions shall be finished true.

xiv. At the tops of dado work glazed tile borders, if specified, shall be provided

xv. Floor tiling and dados shall be measured in square metres after making deductions for openings and the like. Skirting shall be measured in linear metres for specified widths or as per Bill of Quantities. Quoted rates quoted for flooring, skirting and dado work shall be inclusive of forming angles, corner pieces and approved borders.

24. Ceramic Tile in Dado/ Skirting

i) TILES- The tiles shall be of approved make/manufacturer. They shall be flat, and true to shape and free from cracks, crazing, spots, chipped edge and corners. The surface shall be of uniform shade except for patterned tile.

ii) The tiles shall be of nominal sizes of 300 x 600 mm or as approved. The thickness of the tiles shall be 8-10MM unless otherwise mentioned.

TECHNICAL	STANDARDS

Determination of Dimension	-
Sides	±0.5%
Thickness	±0.5%
Straightness of sides	±0.5%
Rectangularity	±0.6%
Surface Flatness	±0.5%
Surface Quality	95% free from visible defects
Water Absorption	≥ 10% and less than 20%
Flexion Resistance	≥ 10%
MOHS Hardness	Min. 3

iii) Color and pattern - The tiles shall be as approved.

iv) Preparation of surfaces - The joints shall be racked out to a depth of at least 12 mm in masonry walls, while the masonry is being laid. In case of concrete walls, the surfaces shall be backed and roughened with wire brushes. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting/dado is commenced.

v) Mortar - 12mm thick plaster of cement, mortar 1:3 (1 cement : 3 coarse sand) shall be applied and allowed slightly to harden. The plaster shall be roughened with wire

brushes or by scratching diagonal at close intervals.

vi) Laying of tiles - The tiles shall be soaked in water, adequately washed clean, and a coat of neat cement slurry applied liberally at the back of tiles and set in the bedding mortar. The tiles shall be tamped and corrected to proper plane and lines. The tiles shall be set in the required pattern and butt jointed. The joints shall be as fine as possible and uniform. Top of dado shall be truly horizontal and joints truly vertical except where otherwise indicated. Where full size tiles cannot be fixed these shall be cut to the required size and their edges rubbed smooth. Care shall be taken to ensure that as far as possible cut tile are in non-exposed locations. Works shall be carried out in all areas only after the Consultant has approved a sample panel.

vii) Pointing -After laying is complete, the joints shall be cleaned off the grey cement grout with wire brush and all dust and loose mortar removed. The joints shall then be flush pointed with white cement slurry added with approved pigments to match the colour of tiles.

viii) Curing and finishing -The surface shall be cleaned and kept wet by sprinkling water for seven days. The finished surface shall be clean, free of patches and glossy and shall not sound hollow. Finished dry surfaces shall be washed with mild organic acid, if so required. The finished surface shall meet the approval of the Consultant.

25. Cementitious Self Levelling Compound Base

(Considered For Under Wooden Flooring, Carpet and Vinyl Flooring Only)

Average 3-5mm thick Cementitious Self-Levelling compound to be applied with primer complete as per manufacturer's guidelines. The existing floor shall be cleaned for loose particles; latent concrete, cement mortar/concrete lumps, dust etc., & making the existing floor ready for receiving the screed by repairing pot holes/ cracks/ joints etc with repair mortar. Vendor shall inspect the site condition & confirm that the existing floor is ready for receiving the proposed Self levelling Compound screed.

To conform to the following standards:

- Compressive strength After 1 day 19N/mSqm

After 3 days 26 N/mSqm

After 28 days 47 N/mSqm

- Indentation resistance

After 1 day 80N/mSqm

After 3 days 90 N/mSqm

After 28 days 125 N/mSqm

26. Painting Works

(All Paint Shall Be Low VOC Paint as per LEED GOLD guidelines)

i. Scope Of Work - This Specification describes the general requirements of painting and decorating on internal and external surfaces, woodwork and metal work and varnishing and polishing to be executed on projects.

ii. Painting, Lime Washing And Colour Washing

a) General

Paint, lime wash and colour wash shall except for white wash, be factory made, delivered to Site in manufacturers' sealed drums in colours approved by the Owner/PMC and conform to the relevant Standards.

Paints shall be such as to be capable of withstanding the effects of weather and the atmosphere and the results of wood decay and metal corrosion and shall have good spreading coverage, be easy to apply, form a thin uniform film upon application, not crack when dry and have hard and durable surfaces.

b) Lime Wash

Materials for lime wash shall be freshly burnt fat lime of good quality free from unburnt stone and other foreign matter dissolved in sufficient quantities of water (4 to 5 litres per kg. of lime), stirred thoroughly and strained through a clean coarse cloth. Clean gum or Fevicol dissolved in hot water shall then be, added in the proportion of 20 gm of gum per litre of lime to prevent lime wash being removed when rubbed.

Surfaces shall be prepared by removing all mortar droppings and other deleterious foreign matter and thoroughly cleaned with wire or fibre brushes to the approval of the Owner/PMC. Holes and/or depressions shall be stopped with mortar and cured prior to lime washing.

Lime wash shall be applied by brush, the first stroke being from the top downwards, the second from the bottom upwards over the first stroke and similarly with strokes from right and left over the first strokes before they dry. This application forms one coat and each coat shall be allowed to dry and shall be

subject to inspection by the Owner/PMC before the next coat is applied. When dry surfaces shall not show signs of cracking and present a smooth and uniform finish free from brush marks, not easily removed when rubbed. Patchy or streaky work will be rejected and shall be re-executed at the Contractor's own expense.

Doors, windows, floors, fittings, fixtures and the like shall be protected from splashes, splashing and droppings, if any being removed and surfaces thoroughly cleaned to the satisfaction of the Owner/PMC.

c) Colour Wash

Colour wash shall consist of lime wash composed as described above to which a solution of water and lime fast pigment, boiled if directed, shall be gradually added and stirred until the required tinge is obtained to the satisfaction of the Owner/PMC.

Surfaces shall be prepared by removing all mortar droppings and other deleterious foreign matter and thoroughly cleaned with wire or fibre brushes to the approval of the Owner/PMC. Holes and/or depressions shall be stopped with mortar and cured prior to colour washing.

Colour wash shall be applied by brush, the first stroke being from the top downwards, the second from the bottom upwards over the first stroke and similarly with strokes from right and left over the first strokes before the dry. This application forms one coat and each coat shall be allowed to dry and shall be subject to inspection by the Owner/PMC before the next coat is applied. When dry surfaces shall not show signs of cracking and present a smooth and uniform finish free from brush marks not easily removed when rubbed. Patchy or streaky work will be rejected and shall be re-executed at the contractor's own expense.

Doors, windows, floors, fillings, fixtures and the like shall be protected from splashes, splashing and droppings, if any, being removed and surfaces thoroughly cleaned to the satisfaction of the Owner/PMC.

d) Oil Bound Distemper

Washable oil bound distemper shall conform to IS codes and be of approved make and shade and shall be applied only in dry weather with a broad stiff brush in long parallel strokes.

Priming coats shall be applied to completely dry surfaces as recommended by the manufacturers of patent distempers and approved by the Owner/PMC and allowed to dry thoroughly before the next coat is applied.

Surfaces shall be cleaned and all cracks, holes and surface defects repaired with gypsum and allowed to set hard. All irregularities shall be removed by sand papering smooth and wiped clean and surfaces so prepared shall be completely dry and free from dust before distempering is commenced. In the case of ·newly plastered surfaces special care shall be taken to ensure that they are completely dry before any application is attempted.

Existing, previously distempered surfaces shall be cleaned of grease, dirt, dust and other deleterious matter and cracks, holes and surface defects repaired with plaster of Paris, allowed to set hard, sand papered smooth and wiped clean. Flaking from previous coatings, if any shall be thoroughly removed.

e) Acrylic Emulsion Paint

Acrylic emulsion paint shall be of approved make, colour and shade to the satisfaction of the Owner/PMC.

Acrylic emulsion paint shall be diluted by the addition of a quantity of water equivalent to half the volume of the paint to be applied. The paint and water shall be thoroughly mixed and then strained through cloth.

Priming coats shall be applied to surfaces by brush and allowed to dry properly; holes and depressions being filled with putty prepared with whitening and plastic emulsion paint and rubbed smooth and dry and touched up with plastic emulsion paint.

Subsequent coats, diluted by the addition of a quantity of water equivalent to about 15% to 20% of the volume of paint to be applied shall be applied to surfaces by brush and allowed to dry thoroughly so

that no brush marks shall be seen.

Surfaces shall be cleaned and all cracks, holes and surface defects repaired with gypsum and allowed to set hard. All irregularities shall be removed by sand papering smooth and wiped clean and surfaces so prepared shall be completely dry and free from dust before painting is commenced. In the case of newly plastered surfaces special care shall be taken to ensure that they are completely dry before any application is attempted.

Existing, previously distempered or painted surfaces shall be cleaned of grease, dirt, dust and other deleterious matter and cracks, holes and surface defects repaired with plaster of Paris allowed to set hard, sand papered smooth and wiped clean. Flaking from previous coatings, if any shall be thoroughly removed.

f) Oil Painting

General

Oil paint shall conform to the relevant Standards and be of the specified make, colour and shade as approved by the Owner/PMC. Materials shall be obtained directly from approved manufacturers and brought to Site in manufacturers' sealed drums and tins for inspection by the Owner/PMC.

Paint for undercoats and finishing coats shall be ready mixed. Mixing by the Contractor shall not be allowed except with the prior written permission of the Owner/PMC, in which case preparation of the ingredients and the control of quality shall be in strict conformity with the manufacturers' recommendations and the relevant Standards and Codes of Practice.

Materials shall be properly stored and protected when not in use with the lids of containers kept tightly closed. Paint in open containers during painting operations shall be covered with a thin layer of turpentine to prevent the formation of skin on the surface.

If required by the Owner/PMC paint supplied by the Contractor shall be quality tested in an approved laboratory as described in IS codes. Rejected paint shall be removed immediately from Site.

Application

Unless otherwise specified, paint may be applied by brush or spray. Brushes of appropriate size shall be either round or oval shaped and shall be maintained carefully throughout the work so as to be pliable and free from loose bristle. All brushes, rollers, implements and the like used for painting shall be cleaned of all foreign matter prior beginning different operations.

Contents of drums and tins shall be well stirred before use and constantly during operations with a small, clean and smooth stick to prevent sedimentation at the bottom of containers.

Painting shall be carried out, as far as possible, in dry, warm weather.

Primer coats shall be applied as soon as surfaces have been cleaned and before the deterioration of surfaces by rust and/or contamination by dust, dirt or any other deleterious material. Sufficient time shall be allowed for one coat of paint to dry before the next is applied.

Painting surfaces shall be protected from sun, rain, condensation, contamination or other surface damage until they are completely dry, 'Wet Paint boards being placed where necessary.

Surface preparation, the application of priming coats, undercoats and finishing coats shall be carried out as specified below or as recommended by the manufacturer.

New plaster shall be carefully rubbed smooth and thoroughly cleaned with fresh water to leave dry and smooth surfaces free from dirt. Surfaces shall not be primed or painted until they are completely dry and hard and have been approved by the Owner/PMC.

Steel surfaces shall be degreased using proprietary brand solvent cleaners approved by the Owner/PMC or mineral turpentine or petroleum and other petroleum solvents, such as trichloroethylene or other equal and approved alkali solutions or detergents.

De-rusting of steel surfaces shall be done by manual scraping using wire brushes, fine steel-wool, sand

paper and the like, mechanically by sand blasting, shot blasting or by flame cleaning or chemical cleaning by methods approved by the Owner/PMC.

Oil paint shall not be applied to woodwork that is not well seasoned. Surfaces

of woodwork to be painted shall be thoroughly dry, clean and smooth and prepared by using coarse and medium grade sandpaper with finished surf aces free from scratches.

Before applying primers to surfaces of woodwork knotting shall be done with two coats of varnish made by dissolving shellac in methylated spirits of wine or as directed by the Architect.

Plastered surfaces: Primary coats shall consist of equal parts of white and red lead mixed in boiled linseed oil to the required consistency applied uniformly over surfaces to be painted. When dry, all cracks, holes and other such defects shall be filled with a mixture of one part of white lead and 3 parts of ordinary putty. Surfaces shall then be rubbed with sandpaper and dusted clean and an undercoat thinly applied so that plastered surface is saturated.

Steel surfaces: Priming coats shall consist of red lead conforming to BIS codes applied uniformly over surfaces to be painted. On old or previously painted surfaces and new surfaces already primed with red lead, surfaces shall be thoroughly cleaned ad primed with red lead on exposed surfaces as necessary or over whole surfaces as directed by the Owner/PMC.

g) Woodwork surfaces:

Priming coats shall consist of red lead, white lead, raw and boiled linseed oil and patent dryer applied uniformly over surfaces to be painted. When dry, small holes, cracks, open joints and other minor defects shall be stopped with putty made from whitening mixed to proper consistency with raw linseed oil and white lead to facilitate hardening of putty. Surfaces shall then be lightly rubbed down smooth with

sandpaper and dusted clean.

Finishing coats unless otherwise specified, finishing of all surfaces shall consist of two coats of paint of approved make, colour and shade. The second coat of paint shall give a flat, semi-glossy or glossy finish as specified or as directed by the Owner/PMC and shall present on even appearance and show no brush marks.

h) Enamel Painting

a) General

Enamel paint shall conform to the relevant Standards and be of the specified make, colour and shades as approved by shall be obtained directly from approved manufacturers and brought to Site in manufacture & sealed drums and tins for inspection by the Owner/PMC.

Paint for undercoats and finishing coats shall be ready mixed. Mixing by the Contractor shall not be allowed except with the prior written permission of the

Owner/PMC, in which case preparation of the ingredients and the control of quality shall be in strict conformity with the manufacturers' recommendations and the relevant Standards and Codes of Practice.

Materials shall be properly stored and protected when not in use with the lids

of containers kept tightly closed. Paint in open containers during painting operations shall be covered with a thin layer of turpentine to prevent the formation of skin on the surface.

If required by the Owner/PMC paint supplied by the Contractor shall be quality tested in an approved laboratory as described in BIS codes. Rejected paint shall be removed immediately from Site.

b) Application

Unless otherwise specified, paint shall be applied by brush. Brushes of appropriate size shall either round or oval shaped and shall be maintained carefully throughout the work so as to be pliable and free from loose bristles.

All brushes, rollers, implements and the like used for painting shall be cleaned of all foreign matter prior

to beginning different operations.

Contents of drums and tins shall be well stirred before use and constantly during operations with a small clean and smooth stick to prevent sedimentation at the bottom of containers.

Painting shall be carried out, as far as possible, in dry, warm weather.

Primer coats shall be applied as soon as surfaces have been cleaned and before the deterioration of surfaces by rust and/or contamination by dust, dirt or any other deleterious material. Sufficient lime shall be allowed for one coat of paint to dry before the next, is applied.

Painted surfaces shall be protected · from suo, rain condensation, contamination or other surface damage until they are completely dry, wet Paint boards being placed where necessary Surface preparation, the application of priming coats, undercoats and finishing coats shall be carried out as specified below or as recommended by the manufacturer.

New plaster shall be carefully rubbed smooth and thoroughly cleaned with fresh water to leave dry and smooth surfaces free from dirt. Surfaces shall not be primed or painted until they are completely dry and hard and have been approved by the Owner/PMC.

Steel surfaces shall be degreased using proprietary brand solvent cleaners approved by the Owner/PMC or mineral turpentine or petroleum and other petroleum solvents, such as trichloroethylene or other equal and approved alkali solutions or detergents.

De-rusting of steel surfaces shall be done by manual scraping using wire brushes, fine steel-wool, sand paper and the like, mechanically by sand blasting, shot blasting or by flame cleaning or chemical cleaning by methods approved by the Owner/PMC.

Enamel paint shall not be applied to woodwork that is not well seasoned. Surfaces of woodwork to be painted shall be thoroughly dry clean and smooth and prepared by using coarse and medium grade sandpaper with finished surfaces free from scratches.

Before applying primer to surfaces of woodwork knotting shall be done with two coats of varnish made by dissolving shellac in methylated spirits of wine or as directed by the Architect.

Plastered surfaces: Priming coats shall consist of equal parts of white and red lead mixed in boiled linseed oil to the required consistency applied uniformly over surfaces to be painted. When dry, all cracks, holes and other such defects shall be filled with a mixture of one part of white lead and 3 parts of ordinary putty. Surfaces shall then be rubbed with sandpaper and dusted clean and an undercoat thinly applied so that plastered surfaces are saturated.

Steel surfaces: Priming coats shall consist of red lead conforming to IS codes applied uniformly over surfaces to be painted. On old or previously painted surfaces and new surfaces already primed with red lead, surfaces shall be thoroughly cleaned and primed with red lead on exposed surfaces as necessary or over whole surfaces as directed by the Owner/PMC.

Woodworker surfaces: Priming coats shall consist of red lead, white lead, raw and boiled linseed oil and patent dryers applied uniformly over surfaces to be painted. When dry, small holes, cracks, open joints and other minor defects shall be stopped with putty made from whitening mixed to proper consistency with raw linseed oil and white lead to facilitate hardening of putty. Surfaces shall then be tightly rubbed down smooth with sandpaper and dusted clean.

Finishing coats: Unless otherwise specified, finishing of all surfaces shall consist of two coats of synthetic enamel paint of approved make, colour and shade. The second coat of paint shall give a flat, semi-glossy or glossy finish as specified or as directed by the Owner/PMC and shall present on even appearance and show no brush marks

i) French Polishing

a) Materials

French sprit polish shall conform to BIS codes and shall be made by dissolving 0.15 Kg of best quality shellac, free from resin or dirt in 1 litre of methylated spirit. Suitable pigment shall be added to obtain the required shade or colour.

b) Workmanship

Surfaces to be polished shall be cleaned and all unevenness rubbed smooth with sandpaper, knots, if Visible, being covered with a preparation of red lead and glue. Holes and indentations in surfaces shall be filled with putty made of whiting and linseed oil. Surfaces shall then be given a coat of filler comprising 2.25 Kg of whiting dissolved in .5 litres of methylated spirit. Dry surfaces shall again be rubber down perfectly smooth with sandpaper and wiped clean.

Polish shall be applied by using pieces of clean fine cotton cloth wrapped around cotton wool made into pads. Pads shall be moistened with polish sparingly, but uniformly and completely over the entire surface. When dry a further coat shall be applied in the same way. Finishing shall be carried out with pads covered with a fresh pieces of clean, fine cotton cloth, slightly dampened with methylated spirit, rubbing tightly and quickly with a circular motion, to give a uniform, high class texture.

j) Wax Polishing

Wax polishing shall be approved quality and make and brought to Site in sealed containers as marketed by the manufacturers.

Woodwork to be polished shall be thoroughly cleaned, stopped and rubbed down perfectly smooth with different grades of sandpaper, the final rubbing done with sandpaper slightly moistened with linseed oil.

Polish shall be applied evenly with clean cloth pads in such a way as to leave no blank patches and rubbed continuously for at least thirty minutes. When surfaces are dry, the second coat shall be applied and rubbed for not less than two hours until surfaces have assumed a uniform gloss, showing no signs of stickiness when touched.

k) Varnishing

a) Materials

Varnish shall be of an approved make and quality.

b) Workmanship

Surfaces to be varnished shall be cleaned and all unevenness rubbed smooth with sandpaper. Knots, if visible, being covered with a preparation of red lead and glue Holes and indentations in surfaces shall be filled with putty made of whiting and linseed oil. Surfaces shall then be given a coat of filler comprising 2.25 Kg of whiting dissolved in 1.5 litres of methylated spirit. When dry, surfaces shall again be rubbed down perfectly smooth with sandpaper and wiped clean.

After preparation of surfaces two coats of clean boiled linseed oil shall be applied and allowed to dry thoroughly. When dry, two coats of varnish shall be applied rally by brush and spread evenly over portions of surfaces with short, light strokes to avoid frothing. Excess varnish shall be scraped out from brushes and varnished portions crossed and laid off lightly. Once varnish begins to set it shall not be touched. If surfaces fail to produce the required gloss, additional coats shall be applied to the satisfaction of the Owner/PMC

at the Contractor's cost and expense.

iii. Polyurethane Paint

Polyurethane paint shall be of approved make and shall be applied as per manufacturer’s printed specifications.

It shall be a three coat application. It can be done either by using a brush, spray or a roller. It shall be available in variety of decorative finishes i.e. in almost all shades and in glossy and matt finishes. It shall offer the following properties

a) Adhesion to concrete / metal surface/wooden surface

b) Sealing effect against heavy rain

c) Good Water vapor diffusion

d) Weather resistance, color stability, gloss retention and chalk resistance

e) Resistance to disinfectants, chemical, fire, radiation, acid gases, abrasion and wear

f) Low soil adhesion

g) Scratch and Mar resistance

h) Have long life and excellent gloss

It shall absorb UV radiation and shall be easily cleaned of radioactive contamination. The ultraviolet part of the solar radiation shall not affect the coating and thereby shall be long lasting. a) Materials

Aliphatic grade “Metal coat” applicable for metal surfaces shall be used, comprised of Isocyanides hardener to be used in conjunction with Acrylic Polyol. The colour shall be as approved by the Consultant..

b) Application

Surface shall be properly cleaned and applied with suitable primer as per manufacturer’s specifications. If surface is not smooth, it shall be treated

with metal putty and primer.

Two coat of metal coat of thickness 25 to 30 microns shall be applied by spray and finished smooth.

Si No.	Parameter	Glossy	Matt	Remarks
1	Product composition	PU	PU	
2	Pack	Two	Two	
3	Shade	As approved		
4a	Viscosity by FC b4 at 30 Deg. C (Seconds) a) Part – A b) Mix	 45 – 50 30 - 35	 45 – 50 30 – 35	
4b	Application Viscosity	22 -25	22 - 25	
5	Specific Gravity	0.98 – 1.2	1.16 – 1.3	
6	Solid Content	42 – 55	55 – 56	
7	Thinner Recommended	930/1000	930/1000	
8	Thinner Intake	10 -15%	10-15%	
9	Mode of Application	Spray	Spray	
10	Curing schedule surface dry hard dry	30 Minutes On	30 Minutes On	
11	Mixing Ratio	4:1	6:1	
12	Finish	Smooth	Smooth	
13	Recommended DFT (U)	25--30	25-30	
14	Glass (%)	90-90	15-20	At 60

iv. Melamine Polish

The melamine polish shall be of best quality and make, as approve`d by the Owner/PMC. It shall be transparent or opaque, as specified by the Owner/PMC.

It shall give silken, smooth finish. The Melamine polish shall have shade and shine, either satin or glossy, as approved by the Owner/PMC. It shall be two component polishes consisting of a base and hardener. It shall be capable of protecting wood from moisture, heat, cold, scratches, stains, cigarette burns etc. It shall have excellent covering capacity. It shall be applicable to all wooden surface of every shape. It shall be applied using brush or spray gun. It shall require lesser time to dry and there shall be no cracks or pealing off of the polish. There shall not be any undulation on the finished surface nor cracks at joints. It shall be of any desired shade as approved by the Architect. It shall have excellent colour, shall be free flowing and shall have good leveling properties. It shall be durable and flexible to absorb cracks. It shall have resistant to scrubs, light rays, heat etc. complete as per architect or Owner/PMC.

Timber works shall be finished by the application of two coats and catalyzed clear lacquer (melamine) wherever it is indicated in the drawing/specified. The finish shall be a stain semi-gloss finish and shall be carried out as follows:-

a) The base shall be sand papered to the desired finish and coated with a colour tings to give it shade. This shade shall be sealed with a coat of spirit finish.

b) b) After the base, first coat of melamine shall be applied evenly by spray to give as even coat to the veneer surface.

c) c) After the first coat has fully dried, the surface shall be rubbed down in the direction of the veneer grain with very fine glass paper and left completely smooth and clean before the second coat is applied.

d) d) When the second coat of melamine is fully dry, the surface shall be rubbed down in the direction of veneer grain with very wire dipped in a petroleum based wax to give lubrication.

e) e) Twenty four hours after completion of this process the melamine veneer surface shall be finished by burnishing a soft cloth to an approved finish.

v. Texture Paint

The external wall/ internal walls /wooden surface wherever specified in the drawings/schedule of quantities shall be finished with approved textured

finish. The specifications shall be as per manufacturer recommendations for the approved products. The sample of shade at textured finish shall be as approved by Owner/PMC.

vi. Acrylic Emulsion Paint

The internal walls of the building where-ever shown on drawings shall be painted with 100% Acrylic Exterior Emulsion Paint with 3 mm thick putty and applying two coat of weather proof exterior acrylic emulsion paint of approved make over one coat of primer from the same manufacturer after preparation

of the surface all as per IS & CPWD specifications & manufacturer’s instructions.

vii. Plaster Of Paris/ Gypsum Plaster Punning

Where specified the walls and ceilings are to be treated with plaster of Paris / Gypsum plaster over cement plaster.

The particular brand of in gradients forming this special plaster and its composition to be used must be previously approved by the Owner/PMC. The entire surface must be of a very smooth surface and minutest unevenness must be removed. Specially trained skilled labour with previous experience of this type work shall have to be employed for the purpose to achieve high grade finish.

27. False Ceiling

i. False ceiling using min.12-mm gypsum board, Glass Reinforced Gypsum Decorative

type ceiling tiles, and Mineral fibre boards/ tiles, plaster of Paris, cornices/ mouldings, (of thickness as per approved drawings) etc, with metal frame work in grid formation, suspended from RCC ceiling complete including making true horizontal levels etc. as per manufacturer's guidelines.

ii. Insulation shall be provided wherever required on the basis of new false ceiling & AIC boxing as per layout requirements. It shall be minimum 50mm thick mineral wool backed with 0.05mm thick aluminium foil & 0.05mmX25mm mesh wire netting fixed with 1.6mm wire ties., A/C boxing with new continuous supply & return air grill, diffusers, shall be provided and fixed and augmented as per the specifications provided complete in all respects.

iii. False ceiling with mineral fibre tiles with nominal' size of 600x600 mm shall be provided as per approved drawings specifications & layout requirements.

iv. Suspended grid shall be & anodised aluminium or colour coated mild steel T-sections type of panels as per manufacturer's specifications.

v. Ceiling shall be capable for housing all service for electrical, air conditioning, LAN & Fire detection/ Fighting etc. Ceiling shall be finished with Acrylic paint /texture paint / wooden veneer/ laminate as per drawings and details, of approved make and quality.

vi. Continuous recess and suspended trough for housing electrical fixtures including any other fixtures as required shall be provided. Stepping and domed profile (having mirror or carbonate sheet finish) as per drawings shall be provided. Cedar wood mouldings out of 20x12 mm and POP cornices out of 50 x 38 mm or with other suitable sizes of cedar wood mouldings & POP cornices shall be provided as per approved drawings & specifications. False ceiling shall be kept free at wall partition junctions.

vii. All cut outs, access panels as required shall be provided, easy access for future maintenance and provision to augment the services in future without the need to

dismantle work surface and or partition /panel shall be provided. Item shall be complete in all respects as per drawings, specifications and directions of Owner/PMC.

a) Plaster Of Paris (Gypsum Anhydrous) Tiles Ceiling

b) Pressed Metal Section Framework For Suspended Ceiling

i. The main load bearing member shall be C shape rectangular tube/ channel with two horizontal 28mm and one vertical 50mm sided and each ends of the C turned down9mm, fabricated of 22 gauge (0.80mm) G.I. Sheet. The cross runner shall be furring channel with 50mm horizontal side, two vertical 10mm and two ends

turned flat 15mm onwards, fabricated out of 24 gauge (0.63mm) G.I. sheet. Wall angle shall be 25mm x 25mm, 24 gauge (0.63mm).

ii. The hangers or suspenders shall comprise 6mm dia. M.S bars, painted with a

coat of steel primer of approved make. These will be fixed to ‘L’ cleats of M.S 25 mm x 25mm x 5mm and 75mm long fixed to the soffit of the of the roof slab with metallic expansion fasteners. The hanger rods of required length shall have threaded end with 2 M.S check nuts at the lower end fixed into holding clamp of size 75mm x 28mm and of manufacturer approved by Owner/PMC, connected with existing AC duct shall be allowing level adjustment. The clamp will hold main runners which shall be running at not more than 1 metre centres in one direction. The cross runner with open side of the channel at top shall be placed below the main runner at right angles at distance as directed by the Owner/PMC but not exceeding 450mm centres in one direction. These will be anchored and screwed properly with main runners at every crossing with a 12 SWG, G.I. wire clip fixed diagonally around the main runner. The cross runners shall be fixed at centres not exceeding 300mm.

iii. The wall angles shall be properly secured to walls with rowel plugs and screws and the ends of main and cross runners shall be supported on wall angle

c) Mineral Fibre Tiles False Ceiling

i. Standards- Description Reference for Codes In general Shall be as per B.S. or equivalent Indian Suspension system Exposed semi recessed suspension system

- Weight Approximately 3.5 kg / sqm.
- Light reflectance Shall be greater than 83%
- Humidity resistance Shall be about 95% RH
- Fire performance
- Reaction Class 0 / Class 1 (BS 476)
- Resistance One hour fire rating
- Acoustical criteria
- NRC (Noise reduction coefficient) 0.55 to 0.9
- Sound Absorption 0.5
- Sound Attenuation 0.32 decibels
- Thermal conductivity 0.052 to 0.057 W/moK

ii. Materials -The mineral fibre boards shall be of shall be of approved make, design, shade and quality. The tiles shall be of specified size 600mm x 600mm and thickness as approved. The tiles have straight and square edges and shall be free from any breakages, marks, stains or bends.

iii. Framework -The supporting framework shall comprise of sections of specified size and weight as per the requirements of the Employer. The main runner shall be appropriately spaced and fixed to soffit by approved hangers. End hangers shall be at a suitable distance from the adjacent wall.

The cross tees shall be appropriately interlocked (both ways) between main runner to form a required module or grid. The wall angle shall be fixed to the wall at specified space intervals.

iv. Workmanship - The ceiling shall be erected in a continuous sequence. All work in mthis section shall be performed in an efficient manner as per the instructions of the architect and as per manufacturer's recommended procedures. The assembly shall be of the semi recessed type and shall be designed to meet the needs of performance, durability and aesthetics. The contractor shall make adequate provisions for adequate supports for lighting fittings, making cut-outs and extra framework for light fixtures, A.C. grills, diffusers, speakers, trap doors, sprinklers, sensors, all detectors, etc., complete all as per lay-out / pattern as shown in drawing, as per manufacture's recommendations, as per approved shop drawings.

v. Protection - Prior to installation, the material shall be stored in a dry and clean area which is enclosed and protected from rain or other causes of excessive moisture and stabilised in the area for not less than 24 hours prior to installation.

vi. Testing - The false ceiling system installed shall be tested for straightness and levels. The panels shall be true to shape and size as specified and shall be from any bends, scratches or visible marks, patches etc. The framework should be carefully examined for rigidity. If there is any sag, the panels should be dismantled and re-erected complete to the satisfaction of the Owner/PMC.

The maximum sag permissible shall be as per that defined in relevant B.S. or equivalent Indian standards.

d) Water Resistant Gypsum False Ceiling

i. Standards- Description Reference for codes In general Shall be as per B.S. or equivalent Indian standards.

- Suspension system Exposed semi recessed suspension system
- Weight Approximately 6 kg / sqm.
- Light reflectance shall be greater than 85%
- Humidity resistance shall be about 100% RH
- Fire performance

Reaction Class 0 / Class 1 (BS 476)

- Thermal conductivity 0.17 W/moK

ii. Materials- Water Resistant Glass Reinforced Fibre Gypsum Tiles- The water resistant fibre tiles shall be of approved make, design, shade and quality. The tiles shall be of specified size and thickness. The tiles have straight and square edges and shall be free from any breakages, marks, stains or bends.

iii. Framework- The supporting framework shall comprise of sections of specified size and weight as per the specific requirements. The main runner shall be appropriately spaced and fixed to soffit by approved hangers. End hangers shall be at a suitable distance from the adjacent wall. The cross tees shall be appropriately interlocked (both ways) between main runner to form a required module or grid. The wall angle shall be fixed to the wall at specified space intervals.

iv. Workmanship- The ceiling shall be erected in a continuous sequence. All work in this section shall be performed in an efficient manner as per the instructions of the architect and as per manufacturer's recommended procedures. The assembly shall be of the semi-recessed type and shall be designed to meet the needs of performance, durability and aesthetics. The contractor shall make adequate provisions for supports for lighting fittings, making cut-outs and extra framework for light fixtures, A.C. grills, speakers, trap doors, sprinklers, sensors, all detectors, etc., complete all as per lay-out / pattern as shown in drawing and as per manufacture's recommendations.

v. Protection- Prior to installation, the material shall be stored in a dry and clean area which is enclosed and the material shall be allowed to stabilise in the area for not less than 24 hours prior to installation. Also care should be taken such that the material does not bear the weight of any unauthorised loads.

vi. Testing - The false ceiling system installed shall be tested for straightness and levels. The panels shall be true to shape and size as specified and shall be from any bends, scratches or visible marks, patches etc. The framework should be carefully examined for rigidity. If there is any sag, the panels should be dismantled and re-erected complete to the satisfaction of the Owner/PMC. The maximum sag permissible shall be as per that defined in relevant B.S. or equivalent Indian standards

e) Fire Seals

In order to stop the spread of the fire through the various openings in wall, slab etc. for various services, fire seals suitable as per application are to be used to sustain fire etc. for at least 120 minutes. The same should be used wherever there is pipe crossing, shall not be paid extra and shall be part of Ceiling / Partition / Panelling etc. items.

i. Pipe Wrap -Wherever there is pipe crossing, pipe wrap of approved make to be used. The pipe wrap should be able to prevent the passage of smoke, toxic gases and fire through gaps in compartment walls and floors cause by the collapse and/or melting of combustible services in the event of fire.

ii. Fire Collars -Fire collars of approved make are to be used wherever plastic pipes and cables penetrate the fire rated element as per manufactures' specifications.

iii. Fire Barrier -Fire barriers of approved make to be used to prevent spread of fire through openings in fire resistant walls and floors where these are used for passage of cable tray, ducts etc.

28. Roof Sheeting Works

i) Material

Embossed polycarbonate sheets of required thickness, in clear required colour, both side uv equivalent coating of 40 microns, with one surface plain and having granular embossing on one surface, light transmission - 72%, impact strength of more than 200 joules.

ii) Laying

To be fixed over a MS structure with aluminium channels –alcox fittings (top plate and bottom plate to be fixed with a self-tapping screw) and epdm gaskets. all junctions shall be sealed with silicone sealants to achieve complete water tightness of the whole system.

iii) Technical data

i) Polycarbonate sheets : as per IS codes

High Impact Strength : >200Nm (falling dart test)-Virtually unbreakable

Good Weather-ability : Continuous temp. (40oC) to (+100oC)

UV Protection : Avoids discoloring

Light Weight : Sp. Gravity – 1.2

Design Freedom : Can be cold bended/curved

ii) EPDM Rubber Gasket

With Hardness : as per ASTM-D2240 and specific

Gravity as per ISO-2781 strength per ASTMD412

iii) Aluminum Section : as per IS codes Alloy – 6063 with tempering T6

iv) MS Square/Rectangular : as per IS codes with YST-section 240.

29. Cement Based Polymer Adhesive

(All Adhesive Shall have VOC limits as per LEED GOLD guidelines)

1. Tile adhesive complies with the BS: 5980 with latest edition. The adhesive shall be polymer modified cement based adhesive. The adhesive should be able to fixing tiles, natural stones in exterior and interior use including swimming pool.

2. Adhesive should be able to improve adhesion, reduce water permeability and widen application. It should be able to fixing upto 6 mm thickness.

3. It should possess low shrinkage and should be flexible to accommodate physical and thermal movements.

4. It should be able to use for indoor and outdoor application.

30. Cementitious Grout

1. The grout shall be of high quality, water resistant, cement based powder grout for grouting ceramic tile, vitrified tile, industrial tile etc.

2. It should be available in all colors to match the tile color. It should have high strength for maximum load bearing. It should be non-shrink, non-bleeding and nonsegregating at fluid consistency.

3. It should not contain any chlorides and or additives which may contribute the corrosion of the structure.

4. It should be weather resistant, non-cracking, non-shrinking. The compressive strength, linear shrinkage, tensile strength and flexural strength should be according to the BS codes.

31. Epoxy Grout

1. It should be hygienic, hard wearing, impervious, epoxy resin based ceramic tile grout with a high degree of resistance to chemical attack, abrasion and impact.

2. The grout should not transfer taints to food stuffs and should not permit the entry of bacteria or dirt and easily maintained in a sterile condition.

3. It should be available in all colors to match the color of the tile color. It should attain very good early strength. It should possess good chemical resistance to acid, alkalies etc.

4. It should possess good tensile and flexural strength and it has a very good dynamic load resistance.

32. Lacquered Glass

Providing and fixing of 6 to 8 mm thick lacquer glass of approved make, color with clear neutral silicon of approved make on a perfectly levelled water proof non-conventional plywood (preferably marine plywood) of minimum 12mm thickness, mounted on the RCC wall/any other structure. The lacquered glass to be of 8mm thick highly durable, humid resistance, poly urethane lacquer glass. The glass should be manufactured by industrial curtain coating process. Lacquered glass to be manufactured to right specifications, relating to consistency of color, opacity and homogeneity throughout production campaigns and also to the ageing properties, mechanical resistance, and resistance to humidity and to chemical agents of the lacquer. The color of the lacquer should remain stable when exposed to normal levels of ultra-violet light in interior applications. Permissible tolerances in the color measurements, on the glass side:

Δ L * ±0.5

Δ has * ±0.5

Δ B * ±0.5

Δ E*ab < 0.5

The value Δ E*ab is an average value of measurements taken from the same production run. The color-

meter used is normally a MINOLTA spectrophotometer CM508I (as per standard test conditions). Manufacturer certificate to be provided.

33. Wood Work And Joinery

The Contractor shall be responsible for providing all plant, tools, materials, labour and all things necessary for the proper execution, completion and maintenance of the works.

Timber

Timber used for joinery shall be the best of its respective class, seasoned for a minimum of six months by air-drying, of natural growth and free from defects such as cracks, splits, shakes, dead knots, soft spongy spots and waves of injurious open stakes. When one kind of timber is used it shall be of uniform colour to the satisfaction of the Architect.

Grains shall be reasonably larger than 6 square centimetres and the aggregate of all knots shall not exceed 0.5% area of any one piece.

Timber shall be kiln dried to IS codes and conform to IS codes in regard to moisture content. The maximum permissible limit shall be +3% for the average moisture content of all samples from a given lot and +5% from individual samples from a given lot. This shall apply when the thickness of timber is more than 50mm. Small size timber tolerances shall be +/- 2% and +/- 3% respectively.

The Contractor shall provide samples of all timber and other materials to be used in the work for the approval of the Architect. All timber and other materials brought on to the Site shall strictly comply with the approved samples.

Timber shall be seasoned, chemically treated and treated with a 10 (ten) year guaranteed and approved anti-termite treatment to render it free from decay and insect attack.

The moisture content of the timber during manufacture, delivery to site, storage, site working, assembly, installation shall be 10 to 12 percent.

Timber shall be hardwood, shall be FSC certified and shall be suitable for the purpose for which it is intended. It shall be seasoned or Kiln dried, absolutely free from worm holes, large loose or dead Knots or other defects which would effect strength or usability and shall be flat, straight non-splitting and dressed on all sides. It shall be matched for colours and graining. Recycled wood or rapidly renewable wood can also be used such as poplar, eucalyptus, bamboo etc only after confirmation of Owner/PMC.

Doors

Doors shall be solid core flush doors as described, external flush doors being made with weatherproof plywood. Flush doors shall conform to IS codes and commercial veneers and laminates shall conform to IS codes. and shall be obtained from approved manufacturers. The solid core shall be wood laminates prepared from battens of well seasoned

and treated good quality wood having straight grains.

The finished thickness of the door shutter shall not be less than 40mm and door frame size shall not be less than 75mm x 120mm.

Decorative veneers shall be Grade 1 and conform to the requirements for decorative veneers specified for Grade 1 decorative plywood interior grade with a thickness not exceeding 1 mm.

Lippings shall be of best quality hardwood. Teak lippings, where described, shall conform to the specification for best quality teakwood. Lippings around doors shall be of one piece not less than 25mm wide with a depth equal to the door thickness. Double leaf doors shall have lippings on the meeting stiles not less than 35/40 mm deep.

Approved plastic or laminated veneers shall be provided where specified and fixed with “Fevicol” or other equal and approved adhesive. Finished surfaces shall be thoroughly cleaned with wax polish.

All hardware shall be of approved finish, shade, specification, type as provided in the Tender document.
Windows

Windows shall be as specified and, unless otherwise described, shutters shall have one pair of hinges, two tower bolts (one 225mm long and the other 150mm long), one handle and one hook with eye and a pegstay. Ventilators shall have two mild steel holdfasts and hinges, one handle and one hook and eye at each end with one tower bolt in the centre.

Cupboards And Cabinets Cupboards, wooden cabinets shall be provided as per approved drawings. Doors may be either hinged type or sliding type as detailed. The cabinetry shall be in 19mm thick marine grade plywood frame work as per the detailed drawings. Intermediate shelves /drawers shall be made in 19/12mm thick marine grade plywood frame work, the drawers shall be provided with imported telescopic drawer channels of approved make. All the exposed wooden surfaces shall be stained to shade as directed by the Consultant/ Owner/PMC and polished melamine. This also includes providing necessary handles, hinges, tower bolts, ball catches, locks etc. of approved make.

Architraves

Railings and architraves shall conform to the shape shown on the drawings or as approved by the Consultant/Owner/PMC and fixed by means of screws, counter- sunk or otherwise, or bolts.

Glazing In Windows, Doors

Glazed windows, louvers, ventilators and doors shall be provided with either clear, float or pinheaded glass 5.5mm thick or as otherwise described, shall be free from all blemishes and conform to IS codes.

Ironmongery And Fittings

Fittings and fixtures and other ironmongery shall be as detailed drawing and shall comply with the relevant IS Standards and Codes of Practice.

All nails, screws, fixings, and the like shall be of hot dip galvanized or brass or nonferrous material as described.

Workmanship

i) General

Workmanship shall be of the best quality and the Contractor shall check all dimensions on Site prior to putting joinery work in hand.

All joinery work shall be accurately set out in strict accordance with the drawings and shall be framed together in the best possible manner and with the best possible method of jointing.

No timber shall be painted, tarred, oiled or the like before it has been inspected by the Consultant /PMC. Any effort to hide defects by plugging, painting and the like shall lead to the timber being rejected by the Consultant/PMC. All rejected timber shall be immediately removed from the Site.

Thickness specified for wrought timber are, unless otherwise specified, prior to planning and an allowance of 3mm shall be made for wrought faces.

Sawing and planning of timber shall be done in straight lines and planes to produce uniform thickness. Joinery work shall be wrought on all faces and finished off by hand with sandpaper with slightly rounded arises.

Before joining wood frame members shall be planed smooth and accurate to the final size. Rebates, roundings, mouldings and the like shall be made before the members are jointed.

Mortice and tenon and dovetailed joints as required shall be strong, neat and shall fit without wedging and/or filling. Joints of frames shall be pinned with 10 to 15mm diameter hardwood pins and white lead after the members have been glued and pressed together.

Joinery work which splits, fractures, shrinks or shows flaws or other defects due to unsoundness, inadequate seasoning or bad workmanship shall be immediately removed and replaced with sound material at the Contractor’s own cost.

ii) Door and Window Frames

Door, window and ventilator frames, transoms and mullions shall be rebated. Top frame members of doors and top and bottom frame members of windows and ventilators shall project about 150mm in brickwork. Vertical members of doorframes shall project about 50mm below finished floor levels.

Door and window frames shall be provided on each side with 3 nos. 225 x 25 x 6mm mild steel flat split hold-fasts which shall be built into masonry or cast into concrete work in accordance with IS codes.

Frames shall be finished smooth to receive paint, polish or any other specified finish. Surfaces of timber fixed to masonry or concrete shall be painted with hot bitumen coal tar or any other approved wood preservative or primer before being placed in position.

iii) Door and Window Shutters

Door and window shutters shall conform to the requirements of IS codes If required, flush door panels shall be tested in accordance with the requirements of IS codes.

All faces of door and window shutters shall be at right angles, free from twist and warp in the plane. Faces shall be sanded to obtain a smooth, even texture.

Shutters shall be painted on the commercial side with two coats of synthetic enamel paint over an approved coat of primer. Decorative veneer sides shall be wax or French or Melamine polished with two or more coats as specified.

Double leaf shutters shall have meeting stiles rebated 20mm deep and shall be either splayed or square type with teak wood lipping not less than 35/40 mm deep.

Care shall be taken to prevent damage of any kind or loss of shape during transport, handling, stacking and hanging.

Fixing

The carpentry timber shall be fixed with nails, spikes, bolts screws, hangers, stirrups, anchors, ties or any other accessories which are suitable to develop the full strength of the member to which they are attached, as directed.

Carpentry timber where fixed to solid masonry or concrete shall be secured with expansion bolts or other positive methods of mechanical fastening. MS hold fast grouted in CC block shall be used to hold the door frames.

Timber - Treatment

All timber shall be protected with an organic solvent water repellent wood preservative to give a highly efficient protection against termite, spider, worm, all insects and fungus and rot attach and shall, where exposed, enhance the appearance of the timber. Colour of the product shall be such as to bring out the natural colour of the respective timbers. Fire retardant paint to timber shall be applied as per the recommendations of manufacturer and shall comply with the requirement of IS. code and local fire requirements.

34. Plastic Laminate

Plastic decorative laminate sheeting shall be of the approved make, colour, shade and texture. Plastic laminate shall be fire retardant to class I of BS:476 code where specified. The thickness shall be 1mm /1.5mm and shall be fixed on to doors/ partitions/ paneling/ boxing etc. with approved adhesive and tapes. Laminate to be fixed in panels of width as specified in drawings including wood edge margin/ laminate on panel edges and grooves behind complete in all respect as per direction and specification/ details and as directed by architect. All grooves to be finished in melamine polish in matching color of laminate.

35. Veneers

Veneer shall be of the timber species of shown on drawings. Veneers are to be kept in sequence as they are being cut from wood and supplied as such to the site for accurate matching or figuring. The veneer shall be finished as specified and shall be equal or superior quality to that laid down in IS codes or as approved.

36. Plywood

All ply wood shall be of best / high quality close grained suitable for veneering, painting or bonding plastic laminate. The thickness shall be as specified in drawings or as approved by Owner/PMC. It shall be resin bonded and weather proof. Exposed edges shall be finished with an edge strip of solid teak wood. tongued and grooved and glued , or as detailed. The plywood of approved brand and manufacture only shall be used in the work. The thickness shall be in accordance with the drawings /schedule of quantities.

37. Medium Density Fibre Board

For Interior Works MDF of approved make /manufacturer shall be of only exterior grade as per IS codes.. It is to be contained that MDF shall be invariably used in place of Ply / Boards .so specified in the specifications of either same thickness or of higher thickness .wherever feasible The minimum thickness of MDF to be used shall be 8mm. Wood screws are not to be used for MDF and only fully threaded parallel shank screws shall be used after drilling pilot holes. Veneering /lamination to the MDF surface shall be done by exterior grade adhesive only. Polyurethane primers shall be used for sealing the edges and painting the rear side. For specifications of various applications the manufacturer users manual shall be followed.

i) Adhesives:-

The adhesives used for all wood work and MDF shall be of approved make of appropriate Grade with Low VOC content as per IS codes requirements. Manufacturer's recommendations shall be followed for adhesive other than above required for any specified / specialized work.

ii) Joinery:-

Joinery shall be carried out strictly in accordance with the drawings, where joints are not specifically indicated recognized forms of joints shall be used. Joinery shall conform to IS Standards.

Panels shall be rendered flame retardant and to conform to local fire regulations.

The Contractor shall submit samples of all materials including samples of veneer for approval.

All materials pre-fabricated, delivered and assembled shall be in accordance with the approved sample.

The Contractor shall be responsible for protecting all items of wood-work done by him. The contractor shall replace at his own expense any damaged work caused through lack of adequate protection or care in installation or handling.

38. Mirrors and Glasses

Mirrors shall be fabricated from best clear plate or float glass of approved quality in imported variety and shall match the International Standards. All fixed panel mirrors shall be +/- 0.30mm tolerance. The edges of mirrors shall be polished and bevelled and mitred as per IS specifications wherever, it's indicated in the drawing. All vision glasses shall be float glass of minimum 5mm thickness or as specified thickness. The edges shall be bevelled as indicated in drawings and shall be done at

approved source. The Etching wherever specified in drawings, shall be done at approved sources as per full-scale drawing approved by the Owner/PMC. The etched panel shall be chemically

washed /treated as per specialist specifications to have a permanent dust free surface.

The Contractor shall be responsible for protecting all mirrors and glasses fixed by him and shall replace at his own expense any broken or damaged mirror / glass caused through lack of adequate protection or care in installation or handling.

39. Fire Doors General Specifications

1. Fire Doors (General)

Fire resisting, means that the construction is designated as capable of resisting the passage of flame and smoke, and providing insulation as defined in under the prescribed conditions of test appropriate to such construction in accordance with the current Indian Standard codes.

2. Scope

This specification covers the design, supply of materials, Manufacture and installation of factory made special type of approved make fire doors of 1 Hour, 2 Hrs. Fire Rating with all accessories and including supply and installation of hardware

3. Codes and Standards

All standards, specifications, acts, and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.

4. General

The Contractor shall furnish all materials, labour, operations, equipment, tools & plant, scaffolding and incidentals necessary and required for the completion of all metal work in connection with steel doors, as called for in the drawings, specifications and bill of quantities which cover the major requirements only. Anything called for in the tender documents shall be considered as applicable to the items of work concerned. The supply and installation of additional fastenings, accessory features and other items not specifically mentioned, but which are necessary to make a complete functioning installation shall form a part of this contract.

All metal work shall be free from defects, impairing strength, durability and appearance and shall be of the best quality for purposes specified made with structural proprieties to withstand safety strains, stresses to which they shall normally be subjected to.

All fittings shall be of high quality and as specified and as per approval. The Contractor shall strictly follow, at all stages of work, the stipulations contained in the Indian Standard codes and the provisions of the safety code and the provision of the safety rules as specified in the General Conditions of the Contract for ensuring safety of men and materials.

Any approval, instructions, permission, checking, review, etc., whatsoever by the Owner/PMC, shall not relieve the Contractor of his responsibility and obligation regarding adequacy, correctness, completeness, safety, strength, quality, workmanship, etc.

5. Hollow Metal Fire Door (2 Hours Fire Rating) with Honey Comb Core

Fire door shall be 2 hour fire rated and door quality shall be approved and tested conformed to Indian Standard Codes and NBC-2016 requirements.

(i) Frame

- Material - Frame to be manufactured from 1.60 mm (16 gauge) galvanised steel sheets complying with latest IS Code coating class zinc coating mill phosphatized.
- Profile - Door frame profile to be double rebated of dimensions 143 mm X 57 mm (+/-0.3) with bending radius of 1.4 mm.
- Manufacture - Frame to be manufactured from 1.60 mm thick galvanised steel sheet to the specified profiles and dimensions. Frames manufactured at factory shall be knock down form with butt joints for bolted assembly at site.
- Door frame preparations – Frames to be provided with a 3 mm thick back plates on all jambs with provision for anchor bolt fixing to wall openings. All frames to have reinforcement pads for fixing of door closer, at appropriate location as per manufacturer’s details.
- Frames to have factory finish-pre-punched cut outs to receive specific hardware and iron mongery.

- Frames to be provided with hinge plates 3 mm thick pre-drilled to receive hinges for screw mounted fixing. All cut outs including hinge plates, strike plates to have mortar guard covers from inside to prevent cement, dust ingress into cut outs at the time of grouting.
- Frames to have rubber shutter silencer on strike jambs for single shutter frames and on the head jambs for double shutter frames.
- Finish Door frames to be suitably cleaned with solvents and etch primered for receiving primer and top coats. Door frames to be primered in zinc phosphate stoving primer (35 microns DFT). Door frames to be finished in thermo setting paint (35 microns DFT) of approved colour and make as specified.

(ii) Fire door shutter

a) Material - Fire door shutter to be manufactured from 1.20 mm (18 gauge) galvanized sheets conforming to latest to Indian Standard Codes and NBC-2016 requirements, coating class zinc coating, mill phosphatized.

b) Manufacture - Shutters to be press formed to 46 mm thick double skin hollow door with lock seam joints at stile edges. Shutters to have no visible screws or fasteners on either face. Internal reinforcement to be provided at top bottom and stile edges for desired fire rating.

c) Door Shutter Cores – Shutters to be provided with honeycomb Kraft paper core to be bounded to the inner faces of the shutter.

d) Door shutter preparations – Shutters to be factory prepared with pre-punched cut outs and reinforcements to receive iron monger as per final finish hardware schedule. The shutter should have an interlocking arrangement at this stile edges for flat surface on either side.

e) Shutters to have pre-drilled hinge plates with hinge guard covers. Shutters with locks to have concealed lock box with lock fixing brackets with pre-tapped holes.

f) For shutter with door closer reinforcement pads to be provided at appropriate location as per manufacturer's design.

g) All ironmongery preparation to have adequate reinforcement for flushes fixing at site.

h) Vision panel for Fire rated door- Vision panel to be provided with Borosilicate clear toughened glass of the thickness 6 mm for upto two hours fire rating. Glass to be fixed with clip on frames for square and rectangular vision panels and with spin turned rings for circular vision panels and Glazing Tape with one side adhesive. Vision Panels to be fixed with clip-on frames for square and rectangular Vision Panels with no visible screws. Unless otherwise specified standard sizes are 200 mm x 300 mm and 380 mm diameter.

i) Finish - Shutters to be suitably cleaned with solvents and etch primered for receiving primer and top coats. Shutters to be primered in zinc phosphate stoving primer (35 microns DFT). Shutters to be finished in thermo setting paint (35 microns DFT) of approved colour and make as specified.

j) Packing - Frame -Individual frames members to be wrapped in protective 70 micron polyethene sheets and placed in individual card board boxes. Individual boxes to be sealed. Frames to be assembled at site with aid of roofing bolts.

Shutters- Shutters to be wrapped in protective 70-micron polyethene sheets and packed in card board and duly strapped. All frames and shutters duly marked as per door schedule for easy identification at site.

k) STORAGE - All knocked down frames shall be stacked flat and shutters vertically on wooden runners and suitably covered as per the instructions of manufacturer to prevent rust and damage.

40. Cement Board on wall

Fixing 8 to 10 mm thick fibre cement board (cement sheet) wall cladding/lining of approved make such as Shera Board, Everest Fibre Cement Board, Visaka Vnext, BISON Panel or equivalent, on galvanized iron (GI) framework comprising 50 mm wide floor and ceiling channels and vertical studs of required size and spacing, securely fixed to wall, floor and ceiling with approved fasteners. The cement boards shall be cut to required dimensions and fixed with corrosion-resistant self-drilling screws at recommended spacing. Joints between boards shall be treated with fibre mesh tape and approved

jointing compound to obtain a smooth, flush surface. The work shall include all supporting framework, brackets, screws, sealants, edge trims, cut-outs for electrical and plumbing services, scaffolding, labour, tools and tackles complete. The finished surface shall be ready to receive paint, texture coating, laminate, veneer or any specified finish as per approved drawings and manufacturer's recommendations, complete in all respects.

Approved Makes

- Shera Board
- Everest Fibre Cement Board
- Visaka Vnext
- BISON Panel
- Ramco Hilux

Technical Parameters

Particular	Specification
Board Type	Fibre Cement Board
Thickness	8 mm / 10 mm / 12 mm (as specified)
Framework	Galvanized Iron Sections
Fasteners	Self-drilling corrosion-resistant screws
Joint Treatment	Fibre mesh tape with jointing compound
Fire Resistance	As per manufacturer's certification
Moisture Resistance	Suitable for dry and semi-wet areas
Finish	Paint

41. Steel Works

1 Rolling Shutters

Rolling shutters shall be in extruded galvanized sections, of approved make, type and finish. These shutters shall be complete with locking arrangements, hoods, guides, pulling devices, springs and other accessories. Wherever specified, mechanical device shall be fixed for easy operation of the shutters.

2 Steel Door / Window

Hot rolled steel sections for fabrication of steel doors, windows, ventilators and fixed lights shall conform to IS codes. Shapes weights and designations of hot rolled sections shall be as per IS codes indicates the purpose or the situation where the sections are normally used. Tolerance in thickness of the sections shall be+0.2mm. The steel doors and windows shall be according to the specified sizes and design. The size of doors and windows shall be calculated, so as to allow 1.25 cm clearance on all the four sides of opening to allow for easy fitting of doors windows and ventilators into opening. The actual sizes of doors, windows and ventilators shall not vary by more than +1.5mm from those given in the drawing.

- Fabrication

a) Frames - Both the fixed and opening frames shall be made of sections which have been cut to length and mitred. The corner of fixed and opening frames shall be welded to form a solid fused welded joint conforming to the requirements given below. All frames shall be square and flat. The process of welding adopted shall be flash butt welding. The section for glazing shall be tennoned and riveted into the frames

and where they intersect the vertical tie shall be broached and horizontal tee threads through it, and the intersection closed by hydraulic pressure.

b) Requirements of welded joints

- Visual Inspection Test

When two opposite corners of the frame are cut, paint removed and inspected, the joint shall conform to the following:

o Welds should have been made all along the place of meeting the members and tack welding shall not be permitted.

o Welds should have been properly grounded and

o Complete cross section of the corner shall be checked up to see that the joint is completely solid and there are no cavities visible.

- Micro and Macro Examinations

From the two opposite corners obtained for visual test, the flanges of the sections shall be cut with the help of the sections shall be cut with the help of a saw. The cut surface of the remaining portions shall be polished, etched and examined. The polished and etched faces of the weld and the base metal shall be free from cracks and reasonably free from under cutting, overlaps, gross porosity and entrapped slag.

- Fillet Weld Test

The fillet weld in the remaining portion of the joint shall be fractured by hammering. The fractured surfaces shall be free from slag inclusion porosity, crack penetration defects and fusion defects.

- Door

The hinges shall be of 50mm projecting type, Non-projecting type hinges may also be used if approved by the Owner/PMC. The hinge pin shall be of electro-galvanized steel or aluminium alloy of suitable thickness and size. Door handles shall be approved by the Owner/PMC. A suitable latch locks for door openable both from inside and outside shall be provided.

In the case of double doors, the first closing leaf shall be the left hand leaf locking at the door from the push side. The first closing shutter shall have a concealed steel bolt at top and bottom. The bolts shall be so constructed as not to work loose or drop by its own weight.

Single and double shutter door may be provided with a three way bolting device. Where the device is provided in the case of double shutters, concealed brass or steel bolts shall not be provided.

- Windows

a) For fixed windows, the frames shall be fabricated as per relevant IS codes specifications.

b) Side hung windows.

For fixing steel hinges, slots shall be cut in the fixed frame and hinges inserted inside and welded to the frame at the back. The hinges shall be of projecting type with

thickness not less than 3.15 mm and length not less than 65mm and width not more than 25mm. Non-projecting type hinges may also be allowed if approved by the Owner/PMC. The diameter of hinge pins shall not be less than 6mm. The hinge pin and washer shall be of galvanised steel or aluminium alloy of suitable thickness.

For fixing hinges to inside frame, the method described above may be adopted but the weld shall be cleaned, or the holes made in the inside frame and hinge revetted.

The handle of side hung shutters shall be pressed brass, cast brass, aluminium or steel protected against rusting and shall be mounted on a steel plate. Thickness of handle shall not be less than 3 mm in case of steel or brass and 3.5mm in case of aluminium. The handle plate shall be welded, screwed and/or riveted to the opening frame in such a manner that it should be fixed before the shutter is glazed and should not be easily removable after glazing.

The handle shall have a two point nose which shall engage with a brass or aluminium alloy striking plate on the fixed frame in a slightly opened position as well as closed position. The boss of handle shall

incorporate a friction device to prevent the handle shall incorporate a friction device to prevent the handle from dropping under its own weight and the assembly shall be so designed that the rotation of the handle may not cause it to unscrew from the pin.

The height of the handle plate in each type of standard windows will be as specified. Otherwise it shall be at a height of 3/8 of the height of shutter, from its bottom. The strike plate shall be so designed and fixed in such a position in relation to the handle that with the later bearing against its stop, there shall be adequately tight fit between the casement and outer frames.

In case where no friction type hinges are provided, the window shall be fitted with peg stays which shall be either of black oxidised steel, pressed or cast brass or as specified, 300mm long with steel peg and locking brackets. The pegs stay shall have three holes to open the side hung casement in three different angles. The peg stay shall be of minimum thickness 2mm in case of brass or aluminium and 1.25mm in case of steel. Where specified friction hinges shall be provided. Side hung shutters fitted with friction hinges shall not be provided with a peg stay.

If specified, side hung shutters maybe fitted with an internal removable fly proof screen in a 1.25mm thick sheet steel frame to the outer frame of the shutter by brass turn buckles at the jambs, and brass tads at the sill to allow the screen being readily removed. The windows with removable fly proof screen shall be fitted with a through – the – screen level operator at the sill level to permit the operation of the shutter through an angle of 90o without having to remove the fly proof screen. The lever shall permit keeping the shutter open in minimum three different position.

- Glazing

Specifications as described shall apply. The glass panes shall have square corners and straight edges. The glass panes shall be so cut that it fits slightly loose in the frames. In doors, windows, clerestory windows of bath, WC and lavatories frosted glass panes shall be used.

Glazing shall be provided on the outside of the frame unless otherwise specified. Putty of approved make conforming to IS codes shall be used for fixing glass panes. Putty shall be applied between glass panes and glazing bars. Putty shall then be applied over the glass pane, which shall stop 2 to 3 mm from the sight line of the back rebate to enable the painting to be done upto the sight line to seal the edge of the putty to the glass. The oozed out putty shall be cleaned and from putty cut to straight line. Quantity of putty shall not be less than 185 gm/metre of glass perimeter. Putty shall be painted within 2 to 3 weeks, after glazing is fixed to avoid its cracking.

Note: Putty may be prepared by mixing one part of the white lead with three parts of finely powdered chalk and then adding boiled linseed oil to the mixture to from a stiff paste and adding varnish to the past at the rate of 1 litre of varnish to the paste at the rate of 1 litre of varnish to 18 kg of paste.

Minimum six glazing clips to be provided per glass pane of all types. In case of doors, windows and ventilators without horizontal glazing bars, the glazing clips may be spaced, according to the slots, in the vertical members provided the spacing does not exceed 30cm otherwise the spacing shall be 30cm.

Note: Where large size glass panes are required to be used or where the door window is located in heavily exposed situation, holes for glazing clips have to be drilled prior to fabrication and cannot be done at any later stages. Where specially stipulated, fixing of glass panes may be done with metal or wooden beading instead of mere putty. Where beading are proposed to be used, the manufacturers shall be intimated in advance to drill holes for hard screws. Usually beads shall be fixed with screws spaced not more than 10 cm from each corner and the intermediate not more than 20 cm apart. When glass panes are fixed with wooden or metal beading having mitred joints, a thin layer of putty shall be applied between glass panes and sash bars and also between glass panes and the beading.

Where metal beading is specified extra payment shall be made on this account.

3. T-Iron / Angle Iron/ Pressed Steel Doors Frames

T-iron / Angle Iron/ Pressed steel doors frames shall be manufactured from uniform mild steel tee section / angle section / pressed steel. The steel shall be of approved grade. The frames shall be got fabricated in approved workshop as approved by the Owner/PMC.

The sizes of door frames shall be as per drawing or as decided by the Owner/PMC. MS tie bar of 10mm dia shall be welded at bottom of the frame. The size of doors shall be calculated so as to allow 12.5mm clearance on all sizes to allow an easy fittings in opening. The actual size of doors, windows and ventilators shall not vary by more than +/- 2mm than those shown in the drawing.

The size of T-section / Angle section / Pressed steel used for manufacture of doors, windows and ventilators shall not be less than those specified in IS codes. Unless otherwise directed by the Owner/PMC.

- Fabrications

The frame shall be constructed in section which has been cut to length and metered. The corners of the frames shall be butt welded to form a true and right angle. All frames shall be square and flat.

The T-section / Angle section/ Pressed steel shall be mitre joined and continuously butt welded all along.

- Fittings

Requisite number of holes shall be made in the frame for fixing of fittings. Detailed arrangements of fixing fittings shall be as shown. All fittings shall be fillet welded to Tiron / Angle iron frame/ Pressed steel all along the periphery of contact.

Butt hinges shall be fixed to the frame as below:

a) MS flat of size 100mm x 25mm x 6mm will be welded with fillet weld all along the periphery of contact on the rear side of the web of T-iron / Angle iron/ Pressed steel to receive the hinges. Requisite number of holes shall be made in T-iron / Angle iron frame/ Pressed steel and MS flat for fixing of hinges with counter sunk steel screws as shown.

b) An alternate method of fixing butt hinges can be adopted by fillet welding the hinge to the T-iron / Angle iron/ Pressed steel frame on three sides. No welding shall be done along the hinge pin to allow free movement of butt hinges as shown.

- Fixing Procedure

Fixing procedure for T-iron / Angle iron/ Pressed steel doors, windows and ventilator frames in masonry opening shall be as shown in the drawing.

42. Aluminium Work

1. General

This specification applies to the Aluminium Doors and Window works to be executed by

the contractor. It is to be read in conjunction with and subject to the general and special conditions of contract and in conjunction with the drawings, the schedule of rates and such other documents as may vary from time to time be agreed upon as comprising part of this contract.

This section covers the aspects of technical performance, product specifications, and execution and time warrantee for the works shown or specified.

The exterior wall system requirements shown by the details are intended to establish dimensions of units or modules and maintain the visual design concept as shown. The exterior wall system manufacturer shall be required to design the entire exterior building wall system, and to make whatever modifications of and addition to, the details as may be required to fulfill the performance requirements. The system consists of all anchors, window, glazing, sealants and other components required for a complete system as indicated on drawings including framing as required to support the system independently from the structural frame of the building. This also incorporates for openable windows.

2. Applicable Codes and Standards

The specified reference standards are Codes which are intended to establish the quality of material and workmanship required for the works. More reference standards published in India and other countries may, in the sole judgment of the Owner's consultant, also be acceptable provided that the contractor furnishes sufficient data for the Owner's consultant to determine if the quality of materials and workmanship at least equals or exceeds the specified reference Codes.

The following is the list of codes included for guidance and compliance with applicable portions only and the omission of any from the list does not relieve the contractor from compliance therewith.

ASTM E 283 Air leakage through exterior windows, Curtain walls and Doors.

ASTM E 330 Structural performance of exterior window, Curtain walls and Doors under the influence of wind loads

ASTM E 331 Water penetrations of exterior windows, Curtain walls and Doors by uniform static air pressure differential. Note:

i) Wherever a reference to any standard appears in this specification and as above it shall be taken as a reference to the latest version of the standard.

ii) Contractor to ensure to keep all the above mentioned Codes at site for references.

3. Submittals:

The following submittals are required:

i) Final design construction documents

ii) Documentation showing conformance with performance criteria.

iii) Shop Drawing: The tenderer shall submit for approval of Owner/PMC including detailed shop drawings within 15 days of acceptance of tender giving full details such as size of sections, detail showing sill, jams and lintel end details with civil structure coupling members and method of fixing anchorage, caulking, flashing etc. The tenderer shall also give all mechanical properties of all sections (e.g. perimeters, area, moments of inertia about bending axes, principal axes, principal moments of inertia, weights etc.) in a tabular form.

iv) Design Analysis and Calculations: Include design calculations for review of design loads and member profiles.

v) Samples:

a) Submit three samples of each required metal finish on 300mm (12 inch) long extrusion of the alloys to be used for the work. Where normal colour and texture variations are to be expected, include two or more units in each sample, to show b) the range of such variation.

c) Submit three samples of glass, 300mm (12 inch) square

d) Provide two samples of typical fabricated sections showing joints, fastenings, quality of workmanship, hardware and necessary items before fabrication of the work proceeds.

e) Glazing materials: 300 mm (12 inch) long samples each colour and type required for glazing gaskets and sealant (Silicon/ polysulphide) with its catalogue. All samples to be provided at no cost to the Owner or Architect.

vi) Statement that the system meets the regulatory requirement of all statutory authorities having jurisdiction over the works in respect of fire, thermal aesthetics, mirroring effect, wind, loading, construction and warranty requirement, nothing in detail any exceptions. The statement /under taking shall be signed by a person authorized to legally represent the company.

4. Material:

i) Tempered/ Toughened Glass

Toughened/ Tempered glass shall be examined by the glass manufacturer to detect and discard any glass which exceeds the following tolerance: 1.5mm bow in 600mm: 3mm bow in 1500mm; 6mm bow in 3000mm; 9mm bow in 4500mm. Where the strengthening process results in essentially parallel ripples or waves, the deviation from flatness at any peak shall not exceed 0.13mm and the difference between adjacent peaks shall not exceed 0.13mm. Where bow tolerance and wave tolerance differ, the stricter requirements shall govern. Direction of ripples shall be consistent and in conformance with architectural design.

ii) Float Glass:

Glass that gives distorted reflections will not be accepted. Reflections due to pressure, paints poor manufacturing process, uneven thickness or poor storage are some of the reasons for distortion. All clear float glass quality should conform to BS – 952 and ASTM C 1036 – 90.

iii) Scratches: Viewed from a distance of 3m, scratches not longer than 76mm shall be allowed only within 76 mm of an edge, or in an area of the glass through which a person normally would not be looking.

5. Construction:

i) General:

All fasteners into and through aluminium shall be non-magnetic stainless steel.

Free and noiseless movement of all components of the exterior wall system due to thermal effect, structural effect, wind pressure, erection or dead load shall be achieved without strain to glass without buckling of any component and without excessive stress to any members or assemblies.

Aluminium surfaces in contact with mortar, concrete, plaster, masonry, wetapplication of the fire proofing and absorptive materials shall be coated with an antigalvanic, moisture-barrier material.

Contact between aluminium and dissimilar metals excluding non-magnetic stainless steel shall receive an isolation membrane for the prevention of electrolytic action and corrosion. ii) Waterproofing:-

A complete drainage system must be incorporated into the exterior wall frame. Water leakage and condensation shall be drained or discharged to exterior face of the wall, and all internal spaces shall be vented by acceptable means to ensure air pressure equalization.

Drainage system shall be sealed off per floor height to prevent infiltrated water from leaking to lower floors.

Movement of water behind and on exposed surfaces must be controlled to ensure that water is not retained and that elements will not be damaged or corroded by water and to minimize the potential for algae and fungus growth as a result of standing or trapped water.

iii) Anchorage System and Building frame

Each mullion will be fixed to the structural steel slab at each floor level. All steel fasteners supplied by the contractor will be galvanized to minimum 80-90 microns (as per IS codes 610gms/ Sqm). Any fasteners to be cast in concrete will be supplied and delivered to site & installed by the contractor. The contractor will coordinate with the main contractor to check the building frame and the exact pointing of fixing bolts or angles on site.

The contractor will also make necessary modifications to the anchor ties to suit different site conditions of steel reinforcement without additional charges.

iv) Mullions and Transoms:-

The Sections of mullions and transoms shall be designed to withstand deflection and wind pressure as described in specifications and shall be rigid enough to support and retain the glass and spandrel under all conditions.

Reinforcing member, where used, shall be completely enclosed and if fabricated from steel shall be galvanized.

The frames shall be formed by approved Colour anodized (25 micron) in AC – 25 grade aluminium section with provision to receive fixed glass, construction variation as indicated.

Sections of the frame shall be cut and profiled for assembly in the best workmanlike manner and finished in a neat and weather-proof construction, with proper tempering of aluminium sections.

All dimensions of the Aluminium glazing shall conform to the overall sizes shown on the drawings. They shall be fabricated to proven and tested detail designs. All parts shall be supplied ready for fixing and complete with all necessary fittings. Samples of typical sections shall be submitted with the tender. The exact dimensions for frame work shall be physically checked at site before starting fabrication.

Before final fabrication is started the contractor will erect a mock-up which will include at least two fixed panels & at least one vent (window) and get same approved.

v) Open able Sash and Ventilator:-

a) Hardware for aluminium windows shall be designed to adequately perform the function for which it is intended and shall be securely attached to the window, and/or adjacent window. The hardware shall withstand the designed wind pressure both in open & closed window position.

The openable sash and ventilator when in closed portion will remain water tight under all weather conditions & passes the water tightness tests as specified.

b) Hinges shall be concealed stainless steel hardware. All hardware and accessories shall be supplied by the Aluminium work contractor, and when exposed, shall be of colour and finish to match members where possible.

Numbers and strength of hardware shall comply with the wind load requirement.

Proposal on the complete set of hardware to be used shall be submitted along with the tender.

The detailed system of the openable sash and ventilator must be proposed by the tenderer as shown on the drawings.

6. Lightning Protection

The contractor shall provide the connectivity for Lighting Protection system in the curtain glazing as per the International Standard and shall also give the requirement of earth pits for the Lighting protection. The Aluminium Work contractor shall install all necessary conductors, wiring connection etc. for the curtain wall. The electrical contractor will be responsible for constructing the earthing system for the lowest point of the curtain wall to ground level.

Proposal on the lightning protection system shall be endorsed by a qualified lightning protection engineer. The whole of the system shall be tested to ensure its compliance with the requirements as laid down in the Indian Standard Code at the cost of the contractor.

7 Mock-Up

Prior to beginning production, furnish and install a sample each for a full size mock

up. Production of any item shall not proceed until the mock up is approved. Mock up with shop drawings shall be submitted for review prior to manufacturing. Use materials, fabrication and installation methods identical with those required for the project.

8 Design Responsibility and Performance Requirements

Manufacturer shall be required to design systems to conform to design intent of profiles shown and design criteria specified, allowing for dead loads, wind pressures, thermal movements, earthquake, forces, erection loads and other conditions of usage which may reasonably be anticipated.

General:

The requirements shown by the details are intended to establish basic dimension of unit area modules and provide site line of members. The manufacturer shall be required to design the entire system, and to make whatever requirements as may be required to fulfil the performance requirements to maintain the visual design concept as shown, including member size and alignment of component.

Wind Pressure

Fabricate exterior windows, doors to withstand the wind pressure shown or if not shown 200 kg/sqm for straight portion and 225 Kg/Sqm for Curved portion including glass and other claddings for both positive and negative sides.

Temperature Variation

Thermal expansion and contraction movements resulting from an ambient temperature range of 2 to 50oc. which may cause a metal surface with temperature variation.

Weather Resistance:

Fabricate exterior units with weather stripping to prevent from uncontrolled penetration of air and water under normal shear weather conditions.

The manufacturer shall be responsible for methods and means of joining fabrication, assembly, suspension, erection and compliance with all design criteria.

9 Quality Assurance

General

The works shall conform to IS codes specifications for Aluminium glazing latest editions and in its absence the standards published in other countries.

Test units It is required to perform all tests unless otherwise noted each portion of exterior wall system for both frame and glazing (fixed/ openable) to the satisfaction of Project Manager.

Tests

Following tests are to be performed as per relevant standards.

- Air infiltration test
- Water Penetration under Static Pressure
- Water Penetration under dynamic pressure
- Uniform load deflection test
- Uniform load structural test
- Testing anchor's to resist seismic stresses without damage of any kind
- Wind resistance test
- Anodising testing.

Deflections shall be measured at the centre line members and at other critical points as deemed appropriate.

10. Site Conditions:

Manufacturer is to take field measurements prior to preparation of shop drawings and

fabrication to ensure proper fitting of work. However, proceed with fabrication and coordination installation tolerances as necessary when field measurements might delay work.

11. Product Handling, Transport, Storage and Protection:

Protect units and finishes in manner that will not cause damage or discoloration to units by covering exposed surface with thick layer clear transparent lacquer or selfadhesive non- staining PVC tape before they are brought on site. The lacquer/ tapeshall be removed on completion of erection/ wet Civil work after approval of Project Manager.

12. Products

Materials: All materials and finishes are to be new and free from defects which may impair the appearance, strength, function and durability of the exterior window system and related construction of the external coverings.

i) Aluminium: The aluminium-extruded sections shall conform IS designation HE/HV/9WP alloy with chemical composition and mechanical properties as per IS codes wall thicknesses to meet required loadings, with minimum for trim being 2.6mm. Test certificate for alloy and its extrusion from the manufacturer is required to be submitted by the contractor for its conformity. Recycled aluminium of approved make shall be used for IS codes and no extra shall be admissible on this account.

ii) Coating/Anodizing: All aluminium sections shall be anodized or powder coated. Anodizing shall conform to IS codes and shall be of AC 25 grade with minimum thickness of 25 +/- 3 microns when measured as per IS codes and the density shall

be at least 32mg/square inch. All sections are to be matt anodized in colour as per sample available with the architects. The anodic coating shall be properly scaled by steam or boiling in de-ionized water as per IS. In case of powder coating, factory applied electrostatic powder coated sections 60+/- 5 micron will be considered for approval. Colour consistency shall be accurate. Abrasion Resistance shall confirm to IS codes.

No visual variation in shade shall be permitted. The fabricator shall clearly indicate

the shade variation tolerance as measured by standard equipment.

Structural and weather seal silicone sealant with Low VOC content of approved make duly approved is to be provided at shop and field joints which are sealed as part of assembly and installation procedures. It is to be applied appropriate for joint sizes, movement and substrate. Preshimmed tape shall be used against surfaces withgrooves having backer rod at the groove of sufficient size and spacing to prevent shim migration.

Polysulphide sealant is to be applied between wall surface and door & window frames in clear shade with preshimmed tape to prevent shim migration.

iii) Glass and glazing:

External glass shall be Double glazed unit as per specifications and details provided in Tender Document.

Glass thickness shown is minimum thickness and shall be as per requirement to withstand loads criteria and their performance.

For all the glasses in glazing works 'edge distance' is to be clearly ascertained and maintained.

iv) Glazing Gaskets and Weather strips:

EPDM extruded gaskets of hardener 40+5 durometer shore A for sponge gaskets, 75+5 durometer shore A for hollow profiles and 60+5 for solid profiles having exception for flame propagation are to be used.

All interior corners of gaskets where compatible with procedures are to be vulcanized. Provide gaskets with continuous splines for positive engagements in splines pockets in frame members.

Gasket profiles are to be designed taking into cognizance the glass edge pressures and the required edge distance.

- Setting Blocks and Shims: Solid extruded EPDM with hardeners 85+5 durometer shore A, minimum length 100mm minimum width corresponding to glass thickness.
- Side Blocks: Solid extruded EPDM 55+5 shore A durometer block shall be of sufficient length to prevent point loading on glass.
- Hardware: To be as per approved samples. Design and fixing of hardware shall be got approved by the Architects. The joining accessories shall be such that they do not cause any bimetallic action and shall be free from visible defects. Visible screws to be anodized made up of stainless steel.
- Fasteners and anchor devices: Fasteners shall be concealed and as approved by Owner/PMC.

Mild steel supports sections of curtain walls should be hot dip galvanized and are to be separated by nylon or fiber gaskets, washers, sleeves and the like.

Fasteners used for bolting aluminium extrusions and their connecting members shall be aluminium or stainless steel. Fastener metals for joining various metal combinations shall be as follows:-

- Aluminium to aluminium- Use only aluminium or stainless steel
- Aluminium to stainless steel - Use only stainless steel
- Stainless steel to stainless steel - Use only stainless steel
- All exposed fastener materials are to be in stainless steel and anodised, except required otherwise.

The Contractor is required to submit test certificates to prove compatibility of any materials or components as required by the Architect/ Owner/PMC in charge without any additional cost for its conformance to the relevant standards.

13. Fabrication

The details shown are based upon standard details by one or more manufacturers. Similar details by other approved manufacturer will be acceptable provided they comply with the size requirements.

Shop Fabrication

a) Aluminium glazing shall be fabricated from extruded aluminium member of alloys specified. Complete the cutting, fitting forming, drilling and grinding of all metal work prior to cleaning, finishing, treatment and application of coatings. Remove arises from cut edges and ease edges and corners to a reading of approx. 4mm.

b) Fabricate and shop assemble frame and sash members into complete window wall system as indicated along with anchors for support to the structure and with hair line joints where mechanical fasteners are used.

c) No bolts, screws or fastenings to impair independent movement.

d) Openable windows, typically, shall be fabricated to allow for inside glazing.

e) Miter all corners and mechanically stake over solid aluminium corner block, set and sealed in epoxy leaving hairline joinery and then seal weather tight.

f) Joinery methods must not discolor finish or be unsightly. Welding and brazing to comply with industry standards using system and rods for assembly and fabrication.

g) All frame corners and meeting rail intersection shall be made permanently leak proof.

h) Fasteners should be concealed except where otherwise shown, indicated or approved.

i) Provision for anchorage to the structure allowing for erection tolerances, thermal expansion and building deflections to make the unit vibration free with no visible or audible evidence of movement.

j) For glass to be fixed with minimum 'edge clearance' and 'bite' on glass, cutting is to be done precisely taking into consideration the recommendations by glass manufacturers, and design parameters along with performance requirement and gaskets and other practical considerations. Do not nip glass edges. Edges may be wheel cut or sawed and seamed at manufacturer's option. For glass to be cut at site, provide glass larger than required so as to obtain clean cut edges without the necessity of seaming or nipping Grind, polish, and ease arises, nip or abrade glass after heat tempering.

k) For weather stripping by EPDM extruded gaskets provision shall be made to insure that water will not accumulate and remain in contact with the perimeter areas of glass and securely staking and joining at corners.

l) All glass pockets, fixed and moving, shall be weeped to provide positive drainage. Water shall be weeped to the exterior via frame weep slots protected by snap-in weep covers integral drips.

m) Except as otherwise indicated provide each continuous unit of framework and all accessory items as a packaged unit. Complete the fabricated assembly, finishing and all other work to the greatest extent possible in the factory before brought to the project site. Disassemble only to the extent necessary for transportation and installation.

n) After fabrication all glazing units (including disassembled parts) shall carry their designation viz., W-1, G-2 etc., size and location to be fixed well identified through self-adhesive non-staining removable PVC tape.

o) Fire stopping: Preformed incombustible insulation with retaining devices to meet the building code requirements. Insulation shall be of required depth to maintain required floor to floor fire separation and of sufficient width to ensure that it fills all voids under compression.

14. Execution

Inspection

Examine all parts of supporting structure, the areas and conditions under which work comprising of glazing items, and associated items are to be executed. Identify conditions detrimental to the proper and timely completion of the work and proceed with the work after getting the unsatisfactory conditions corrected, if any.

Co-Ordination

Wherever possible, check actual opening in the construction work by accurate field measurements before fabrication and execution as well. Show recorded deviation if any, on final shop drawings and co-ordinate installation within fabrication tolerance to ensure proper fit of units/ modules.

Preparation

Co-ordinate setting drawings, diagram templates, instructions and directions for the installation of anchorages which are to be embedded in concrete or masonry construction.

Bench marks for elevations and building line-offset marks for alignment shall be established on each floor level by the contractor who shall be responsible for their accuracy. Should any error be found in

their location the contractor so notify in writing and shall proceed in the affected areas after the errors have been corrected/ rectified.

Silicone sealant shall be applied all-round the junctions of window/ door frames and walls adjoining as per architectural drawings/ shop drawings and manufacturer instructions through an experienced applicator only.

15. Installation

The installation of fabricated frames shall commence when called for by the Owner/PMC. This shall be properly coordinated with the finishing works.

Installation of frame works shall be done under direction and supervision of manufacturer's representative.

All parts of the work shall be erected in plumb, level and true to line in proper alignment and in relation to established lines and grades and as shown on approved shop and or erection drawings without warp or rack of frames, sash or panels while positioning. Anchor securely in place. Separate corrodible metal surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

Do not install defective component parts including warped, bowed, dented, abraded and broken members or glass with edge damage. Remove and replace members/ unit which have been damaged prior to installation.

Do not cut, trim, weld or braze component parts during erection in any manner which would damage the finish, decrease the strength, or result in a visual imperfection or a failure in performance. Return component parts which require alteration to the shop for re-fabrication or for replacement by new parts.

Install component parts in level, plumb and true to line with uniform joints and reveals. Secure to structure with no staining and non-corrosive shims, anchors, fasteners, spacers and fillers. Use erection equipment which will not mar or stain finished surfaces or damage the component part in any way.

16. Erection Tolerances

Dimensional variation in the building frame and/ or work surrounding or surrounding the work are as determined in the field by field measurement of the work in place.

The work shall be designed to accommodate all tolerances and anticipated dead and live load movement, creep, sway and torsion of the structure without any harmful effects. All parts of the work, when completed shall be within the following tolerance:

- General: 3mm (1/8 inch) maximum deviation in any storey height or in any 3m (10 ft) vertical or angular run or in any 6m (20 ft) horizontal run.

6mm (1/4 inch) maximum deviation in any 12.2 m (40-ft) runs, any direction.

- Locational: 3mm (1/8") maximum change in deviation for any member for any 3m (10 ft) run, any direction.

9mm (3/8 inch) total maximum deviation for any member at any location.

- Offsets: Limit offsets in the end to end and edge to edge alignments of adjoining and consecutive members, which form planes, continuous runs and profiles to the following:

Slope or curvature shall not exceed 2% when measured at intervals of 25mm (1 inch) in any direction.

4mm (1/6 inch) maximum offset in flush alignments including alignments which are to be 13mm (1/2 inch) or less out of flush and alignments which separated

50mm (2 inch) or less by a reveal or protrusion in the plane of the wall.

3mm (1/8 inch) maximum offset in alignments which are out of flush by more than 13.0mm (1/2 inch) or separated by a reveal or protrusion in the plane of the wall.

Maximum offset from true alignment between two members abutting end-to-end, edge to edge in line or separated by less than 76mm, 0.8mm (shop and /or field joints 0< This limiting conditions shall prevail under both no load and full load conditions.

All aluminium frames shall be kept protected after installation by lacquer/ tape to avoid scratches by others.

17. Sealant

Sealing materials for sealing shall be structural or weather seal silicone sealant of approved make used in strict accordance with the manufacturer's printed instructions and shall be applied only by applicators/ mechanics specially trained or experienced in their use. Before applying sealant all dirt, dust, moisture and other foreign matter shall be completely removed from surfaces and shall be masked, when required, to maintain a clean and neat appearance. This shall provide a smooth finish surface.

18. Anchorage

Anchorage of the work to the structure shall be by approved methods in strict accordance with approved shop and/ or erection drawings. Supporting framework and brackets shall be so designed as to provide three dimensional adjustments and accurate location of all components. After the unit is properly positioned all connections so designated on approved shop drawings shall be rigidly fixed bywelding or other positive means.

Anchor component parts securely in place as shown by bolting, welding or other permanent mechanical attachment system which will comply with performance requirements and permit movements which are intended or necessary. Install slip joint lining wherever possible to ensure movement as in tended or necessary.

Wherever concealed contact surface or dissimilar materials before assembly or installation is existing or wherever there is the possibility of corrosive or electrolytic action, apply a suitable bituminous coating of approx. 0.76m (0.03 inch) dry film thickness or other suitable ermanent separator.

19. Setting

Set all members and other members in a bed of compounder with joint fillers or gaskets to provide weather tight construction.

20. Cleaning, Protection And Security

Clean debris, dust and other substances caused during erection and keep the scrap, if any, away from the site.

The installed frames, sections and other components of aluminium glazing work in passages and exit(s) shall be kept protected and guarded for any damage by other working contractor's workmen.

21. Glazing:

General:

Before glazing, openings shall be checked to see that they are square, plumb and true plane. If found otherwise glazing shall not proceed until proper corrections are made. Inspect each piece of vision glass immediately before installation. Eliminate all which have edge damage or face imperfections.

Preparation Comply with recommendations and requirements of glass manufacturers for installation of all glass.

Clean glazing channels, stop and rabbets to receive glazing materials of obstructions and deleterious substances, which might impair the work.

Apply primer or sealer to joint surfaces wherever recommended by gasket manufacturer.

Clean with solvent all glass edges and faces which will be in contact with gaskets to remove all traces of cutting oils and other contaminates.

Setting Blocks and Spacers

Locate setting blocks of proper size at sill one quarter in from each end of the glass unless otherwise recommended by the glass manufacturer. Set blocks in this course of the heel-bead compound, if recommended.

Provide spacers for all glass sizes larger than a combined total of 1.27m or more for any two adjacent sides to separate glass from stops, except where continuous glazing gaskets are provided. Locate spacers no further than 600mm apart and no closer than 300mm to a corner. Place spacers opposite one another. Make bite of spacer on glass a nominal 6mm or greater.

Installation

Glasses shall be installed and blocked in such a manner as to ensure proper glass bite on all sides. Correct glass sizes to insure glass bite shall be verified by measurement of the frames. Protect glass from edge damage at all times during handling installation and subsequent construction operation. Required glazing channel dimensions are to be provided as per glass size for necessary minimum 13mm bite on the glass, minimum edge clearance and adequate sealant thickness with reasonable tolerances.

Provide the correct glass size for each opening, within the tolerances and necessary dimensions by identified numbering from fabrication. Perimeter clearance must be sufficient to avoid all point loading. All structural silicone sealant to be applied by approved applicator of the manufacturer.

Provide watertight and airtight installation of each piece of glass so as to with stand temperature changes, wind forces and other effects as enumerated and specified.

43. Structural Glazing/DGU windows

1. General

The complete structural glazing should contain at least 20% recycled content. The minimum VLT of structural glazing should be 25% as per green building requirements or as specified in design document or as per design requirements.

The Contract Documents define only the design intent and general performance requirements. The Contractor is entrusted with total responsibility for design, structural calculations, shop drawings, fabrications, installation, warranties, certifications and related documentation. The Contractor shall be entirely responsible for the design, fabrication and erection of the systems, and all work shall be performed entirely by his own forces. Design approved metal framing members to accommodate expansion and contraction of components without buckling, creating stress on glass, structural components and fasteners, joint seals or other damaging effects.

The Contractor shall provide to sealant manufacturer samples of all relevant substrates, including finished aluminum, coated glass, gaskets, setting blocks and brackets. Sealant manufacturer shall perform tests to verify adhesion, staining and chemical compatibility. The Contractor shall use sealants and substrates only in combinations for which favorable addition and compatibility results have been obtained. Aluminum surfaces in contact with mortar, concrete, plaster, masonry, wet application of the fire proofing and absorptive materials shall be coated with an anti-galvanic, moisture barrier material.

2. Samples

Sample of one typical panel shall be fabricated, assembled and installed for approval. It shall be of type as per approved drawings. All samples shall be provided at no cost to the Owner.

3. Design Considerations:

The Contractor should possess adequate engineering background and facilities inclusive of trained system personnel from their parent company and should be able to prove their design and engineering capabilities to meet structural design parameters. The Contractor shall submit structural calculations for the system and it shall be stamped and signed by a qualified structural engineer, including mock-up complying with current design rules of the relevant aluminum code include analysis for wind, dead loads, deflections and if appropriate seismic loads on framing members and anchors. All Curtain glazing shall have mechanical joints shall be designed to withstand a wind load of 200 kgs per sqm or as per Indian standard codes whichever is more. The design shall also ensure that the maximum deflection of any member shall not exceed 1/175 of the span between supports or 20mm, whichever is less for vertical elements & 1/250 of the span between supports for horizontal elements. Air leakage through windows should not exceed 0.60 Cu.ft/Sq.ft. Minimum design pressures both inward, outward and acting perpendicular to glass (including return surfaces) shall be per the requirements the Wind Loading as Indian standard codes and earthquake regulations.

The framing members should be designed such that deflection perpendicular to the wall plane of any unsupported span shall not exceed 1/175 or 20mm whichever is the least, under the required design load both positive and negative. Also no failure of structural silicone Jolts, damage to joinery, components, or permanent set in the framing members in excess of 0.2 percent of the span shall occur under 1.5 times the design load. Deflection in the wall plane of any glazed horizontal span should not

exceed ½ the glass edge clearance dimension below. The Contractor shall also submit the calculations for the structural silicone joint, size as required.

4. Water Tightness

A complete drainage system must be incorporated into the curtain wall frame. Water leakage and condensation shall be drained or discharged to exterior face of the wall and all internal spaces shall be vented by acceptable means to ensure air-pressure equalization when possible.

Drainage system shall be sealed off per floor height to prevent infiltrated water from leaking to lower floors.

Movement of water behind and on exposed surfaces must be controlled to ensure that water is not retained and that elements will not be damaged or corroded by water and to minimize the potential for algae and fungus growth as a result of standing or trapped water.

5. Shop Drawings

The Contractor shall prepare detailed shop drawings incorporating all allowances for construction and fabrication tolerances.

The Contractor shall submit detailed shop drawings for all components of glazing works.

The Employer's review will be conformance to the design concept and for the general arrangement only. And such review shall not relieve the Contractor of any responsibilities as stated herein or any other applicable items herein specified.

The Shop drawings shall show joinery techniques, provisions for horizontal and vertical expansion, glass and metal thickness, framing and anchor member profiles, identification all materials including metal alloys, glass types, fasteners and glazing materials, all shop and field sealants by product name. This shall also show relative layout of all adjacent walls, beams, columns and slabs with all dimensions to each other and grid lines/ dimension position of glass edge relative to metal daylight, anchorage details to the building structure and coping details at the parapet are also to be submitted. The drawing shall also indicate all gaskets, weather strips and Aluminum extrusions and fire seals.

Shop Drawings shall be signed and sealed by a Qualified Structural Engineer with specific experience in Curtain Wall construction and design.

6. Samples:

The Contractor to submit samples for review three (3) sets of labeled samples of each required type and colour of metal finish, on 300mm long sections of aluminum extrusion shapes. Samples must show extremes of colour texture variation. Samples will be reviewed by Owner/PMC for colour and texture only. Compliance with other requirements is the responsibility of the Contractor. Colour and texture range of production material shall match approved samples.

Owner/PMC reserves the right to require samples which will show the fabrication techniques and workmanship of the component parts, and the design of accessories and other exposed auxiliary items, before fabrication of this work proceeds.

7. Aluminium

Extruded aluminum sections should conform to Indian Standards designation HE9WP/HV9WP, the chemical composition requirements of Indian standard codes, and technical properties as laid down in Indian standard codes. Standard commercial tolerances shall apply to finished, fabricated and assembled materials.

- Mullions and Transoms

The sections of mullions and transoms shall be designed to withstand deflection and wind pressure as described in specifications and shall be rigid enough to support and retain the glass and other construction variation as indicated.

Reinforcing member, where used, shall be completely enclosed and if fabricated from steel shall be galvanized and protected with two coats of zinc chromate where welded shall be treated in the same way.

The frames shall be formed by integrated colour anodized aluminum section with provision to receive fixed glass spandrel and other construction variation as indicated.

Sections of the frame shall be cut and profiled for assembly in the best workmanlike manner and finished in a neat and weatherproof construction with proper tempering of aluminum sections.

All dimensions of the curtain wall shall conform to the overall sizes shown on the drawings. They shall be fabricated to proven and tested detail designs. All parts shall be supplied ready for fixing and complete with all necessary fittings. Samples of typical sections shall be submitted with the tender. The exact dimensions for frame work shall be physically checked at site before starting fabrication.

All jolts shall be mechanical, jolted with aluminum angles with stainless steel screws.

8. Silicone Sealant:

The Contractor shall send a sample of anodized/ powder coated aluminum section & reflective glass to the silicon sealant manufacturer and get his approval. A copy of that certificate to be submitted to Owner/PMC . The cost of samples, carriage of the samples and testing charges, if any shall be borne by the Contractor.

The Contractor shall submit, for record only, glass manufacturer's written statement that any insulated glass, reflective glass and spandrel glass is supported by structural silicone is suitable for such application.

The colour/ shade of sealant shall be decided by the Owner/PMC and the Contractor to get approval before procurement.

9. Glass Specification:

Glass specification shall be as per Design parameters specified in Part -B / Section-11/ Volume-III of the tender document.

10. Accessories:

Extruded gaskets, weather stripping, extruded seals and spacers, which do not come into contact with structural silicone sealant shall be of Ethylene Propylene Diene Monomer (EPDM) or approved equivalent. Where in parallel contact with structural silicone sealants, all gaskets, setting blocks and spacers other than foam glazing tapes shall be of heat cur silicone rubber, chemically compatible with the silicone sealant and suitable for the specific purpose intended. All extruded gaskets, weather stripping and spacers other than foam glazing tapes shall have continuous mechanical engagement to framing members adhesive attachment is not acceptable. The cladding system shall be constructed with (and shall maintain during its design life) a standard of seal which shall not result in any reduction of sound insulation performance.

Gaskets, weather stripping and fire seals used to achieve the required waterproofness and/ or air tightness shall be selected to accommodate fully the range of dimensional tolerances associated with fabrication and installation of the cladding system. Gaskets, weather stripping and seals shall be formed from materials capable of retaining their elastic qualities, dimensions and resistance to physical and chemical attack sufficient to maintain the full water tightness, air tightness and acoustic performance for the design life of the curtain wall.

Extruded gaskets, weather stripping, fire seals and spacers mechanically engaged by flutes or pockets extruded in framing member shall be installed without residual tension or extension. Dry lubricants may be used to reduce drag during installation of synthetic rubber extrusions and to induce compression so as to prevent gradual elastic shrinkage and retraction from their ends. Wet lubricants containing detergent shall not be used for any purpose which may bring the liquid into contact with the coated surfaces of vision and spandrel glass.

11. Fabrication & Installation

Installation shall be in true line vertically and horizontally.

Work shall be done by competent workmen who are thoroughly skilled in their trade. Assemblies shall be neat and free of defects that impair strength, function or appearance. The work shall be accomplished in compliance with the specified criteria without buckling opening or joints. Under stress on fasteners, sealants and gaskets, opening of welds cracking of glass leakage noises and other harmful effects.

As far as practicable fitting and assembly of the work shall be done in the shop.

All exposed work shall be carefully matched to produce continuity of line and design. All joints in exposed metal work, unless otherwise shown or specified shall be accurately fitted end rigidly secured with joint sizes conforming to industry standards.

Except where otherwise shown specified or directed the method of assembly and joining shall be as per approved shop drawings. Fabricate and fasten metal work so that the work will not be distorted nor the fasteners over stressed from the expansion and contraction of the metal.

All welding shall be in accordance with the appropriate recommendations of the Indian standard codes and shall be done with electrodes and/ or by methods recommended by the manufacturer of the alloys being welded. All welds behind finished surfaces shall be done as to minimize distortion and/ or dis-coloration on the finished side. All weld spatter and welding oxides on finished surfaces shall be removed by de-scaling and/ or grinding.

Unless otherwise shown or specified, all weld beads or exposed surfaces shall be ground and finished to match and blend with finish on adjacent parent metal. Grinding and polishing of nonferrous metal shall be done only with clean wheels and compounds free from iron and iron compounds. No soldering and/ or brazing shall be allowed.

The Contractor shall conceal all the fasteners where visible in the finished work.

All aluminum components shall fabricate before finishing, Cutting of components will not be acceptable.

As the building is exposed to varying weather actions, all fasteners shall be stainless steel, self-tapping screws with Aluminum brackets. Steel anchors shall be pre-holed and galvanized. The bolts shall be steel chromium plated along with nuts and covered with butyl sealing compound.

Where aluminum comes into contact with masonry, brickwork, concrete, plaster or dissimilar metals, it shall be coated with an approved insulation lacquer, paint or plastic tape to ensure that electro-chemical corrosion is avoided.

The Contractors shall be responsible for placing in position the curtain wall frames for the satisfactory performance and should be totally leak proof for a minimum period of ten years

12. Sealant And Gasket Application

Sealant and gasket shall be provided wherever shown in the drawings or required for a permanently weather tight installation. The sealing mechanism for each location and

use shall be as indicated on drawings in those locations where a mechanism is necessary but is not indicated. It shall be of type recommended by the Contractor and approved by the Owner/PMC .

All adjoining surfaces shall be protected to receive sealants against staining by masking and/ or other methods.

Joints and joint surfaces shall be clean, dry and free of any material that may have an adverse effect on the bonding and/ or seal of the sealant and gasket materials.

Apply sealants and gasket under the conditions recommended by the manufacturer(s) Prime all surface to receive sealants and gasket unless recommended otherwise use no sealant that has started to set in its container or a sealant that has exceeded the self-life published by the manufacturer.

Fill all joints continuously and completely with sealant forming a neat uniform concave bead. Finish the material flush with adjoining surfaces unless otherwise shown on the drawings. All sealant surfaces shall be tooled smooth.

13. Certification: The Contractor shall submit a letter of certification from the sealant manufacturer stating that the sealant has been tested for adhesion and compatibility on production samples of metals, glass, and other glazing components, and that all sealant details and application procedures shown on the reviewed shop Drawings are acceptable for use.

Where the curtain wall and other cladding impinges on, intercepts, covers, is attached to or supported by the work of other trades, for instance at parapet-level junctions with roof membranes and back-up walls, the Contractor’s shop drawing and location drawings shall clearly distinguish elements and components of construction by other.

14. Anchorage System And Building Frame

Each mullion shall be fixed to the structural slab at each floor level. All steel fasteners shall be galvanized to minimum 80-90 microns coated with zinc chromate primer and supplied by the Contractor.

15. Water Tightness

No gross leakage shall be observed when subject to test for water penetration as described in Indian Standard codes as applicable. .

16. Method Statement For Hose Testing At Site:

Test Area:

Area (s) to be tested will be selected by the Owner/PMC in accordance with the standard. The total area will be not more than that can be tested in one day. Testing shall be done at least one area of 100 square feet, in accordance with the test standard, or more, depending on the time, and availability of suitable access to the exterior. In case of failure the prescribed procedure for a reasonable time but not more than that can be completed on the same day shall be followed. The test will be supervised via two-way radio from the inside.

Equipment: Requirements

- (Optional) washing of the area
- Visual checking of test area for snags, visible defects etc.
- A cradle or scaffolding on the exterior at the locations (s) of the test specimen (s) with an operator, a person to stabilise the cradle, a person to hold and point the nozzle, technical person to communicate between the people on the exterior and test engineer.
- Clean water in a minimum ¾" supply hose with approximately 4 bar pressure. Note that the pressure given for the test is with the water flowing, much higher actual pressure is necessary. Water pressure drops 1 bar for every 10m rise in height.
- Drying of test area and application and removal of tape if necessary to locate leaks.

Test Criteria:

Water will be sprayed at a pressure of 30 –35 psi (2.07-2.41 Bar) in accordance with the test standard. The flow rate will not be monitored. The nozzle will be held 30 cm. from the wall spraying 1.5m lengths back and forth along each joint, successively, for five minutes each, working from the bottom up. Joints are interfaces between materials, and where these are less than 120mm apart are to be considered one joint.

Test Procedure

The initial area shall be the width of the cradle. The lowest horizontal joint will be wetted first, covering each 1.5m length in five minutes.

Next the cradle will be positioned so that the first 1.5m above the bottom horizontal joint can be reached and each vertical will be sprayed in turn over a period of 5 minutes.

The cradle will then be raised to test the next 1.5m and then the next horizontal and so on.

Leakage

If there is any leakage the test will be stopped and the procedure described in the Standard will be followed up to the time allowed.

A compliance report suggesting any modification/corrective steps to be taken if any leakage was observed.

17. Field Check Of Glazing Systems For Water Leakage Scope and Purpose

This field check is intended to determine the resistance to water leakage of only those joints, gaskets and sealant details in the glazing which are designed to remain permanently closed and watertight. If operable joints such as those around doors and operable windows occur within the glazing area involved, appropriate modifications both of procedure and performance requirements should be made when testing such joints or details.

Preparation of Wall

All wall framing and/ or wall units shall be installed on the lower two typical floors of the building for curtain wall resting and on the lowest typical floor for storefront testing. The area shall be compressed at least 75 lineal feet and shall be fully glazed to provide a complete wall installation. All of this work shall be done in strict accord with approved shop drawings and job specifications. The architect will then designate an area of the completed wall to be tested. The test area shall be a representative sample of typical construction and shall have no outstanding punch list items or other visible defect. If no test area and/ or location have been identified, an area should be selected by the persons doing the test. This area should be selected to provide representative performance data, usually a minimum of 100 square feet. The area to be tested should include, perimeter caulking, typical splices, frame intersections, and, if applicable at least 2 entire intermediate vertical member and an intermediate horizontal member.

Apparatus

The test shall be conducted using a Type B-25, # 6.30 brass nozzle with a ½" FPT as manufactured by Monarch Manufacturing Works., Inc. The nozzle shall be used with a

¾" diameter hose and shall be provided with a control valve and a pressure gauge between the valve and the nozzle. The water pressure to the nozzle shall be adjusted to produce 30 to 35 psi at the nozzle inlet.

Procedure

The water shall be directed at the test section and perpendicular to the face of the wall. The nozzle shall be moved slowly back and forth above approximately five (5) linear feet of the framing and joints, at a distance of 1 foot (305mm) from the most exterior surface of the wall for a period of five (5) minutes.

Working from the exterior, the wall test section shall be selectively wetted progressing

from the lowest horizontal framing member, then the adjacent framing Intersections, then the adjacent vertical framing members, etc. during the test, an observer on the

Indoor side of the wall, using a flashlight if necessary, shall check for any leakage and shall note where it occurs.

If no leakage occurs during the five minute test, the next five feet of framing shall be wetted for five minutes, and testing continued in this manner until the entire test area is tested.

If water leakage occurs and the source of the leakage cannot be identified, the following sequence shall be followed.

After allowing the wall to dry completely and working downward from to top of the area to be checked, all joints, gaskets and framing within this area shall be completely and tightly covered, on the outdoor side, with a water proof adhesive masking tape if necessary, use small amounts of sealant where the tape wraps around framing corners and joints to ensure that the masking is complete and waterproof.

Starting at the bottom of the prepared area, the masking tape shall be removed from the lowest horizontal framing for a distance of not more than 5 feet (1524 mm) from one end of the frame, including the joint Intersection or corner at that end. This exposed length shall be subjected to the nozzle spray as directed in Section 1.7.5 (a)

If no leakage occurs during the five minute test period, this length of framing shall be considered satisfactory and shall remain uncovered. If leakage has occurred at any point, the framing shall be re-taped at such points to prevent further leakage of these points during the subsequent checking of joints and framing adjacent to or above them.

This process shall then be repeated on all framing, gaskets and joint Intersections within the designated area, using increments of exposed framing length not exceeding five feet (1524mm) and always working upward on the wall.

Note : In some cases, due to unforeseen delays or other causes, more than one working day may be required to completely check the designated area, necessitating that some or all of the masking tape be left in place over night. The tape should not remain on finished metal surfaces any longer than necessary, especially where subjected to strong sunlight, as this may make its removal difficult and may also cause staining. It is recommended that in no case should the tape be left in place more than 48 hours.

Remedial Work and Re-Checking

Wherever leakage has occurred, the framing shall be made watertight in a manner acceptable to the architect. Remedial work involving the use of curing-type compounds shall be allowed to set before it is re-checked for leakage.

After all necessary remedial work has been completed, the required curing time, if any, has elapsed, all repaired framing sections shall again be checked, following the same procedure as before (Section 4). Should leakage still be found, further remedial measures shall be taken and checking shall be repeated until all framing in the designated area is found to be satisfactory.

Note: For these specifications, water leakage is defined as any uncontrolled water that appears on any normally exposed Interior surfaces, that is not contained or drained back to the exterior, or that can cause damage to adjacent materials or finishes. Water contained within drained flashings, gutters and sills is not considered water leakage. The collection of up to one half ounce of water (15 ml) in a five minute test period on top of an interior stop of stool integral with the system shall not be considered water leakage.

18. Cleaning And Protection

Glass shall be protected from breakage immediately upon installation. Use streamers or ribbons suitably attached to framing and held free of the glass. Do not apply warning marking directly to the glass.

Protect glass and glazing materials during the construction period so that they will be without any indication of damage at the time of acceptance. Cover glass as required to protect it from abrasion and other activities that might abrade the surfaces.

Remove and replace glass which is broken, cracked, chipped or damaged in any way and from any source.

All debris caused by or incidental to the installation work shall be properly removed from the job site as the work progresses.

Wash glass on both faces (inside and outside) not more than 4 days prior to acceptance. Comply with instruction and recommendations of the glass manufacturer and glazing material for cleaning in each case. Remove manufacturer protective covering from frames when directed.

19. Warranty

Immediately on completion of the work contractor shall submit a warranty for all glazing work done by him against manufacturing defects, malfunctioning or under capacity functioning.

The warrantee shall be valid for a period of Ten years from the date of virtual completion of the work.

The warrantee shall relate to materials and its installation work within limits of specified tolerances for vibrations, wind whistles, colour, gloss and other performance levels.

The warranty shall include replacement of sealant and glazing materials which breakdown in any form, lose adhesion to the glass or metal framing. The contractor shall rectify and allow for all costs associated with making good, any defect or breakage during this period for the system.

The warrantee shall expressly include replacement and making good of all defective

or under-rated capacity/ efficiency parts as acceptable in the contract.

20. Insulation

XPS (Extruded Polystyrene) Insulation shall be used on exterior walls and exposed roofs. For walls, 60 mm XPS insulation with 32 kg/ cum density and K value 0.028 W/m-K and Resistance of 2.14286 sqm K/W to be used. For podium, exposed roofs etc. XPS insulation 100mm thick with 32kg/ cum density and K value 0.028 W/m-K and Resistance of 3.571 sqm K/W to be used.

XPS shall be of approved make and installed as per manufacturer’s specification.

44. Modular Toilet Cubicles

This item shall be executed as per manufacturer specifications. Shop drawings shall be submitted and samples to be got approved before going for execution by the vendor.

1 Green Guard Certified Restroom Cubicle With (Standard Dimension Of 2100mm Height X 900mm Width x 1550mm Depth, which includes 600mm door size width).

Restroom Cubicle with (standard dimension of 2100mm Height x 1300mm Width x 1995mm Depth, which includes 750mm door size width). –as per dwg – to be finalised

2. Compact Laminate:

12mm compact laminate made as per IS codes and as per fire retardant bs-476/97 standard. The solid compact laminate (phenolic core board) is based on thermostatic resin, homogeneously reinforced with cellulose fiber and laminate on both side with suede finish, scratch and impact resistant, to achieve the cubicles dimensions jointless partitions. The cubicle system will be equipped with heat and bacteria resistance, to supply and install restroom system complete with stainless steel accessories, the modular shall possess 100% resistant properties towards: water, chemical, impact.

3. Accessories:

Standard make stainless steel grade 304 with satin finish accessories (a) ss top rail, (b) coat hook with door stopper, (c) hinges – gravity to close, (d) privacy thumb turn c/w occupancy indicator, (e) door knob, (f) screws & wall plugs, (g) ss “u” channel & (h) adjustable pedestal.

4 Hardware & Fixing:

All screws will of 304 Grade in stainless steel with satin finish. All pilasters are supported by stainless steel Bottom Cladding. The base of the stainless steel bottom cladding will be anchored to the floor with a clearance height upto 150mm. Fixing of intermediate panels to the wall shall be stainless steel ‘L’ – Bracket or stainless U Channel section are fixed into wall with screw inserts.

45. Structural glazing and aluminium composite panel cladding

1. General Requirement

• The Scope of works under this contract includes design, supply, installation, protection, Guarantees, testing and maintenance up to the defects liability period of facade works i.e. Aluminium composite panel cladding, Structural glazing works- DGU and SGU, Spider glazing and allied works at all levels in the building.

• The work under this includes all Labour, materials, equipment and services as required for the complete design, engineering, testing, fabrication, assembly, delivery, anchorage, installation, protection and waterproofing of the above mentioned items and all in accordance with the true intent and meaning of the specifications and drawings taken together, regardless of whether the same may or may not be particularly shown in the drawings or described in the specification provided that the same can be reasonably inferred there from. Anchorage includes all primary and secondary anchor assemblies and supportive structural framing as required to secure above-mentioned items in the building Structure.

The detailed scope of works is as outlined hereunder:

1 The Structural Glazing & Aluminium Composite Panel Cladding works, at all levels in the building described hereafter shall include but will not necessarily be limited to the following:

a. Frame, vision panels, doors and windows.

b. Openable panels wherever indicated, inclusive of all accessories, fittings etc. required at all levels, as per requirement.

c. Coping, soffit trimmers and external metal cladding panels for the wall cladding system.

d. All caulking, sealing and flashing including sealing at junctions with roof waterproofing and exterior wall, flashing at doorway, raised kerbs and in window surrounds.

e. Sealant within and around the perimeter of all work under this section.

f. Separators, neoprene / EPD and silicon gaskets, trims etc.

g. All steel structural framing and beam supports, anchors and attachments as required for the complete installation of the whole system, wherever specified. Inserts in concrete, anchor fasteners etc. for the anchorage of all work under this section to the approval of structural consultants.

h. Isolation of all dissimilar metal surfaces as well as moving surfaces similar or dissimilar.

i. fire stops flashing, Sealing of all interfaces with building etc.

j. Protection of aluminium/glass etc with safety film during storage /installation until handling over.

k. Engineering proposals, drawings and data sheet for all the design specifications.

l. Shop drawing data and structural calculations of all the system including framing, sealant, fasteners and cladding.

m. Scheduling and monitoring of the work.

n. All samples, mock ups and test units.

o. Coordination with civil contractor and other agencies / contractors employed on site.

p. All final exterior cleaning of the Aluminium composite panel cladding.

q. Hoisting, staging, scaffolding and temporary services.

r. Specified tests, inclusive of necessary tests reports for silicon and aluminium anodizing /PVDF.

s. Maintenance manual.

t. Design and performance guarantees.

u. Periodic inspection, supervision and advice by tenderers. Principal as well as back-up guarantee in an acceptable format by the principal for the quality and performance of works.

v. Construction monitoring for regular quality and technical inspection to ensure the work conforms to the shop drawing details (including any modification made during testing) and acceptable standards of quality.

2. REFERENCE AND STANDARD

Design of the aluminium structural glazed semi unitized system shall comply with all government codes and regulations for wind pressure design for Gandhinagar, all calculations shall comply with the requirements of the relevant National Building Code and Indian Standard Code IS 875 Part-3,1987,unless specified otherwise.

Materials and workmanship shall comply with the latest edition of the following standards as minimum.

BS 1474 Use of aluminium

BS 3958 PART 5 Thermal Insulating Materials

IS 875 (part 3) Wind Loads

ASTM E 283-04 Rate of Air Leakage ASTM E 330 10 Structural Performance ASTM E 331-09 Water Penetration AAMA 501 Composite Panels

IS 8183 Mineral wool

AS 1664-1979 The use of aluminium in structure.

ANSI Z97.1.84 Safety glazing materials used in Buildings. ASTM C 864-90 Specification for compression seal gaskets ASTM

C 1115-89 Specification for silicon rubber gaskets.

ASTM C 920-87 Specification for sealants.

ASTM D-523-89 Gloss retention for Cladding panels.

ASTM D-2244-93 Colour retention of cladding panels.

ASTM C 509-90 Specification for sealing material.

BS 8118 Structural use of Aluminium's.

Copies of all codes proposed to be followed /or design; material, installation and testing shall be submitted to the Architect within 2 weeks of issue of Work Order.

GENERAL

- All braces, supports and connections for the cladding shall be designed, provided and installed complete as required.
- All design calculations for all the systems shall be designed, procured and installed only after the verification of consultants.
- Anchors shall be located as approved by the Consultant.
- Member shapes and / or profiles if schematically shown on the Architect's drawings are not necessarily the shapes requires or best suited for the particular condition. Final shapes and locations shall be as designed by the contractor and are subject to the Architect's review and approval.
- No holes shall be burned, filled or drilled in any structural steel members unless expressly approved by the structural consultant in writing.
- The contractor shall provide detailed layouts, alignments jigs etc. for the proper and exact placement of all welded anchor studs, anchorage components, and embedded anchor assemblies etc.
- All metal structural glazing and cladding elements and their applicable anchorage assemblies shall he designed to accommodate all thermal and building movements

without any harmful effect to the structural cladding.

- No field forming, cutting and / or alternations of primary wall elements will be allowed. All framing members shall be shop fabricated and factory finished. No unfinished surfaces will be permitted on exposed surfaces.

Identification of Cladding and Glazing Panels

- The Contractor shall provide a complete numbering system and schedule for all cladding and glazing panel units. Each panel shall be individually numbered in such a way that the manufactured history can be traced. If possible, provide a permanent concealed marking system. Submit details for review and Acceptance.
- Identify the location of each individual panel on shop drawings and as-built drawings.
- Before the panels are delivered to the Site, provide suitable marks or identification for each panel for showing its correct location and orientation when installed.
- Identification labels on glass shall be made on a non-marking adhesive tape fixed to the glass. No tape shall be put onto the reflective coating side of a glass panel.

Quality Assurance for Structural Glazing

- Deglazing should be used as method of quality inspection for units which are structurally glazed.
- Deglazing is used to confirm good adhesion and proper fill of the structural joints.

Deglazing involves completely detaching the glass from the frame.

- The structural silicone sealant should be tested for adhesion to both the glass and the frame
- The inspection should include the following:

– Size of Structural Bite

– Size of Structural Glue line

– Adhesion of Silicone Sealant with glass and frame

– Joint type/Condition of Sealant applied

– Appearance of the sealant/uniformity of colour/bubbles, etc.

– Deglazing frequency should be performed according to the following schedule

– 1 unit out of the first 10 units manufactured (1/10)

– 1 unit out of next 40 units manufactured (2/50)

– 1 unit out of next 50 units manufactured (3/100)

– 1 unit out of every 100 units manufactured thereafter.

– A deglaze report should be completed after each test and this should be submitted by the manufacturer as part of the warranty application.

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Joints in Metal Work

• All exposed work shall be carefully matched to produce continuity of line, design and finish. Joints in exposed work, unless otherwise shown or required for thermal movement, shall be accurately fitted. Rigidly secured with hairline contracts and sealed watertight.

• Where two or more sections or metals are used in building up members, the surface in contact shall be brought to a smooth, true and even surface and secured together so that the joints shall be absolutely tight without the use of any pointing materials. Extrusions shall be tolerated to eliminate any edge projection or misalignment at joints.

Sleeves

• Unless otherwise noted, all aluminium sleeves shall be extruded sections designed to accurately interlock with adjacent sections and incorporate serrated surfaces for the secure bedding of sealant between the parent metal and the sleeves.

Protection of metals

Protection against galvanic action shall be provided wherever dissimilar metals are in contact.

• Aluminium, which is to be in contact with cured concrete, mortar or plaster shall have the contact surface protected wherever crevices between the contact surfaces may entrap moisture and corrosive elements. All metals, except stainless steel, which are to be in contact with fresh concrete, mortar or plaster shall have the contact surfaces protected with epoxy paint.

• Furnish a schedule of all protective coatings and related items including the

Designation of area and or specific locations, materials used, special instruction, specification data sheets, etc.

Welding

• All welding in aluminium work shall be done by the inert gas shielded arc or flux less resistant techniques and with electrodes and/or by methods recommended by the suppliers of the metals being welded, type, size and spacing of welds, shall be as shown on approved shop drawings.

• Welds in galvanized metal shall be touched up with zinc rich paint.

• Welds behind finished aluminium surfaces shall be so done as to eliminate distortion and/or discoloration on the finished side. Weld spatter and welding oxides on finished surfaces shall be moved by scaling and/or grinding. Provide low heat fitted welds used chill bar on finished side to eliminate dimpling, distortion and/or discoloration on the finished or exposed surface. Plug, puddle or

spot welding is not permitted. If weld beads are shown on exposed finished surfaces, the surfaces shall be ground and polished to match and blend with finish on adjacent parent metal.

• Structural welds shall be made by certified welders and shall conform to the general recommendations and regulations.

• Wherever welding as done in proximity to glass or finished surfaces. Such surfaces shall be protected from damage due to weld sparks, spatter to tramp metal.

• All welds shall be scheduled and designated on the shop drawing so that anyone can witness and assess the assembled units to ensure that all welds conform to the designated and approved type, size, spacing etc.

Soldering

• All soldering and/or brazing shall be done as recommended by the suppliers of the

metals involved.

Shop painting of Carbon Steel

• Item of carbon steel, unless galvanized or scheduled for other finish, shall be thoroughly cleaned of all loose scale, fillings, dirt and other foreign bodies and shall be painted with zinc chromate primer.

Factory Application

• As much work as possible all fabrication shall be carried out in the factory.

• Site work shall be kept to a minimum.

Lightning protection –

• The whole of the curtain wall shall be bonded as directly as possible to the lightning protection system. At each end of each continuous length of curtain wall, cladding or louvers, provision shall be made at top and bottom for bonding by the electrical contractor engaged by the Employer. The exact locations and details of the bonding points shall be as determined by the Architect/ Electrical Consultant.

Fire-stop and Interface with building.

• A fire-cum-smoke seal shall be provide at each window-head level, in addition the contractor shall provide aluminium flashing to approve design at the window sill level and on 2 sides of Vision panels.

• All interfaces with building structure and other elements shall be

sealed/flashed/provided with expandable gaskets to Architect‘s approval.

• Provisions shall be made (e.g. capping of all ends of mullions) to prevent sound transmission through the system. Provision shall also be made to prevent metal-to- metal friction due to thermal changes and wind pressure.

4. PERFORMANCE REQUIREMENTS

All components, assemblies and completed work included in or pertaining to the work of this section shall conform to or exceed the following performance standards and comply with all applicable and governing building codes and regulations.

• Thermal Movement: Provided for noiseless contraction and expansion of component materials for an ambient temperature range of 100°C to 480°C and a material temperature range of 1000°C without buckling, opening of joints, glass breakage, undue stress on fasteners, or other detrimental effects. Make allowance for vertical and horizontal expansion. For fabrication, assembly and erection,

procedures shall take into account the ambient temperature range at the time of the respective operations.

• Building Movement and Related Building tolerance: The design and installation of the structural aluminium cladding systems shall accommodate all inherent building movements and or deflections and the fabrication and installation tolerances of all related work not involved in this section without the loss of, or any detrimental effects to, the performance requirements herein specified. The contractor shall verify and coordinate all such movements and / or tolerance with the Structural Consultants and the Architect before designing all the components of structural aluminium cladding so that movement and deflections in the structure do not at any time affect the integrity and safety of aluminium cladding and vice versa.

• Thermal property: All insulation materials, fire-stops and smoke seals shall comply with the Current requirement of the GIFT City and other concerned authorities as Chief Fire Officer (Gandhi Nagar Fire Brigade).

Structural Properties

a) The design of aluminium structural cladding and all related components shall comply with the requirements of National Building code. 1.8. 875 and Indian Standard Code IS.456,

b) No aluminium structural glazing semi unitized system and cladding elements including sealants and sealed joints shall sustain permanent deformation of failure under loading equivalent to 1.5 times the design wind pressure herein specified.

c) Deflections: The specified deflections must be reduced if they are in any way detrimental to the aluminium structural cladding elements and sealants.

• The maximum deflection on design wind pressure shall not exceed L 250 (double glazing) and L 175 for Single Glazing of height or 15mm whichever is lesser for mullions,

• No vertical deflection shall exceed L/300 of span of transom

•Maximum deflection on glass under design wind pressure at centre of any panel

shall not exceed 15mm. Or as recommended by the manufacturer whichever is less.

5. MATERIALS

• Materials and components used shall be of the best quality and suitable for the purpose to Architect approval and shall have been tried and tested in environments similar to that of Gandhinagar.

• Aluminium sheet panels shall be of a minimum thickness of 2 mm and of max 3 mm for solid sheets and 4 mm, for insulted composite units.

• All materials shall be free from any defect that may impair the strength, functioning or

appearance of the cladding system or adjacent construction.

• Testing by independent testing laboratories or reviews of data by the Architect shall not relieve the contractor‘s responsibility to verify for himself that the work conforms to the intent of the contract documents.

INSULATING GLASS UNIT (DGU) General

• Provide Insulating Glass Units (IGUs) (also known as double-glazed units) of

accepted types in accordance with ASTM E2190, AS/NZS 2208, and the recommendations of IGMA. Submit complete details, including all construction details, primary and secondary seals, gas filling and corner treatment, nature of spacers, evacuation and assembly process.

Relevant Standards:

- ASTM C1087 - Standard test method for determining compatibility of liquid-applied sealants with accessories used in structural glazing techniques.
- ASTM E546 - Test for dew point of sealed insulating glass units.
- ASTM E773 - Standard test methods for seal durability of sealed insulating glass units.
- ASTM E774 - Standard specification for sealed insulating glass units.
- IGMA - Insulating Glass Manufacturer's Alliance.

Seal Performance

- IGUs shall incorporate accepted poly isobutylene primary (vapor) seals continuously bonded to glass, and two-part silicone secondary (structural) seals. Primary seal

shall be not less than 3 mm deep. Secondary seal shall completely cover spacer with no gaps or voids, continuously bonded to glass.

- The secondary sealant shall be structural silicone specifically used for IGU manufacturer. The sealant bite for the secondary seal is to be determined based on load sharing principles.
- Spacer bar shall be a proprietary aluminium type, desiccant filled, anodized in a colour compatible with seals. Conceal spacer bar within the depth of the glazing

gasket line to ensure smooth sight line. Submit details and colour samples for review and acceptance.

Structural Edge Distances

- Submit, for review and Acceptance, computations for distance between the outer edge of the glass and the innermost edge of the aluminium spacer indicating minimum bite of secondary (structural) seal and spacer bar depth. Include sealant manufacturer's recommendations and load tables.

Edge Quality

- Heat treated glass lights of IGUs shall have clean cut edges. Internal toughened lights of IGUs shall have belt arrived edges.

Quality Records

- Submit production, test records and MTC's for IGUs. Indicate test procedures, acceptance criteria and pass/fail rate as per relevant Standard codes.

Testing

Contractor shall submit Material Testing certificates (MTC) of all the materials received from the authorized vendor as per relevant IS Codes. The contractor shall also send samples of all materials to an accredited and approved testing laboratory for testing and the unit type shall have attained Class A as defined in ASTM E2190 when tested in accordance ASTM E2190.

Warranty

- All IGUs complete shall be warranted for the warranty period of ten years. For a period not less than the warranty period, all IGUs shall be free from evidence of manufacturing defects and shall be free from: Intrusion of moisture or dirt. Internal condensation at temperatures above -10 degree Celsius. Other visual evidence of seal failure or performance failure or colour change.

ALUMINUM COMPOSITE PANEL CLADDING (ACP)

- The alloy for the aluminium panel shall be of alloy 3005 / 3105-H14 confirming to BS

1475.

- Composite panel shall have a minimum total thickness of 4 mm. The panel may be reinforced behind to meet the required structural design and deflection criteria.

- The panel shall be designed with the fixity to allow temperature variance and surface temperature differentials due to ambient temperature differential without causing any effect on flatness of the panels.

The installed composite panel surface shall not have irregularities such as oil canning, waves, buckles, and other irregularities .When viewed at any position not less than 15 degrees to the true plane of the panel.

- The Aluminium composite panel shall be of total 4 mm thickness comprise of Aluminium skin of minimum 0.5mm with fluorocarbon paint finish + 3mm thick mineral core with Fr grade —B‖ (Confirms to EN 13501) + 0.5 mm aluminium skin with service coat.

- In case of Non Fr grade (Subject to written confirmation from Client / PMC / Consultant) then the core shall be 3 mm Virgin Polyethylene (PE) Core in Translucent in color (No Black in color)

- ACP aluminium outer skin and inner skin should confirm to alloy 3005/3105 grade and H16 or suitable temper with minimum mechanical properties as per given values.

- Surface of the Composite Panel should be finished with Lumiflon based fluorocarbon coating or Kynar-500 based PVDF coating (Polyvinylidene Fluoride) on the topside

with minimum 30 micron thickness and a service coating on the reverse side.

- Lumiflon – based flouro carbon coating or Kynar-500 based PVDF coating on the topside shall be done in two types as below.

- Solid Colour is two coat two-bake system.

- The total dry film thickness of the topside shall be 25 micron minimum consisting of a conversion coating, an inhibitive primer and Lumiflon-based fluorocarbon coating or Kynar-500 based PVDF coating.

- —Metallic Color‖ is three coat three-bake systems or two-coat two-bake Systems.

With minimum thickness of 30 micron.

- The top coated surface shall comply with the —specification for coated coil for exterior building applications‖ issued by ECCA (European Coil Coating Association). The coating shall confirm to AAMA 2605 for exterior grade finish.

- The reverse side of the cladding panel surface facing the wall shall have polyester base coating to protect against the possible corrosion problems.

- The finished surface shall be protected with a self adhesive peel off foil with 80 microns thickness white or black, tested to with stand at least 6 months exposure to

local weather condition without losing the original pill off characteristic or causing stain or other damages on the coated surface of the aluminium composite panel.

- If the stain or any damage noticed after pill of by the fabricator, such panel should be replaced with new one of the same shade and colour, at no extra cost.

- Skin Material: 0.5 mm thick aluminium sheets of Alloy 5005A – H22/ 3105

– H14 or 3003 – H14 and manufacture by adopting Direct Casting Method

- Core Material: 3 mm thick mineral core material based on Aluminium / Magnesium Hydroxide having fire retardant property. (Class B) Class B – S1 – d0 Confirming to EN 13501-1 Confirms to Class O as per BS 476 Part 6 & 7

Physical Properties

- Specific Gravity : 1.23- 1.9
- Weight : 7.6 Kg/m2 for 4 mm
- Thermal Expansion (ASTM D-976) : 2.4mm/m at 100 deg Cel or 1.2mm/m/500oC
- Thermal Conductivity (ASTM D-976) : .41- 0.5 W/m.K
- Deflection Temperature (ASTM D-648) : 110 - 1150 C

Mechanical Properties

- Tensile Strength (ASTM E-8) : 49 -130 N/mm2
- Yield Strength (ASTM E-8) : 4.5 Kg/ mm2
- Elongation (ASTM E-8) : 5- 14%
- Flexural elasticity (ASTM C-393) : 14*105 Kg.mm2

Mechanical Properties of Skin Aluminium

- Yield Strength (ASTM E8) : 15.5 Kg/mm2 (3105 H14)
- Modules of elasticity (ASTM C393) : 7000 Kg/mm2
- Bond integrity (Vertical Pull, ASTM C-297) : 120 Kg/mm2 (12.2 N/cm2)
- Deflection temperature (ASTM D648) :1150C
- Sound transmission loss in Accordance with ASTM E413 (STC) 26 – 30 dB
- Aluminium coil for coating: Manufactured by direct casting method to ensure the compressive strength and other characteristics of the coil as per standard.
- The panels shall be finished in a manufacturer's continuous coating line with

Lumiflon-based fluorocarbon coating or Kynar-500 based PVDF that should be tested by the manufacturer to meet the criteria published as per the product.

Terrace Coping

- Copping at terrace level sealing the glazing system and parapet wall shall be of

4mm thick ACP in PVDF finish / Al. Extrusion with required Aluminium structural back up support designed for wind load.

- Additional stiffeners shall be provided in the form of top hat profile running continuous length wise and connected mechanically at panel joint returns.
- Joints at the grid center shall have weather sealant covered with Aluminium Cap on top to avoid any insect or birds damaging sealant.

• Aluminium Wall/Column/Roof Cladding.

The aluminium cladding shall be fabricated with a minimum of 4 mm thick aluminium composite panel of approved make comprising of a thermoplastic resin core sandwiched between _o skins of aluminium alloy. The panels shall be PVDF coated to minimum 35 micron thickness in approved metallic colour. The resin content of the PVDF shall be 75% to 80%. The back of the panel shall be achromatized 3-4 micron thick or otherwise protected to Architect‘s approval. The insulation in-fill of the composite panel shall be non-toxic on burning. The panels shall be acceptable to the Chief Fire Officer.

Fasteners:

- All fasteners shall be of stainless steel with self locking devices, unless otherwise noted, and of sufficient size and strength to withstand the applicable design wind load and dead load forces with safety allowance factors as required for the specific materials. The spacing and quantities of fasteners shall be as required to develop

the maximum strength of the member they secure or support. Washers and/or other accessory items shall be of the same material as the fastener. Torque tightens all assembly fasteners to achieve the maximum torque tension relationship in the fastener.

- All fasteners shall be concealed unless otherwise shown or approved. The head

style for all exposed fasteners shall be countersunk oval head unless otherwise noted on the drawings. Exposed fasteners shall be finished to match surrounding metal finish.

- All fasteners including washers and accessory items shall be scheduled and designated on the shop drawings so that anyone can witness and assess the assembled units to ensure that all fasteners conform to the designated and approval type, size, material, spacing, etc. when certain items are not readily apparent, such as material and alloy or torque tightening requirements, special instructions for the identification and appraisal of such items shall be issued.

- Bolts, anchors and other fastening devices shall be of approved types as required for the strength of the connections, positive results during the pullout tests, shall be self- locking, unless otherwise noted shall be suitable for the conditions encountered, and shall be torque tightened, where required to achieve the maximum torque tension relationship in the fasteners. Washers, nut and all accessory items shall be of the same material as fasteners.

- Fastening devices between aluminium and aluminium shall be AISC Type 302 (18-8)

stainless steel unless otherwise approved.

- Fastening devices between aluminium and dissimilar materials shall be 300 series non-magnetic stainless steel unless otherwise approved.

- Exposed fasteners are subject to Architect‘s approval and shall be stainless steel.
- Self-locking fasteners shall be stainless steel with nylon inserts of patches.

Extrusions:

In general aluminium alloy for extrusions shall be 6063 T6 as per BS 1474. However, the grade and tempering specification shall be as recommended by the supplier for each application and shall be approved by the system principal.

All aluminium sections shall be either anodized in approved colour to a minimum thickness of 20 microns or coated with PVDF as specified and approved by the consultant.

Aluminium Flash:

A Flashing concealed from view shall be made from mill-finished aluminium sheets 1.5 mm thick. Visible flashing (e.g. on periphery of vision panels) shall be 2 mm thick aluminium sheets anodized in approved colour.

• Capping

Top capping if required shall be made from 3 mm stretch-levelled aluminium sheets coated with 35 micron PVDF in approved colour.

• Soffits and suspended ceiling System

Soffits and suspended ceiling system if required shall be of similar metal of the aluminium wall cladding with a similar finish. The Architect shall select colour and shape.

• Protection:

Materials used as permanent or temporary protection for metals shall conform to relevant Indian / international Standards.

• Brackets:

Brackets shall be made from stainless steel section 316 grade or approved Mild Steel preferably hot dipped galvanized. Slots in brackets shall be pre-drilled / punched and not flame cut. The surface shall be serrated for additional grip.

SEALANTS

All sealant applications must be clearly designated on the applicable shop drawing details and reference etc. a master sealant schedule specifying materials, special instructions and application procedure. Provide documentation for the same. The compatibility and sequence of installation for all sealants must be carefully considered in all proposals in order to ensure cure and optimum performance. Sealants must not degrade and / or fail under all design conditions including but not limited to thermal movement, water, ultra violet exposure and / or there adverse environmental conditions. The following sealant materials are specified for performance standards only. All proposals must be equal to or better than the materials herein specified. The designation of sealant types noted on the drawings is intended for general design guidance. Final selections by the contractor for the sealant types shall be based on their conformity with the performance requirements herein specified and meet with the Architect‘s approval. Maximum precautions shall be taken to prevent failure of sealant.

• Structural sealant: Dow coming Silicone sealant 995, GE ultra glaze 4000 or approved equivalent recommended by manufacturer. All exposed and concealed metal to metal (including tight or butt type metal to metal assembly prior to assembly); perimeter metal to concrete joint shall be silicone base sealant, preferably 2 components, in approved colour, conforming to the manufacturer‘s recommendations for the specific uses and performance criteria. The manufacturer shall conduct laboratory test for adhesion for each lot of aluminium sections and glass. Laboratory reports shall be submitted to the Architect/Structural Consultant.

• Weather sealant: The grades of the sealants for the concealed metal to metal and concrete joints such as embedment and lapping of flashings where elements are to be installed or embedded in a full bed sealant shall be the best recommended by the manufacturer for the application (Dow Corning, GE or equivalent).

• Joint fillers and back-up materials shall be non gaseous polyethylene foam, sponge neoprene as per the written recommendation from the applicable sealant manufacturer for each specific application. Shape size hardness, compatibility and bond-breaking requirements are all factors to be considered.

• All sealants must be non-staining and compatible with adjoining sealant backup materials, substrate materials and their respective finished and / or applied colour coating.

• Exposed assembly sealant will not be permitted at any wall area.

• All sealants shall be given 10 years guarantee for materials, workmanship and performance from the date of completion of contract.

GASKETS

Gaskets and seals shall be extruded EPDM or neoprene of approved quality compatible with substrates, finished and other components they are in contact. All gaskets exposed directly on the Extruded EPDM sections shall have the following properties:

Shore Hardness	60 + 5A Tensile Strength	Min 70 kg/cm2
Elongation	300%	
Ozone resistance	No crack at 50 + 5 pphm test temp. of 40 + 20° C for the test	

Duration of 96 hours and 20% strain.

ISOLATORS

• Isolators between steel and aluminium members and wherever required shall be of rigid type, high impact, smooth both side Teflon with a minimum thickness of 0.8 mm or other non-conducting material as approved by the Architect.

METAL COATINGS

• Aluminium shall be matt anodized to minimum 20 microns / PVDF coated as per

Architects approval as per approved colour.

• Coatings to aluminium sections and cladding where specified shall be fluoropolymer formulated and will consist of a 3-coat system comprising primer, colour coat and clear anti Abrasion topcoat. The coating system shall meet or exceed all the requirements of AAMA 605 — Voluntary specification for high performance organic coatings on architectural extrusions and panels.

The total dry film thickness shall be 35 microns.

• After selection of colour by the Architect, the Contractor shall prepare a mock up 300 mm x 300 mm, 4 panels cut and grooved indicating 4 ways joint which shall define the colour and gloss range and submit them for approval.

• All samples shall be identified and have a full laboratory report attached.

• The coating system, including materials and application shall confirm to the requirements and recommendations of the paint manufacturer.

• The testing agency, Manufacturer and the Contractor shall certify the material testing reports and submit the same to the Architect / Consultant / Engineer-in-charge.

Performance Requirements

Salt Spray resistance — with stand a minimum of 3000 hours exposure to 5% salt solution at 95% RH, 37.5 degrees C with no more than 1.25 mm creep age or loss of adhesion from scribed line or cut edges.

Humidity Resistance — with stand a minimum of 3000 hours exposure to 100% RH at

37.5 degrees C with no more than a few blisters, size no.8 (ASTM D714—56)

Abrasion Resistance — Withstand abrasion of sand with an abrasion coefficient value of 65 minimum when evaluated per ASTM D968-51 test method.

Mortar Resistance — Withstand wet mortar, 24 hour part test at 100% RH without gaining adhesion or any oil painted surface of solid colours.

Detergent Resistance — Withstand immersion on in 3% synthetic detergent solution for 72 hours at 37.5 degrees C with no loss of adhesion no blistering and no visible change.

Colour Retention — Withstand immersion chalk rating of No.8 for colours and No.6 for white per test method ASTM D659-44 (1970).

Field Touch-up and Repair: The contractor shall supply materials for air-dry touch up

for spray or brush application per instruction of manufacturer.

The contractor shall furnish to owner, a written guarantee warranting all work in connection with organic coating system be free from defects in materials and workmanship for a period of Ten (10) years from date of completion and to correct promptly any defect free of cost. The following units considered as defects without being limited thereto:

• Peeling

• Checking

• Blistering

• Chalking in excess of Chalk rating when measured in accordance with ASTM D659-44 (1965).

• Fading or colour change in excess of 5 NBS unit when calculated from measurement

on a spectrophotometer or colour meter capable of colour measurement by reflectance reading in accordance with ASTM D244-68.

Waterproofing

• A Complete drainage system must be incorporated into the structural glazing frame. Water leakage and condensation shall be drained or discharged to exterior face of the wall and all internal spaces vented by acceptable means to ensure pressure equalization where possible.

• Drainage system will be sealed off at every floor to prevent infiltrated water from leaking to lower floors.

• Movement of water behind and on exposed surfaces must be controlled to ensure that water is not retained and the elements will not be damaged or corroded by water and to minimize the potential to algae and fungus growth as a result of standing or trapped water.

Anchorage System and Building Frame

• Each glazed unit shall be fixed to the structural slab at each floor level. All fasteners shall be stainless steel of approved grade. The contractor shall also make necessary modifications to the anchor fasteners to suit existing site conditions of steel reinforcement without additional charge.

Mullions and Transoms

• The sections of mullions and transoms shall be designed to restrict deflection under wind pressure as specified and shall be rigid enough to support and retain the glass under all conditions.

• Reinforcing members, where used, shall be completely enclosed and if fabricated from steel shall be galvanized and protected with primer and two coats of zinc chromate.

CLADDING

• Cladding shall be non-toxic composite aluminium panels of adequate strength with approved aluminium details. The panels shall be 4 mm thick composite units comprising of a thermoplastic resin core sandwiched between _o'skins of aluminium alloy, finished with PVDF coating overall 35 micron thick of approved metallic colour. The resin content of the PVDF coating shall be 75% to 80%. The back of the panel shall be achromatized

3-4 micron thick, compatible with adhesives for stiffeners if any or given a polymer coating.

• All cladding panels of one kind shall be obtained in one lot from the manufacturers.

• Each panel shall be guaranteed for a flatness of 1 mm form the true face after installation under no-wind conditions. Deviations from the true alignment of adjoining panels shall not be cumulative. Full load deflections shall be kept to the minimum possible. Each panel shall be capable of withstanding 300 Kg/Sqm wind pressure without any permanent deformation.

• The cladding system shall be adequately ventilated. The air-gap between the cladding panels and the concrete/block-wail shall be at least 50 mm to allow proper ventilation of the rain screen system. The cavity shall he closed by a perforated bird/vermin-proof closer at bottom and by a flashing at top

• The fabrication processes including cutting, grooving, benching, folding, joining, root-in as well as approved aluminium support framework, fixed to wall with aluminium/ galvanized steel brackets.

• The composite Aluminium panels shall satisfy the relevant fire codes requirements.

PERFORMANCE TESTING Measurements

The measurements given on Architect's drawing shall not be used by the contractor for preparing his shop drawings and for executing the work. All dimensions shall be actually measured on site and in case of any discrepancy between measurement on site and in drawings; module shall be decided in consultation with the Architect/ Consultant.

• The contractor shall carry out site tests as specified, at his own cost.

• The contractor shall supply copies of shop drawings and calculations to the Test

Laboratory prior to installation of the test units. These drawings shall include:

• Test elevation of sections:

• Full scale typical details structurally glazed windows (intersections of number):

• Typical support details:

• Extent of sealants:

• Size and number of pressure equalization/drainage slots or holes:

• Blanking off details: and,

• Method of installation

Any deviations from the drawings shall be recorded and noted in the final report.

Form Report:

Details of the test sample (including an outline of the simulated building frame) and the test apparatus, instrumentation and method shall be clearly given in a report.

• The report shall include the following:

a) An identification and general; description of the façade and Certificate of Identity from the builder or his nominated contractor.

b) Drawings of the actual test sample showing modifications, if any. c) Test sequence with pressure used in all tests.

d) Location of all transducers for the structural performance test. e) Displacements span deflection ration and air infiltration rates. f) Other pertinent observations.

Records drawings:

• The testing laboratory shall keep a copy of approved shop drawings and calculations at testing laboratory accurately and neatly record on the above mentioned shop drawings all changes, revisions, modification, etc. made to test unit, which shall become the record drawings.

• At completion of testing and after approval of test reports, the testing laboratory shall

submit the marked up record drawings to the Architect.

Cost of performance Testing:

• The testing laboratory shall provide the test chamber and support structure for the test. The Contractor shall allow for the cost of the fabrication, erection, testing, corrections to and the demolition of the test unit. The contractor shall fabricate, erect, correct and demolish the test unit.

INSTALLATION Temporary Marking :

• Provide temporary marking of glass (if necessary). Use a soluble marking compound and remove all traces on completion. Do not use lime or advertising stickers.

Glazing :

• All glass processing shall be under controlled condition. Mock-up glass shall not be used on the building. Glass shall be of the specified types and quality, with seamed edges and corners. Inspects all lights of glass before installation. Do not install defective glass.

• Before setting glass, inspect frame for proper dimensions and squareness. Adjust frame and/or glass size as required to meet specified requirements. Use fixtures to

keep the frame in true squareness.

• Except as otherwise specified, glass shall comply with FGMA (Flat Glass Marketing

Association) Glazing Manual.

- Thoroughly clean glazing pocket before setting glass. Solvents shall be compatible with Aluminum, glass and glazing materials. Place glass support blocks at end points as per guidelines.
- Details of installation shall permit replacement of glass after the construction period.
- Replace any glass, which breaks or sustains edge damage, surface damage or damages to reflective coating as defined above.
- Edge Deflection of DGU: The edge deflection of the unit shall meet the requirements as - no greater than span/250. The process shall be involved extensive testing to ensure the sealants do not compromise the integrity or aesthetics of the DGU.

Experience of glaziers and log-books:

- Glazing shall be carried out by experienced personnel who have pre-qualified for the type of work undertaken. All work shall be supervised by a trained and experienced glazing supervisor.
- Details and experience of each glazier shall be recorded in the logbook. Samples of each glazier's work shall be periodically removed for testing.
- Maintain a glazing logbook on a daily basis for all glazing and submit progressively.

The glazing log book shall be available for inspection at any time without notice.

- As a minimum the logbook shall contain:

– Date.

– Name of glazier.

– Individual panel numbers glazed / intended location of installed work.

– Sealant manufacturer and type, colour and batch number.

– Daily air temperature inside and outside.

– Tape and accessory manufacturers and types.

– Glazing supervisor's verification.

Qualification of workmen:

All work shall be performed by skilled workmen, especially trained and experienced in the applicable provisions of the listed references and standards and/or as the otherwise noted on the Architects drawing or as specified herein.

Setting out:

Bench marks for elevations and building lines offset marks for alignment shall be established on each floor level by the main contractor, should any error be found in their location, the contractor shall notify the PMC and the main Contractor in writing and installation work shall not proceed in the affect area until the errors have been corrected.

Within 2 weeks upon the award of the contract, the sub-contractor shall submit the structural cladding anchorage plan for endorsement by the PMC and approval by the Architect. The sub-contractor shall co-ordinate his system of anchorage with PMC/Civil Contractor according to site conditions.

Prior Inspection of the Structure:

After the setting out has been established and before beginning installation in any area, the sub-contractor shall examine all parts of the structure on which the curtain walling system/metal wall cladding are to be placed in that area. Should any conditions be found which, in his opinion will prevent the proper execution of his work or endanger its permanency he shall report such condition in writing to the PMC and the Main Contractor. Installation work shall not proceed in that area until such conditions are corrected or adjusted to the satisfaction of the PMC.

Workmanship

All parts of the aluminium structural cladding system shall be erected true plumb and in proper alignment and relation to established setting out as shown in approved shop drawings.

Erection Tolerances

The installed metal wall cladding/curtain walling system components shall conform to the following erection tolerances under no-wind condition:.

a) Amount of total deviation and/or misalignment in any direction for vertical members:

3mm maximum in a height of 4M (non-cumulative) and maximum 7mm in full height of cladding/curtain walling.

b) Amount of total deviation and/or misalignment in any direction for horizontal members: 3mm max in a length of 7M and 5mm in full length.

c) Maximum offset from true alignment between two abutting members shall be 1 mm. No edge projection or misalignment will be permitted.

d) Maximum joints gaps or opening between removable glazing stop and adjacent member shall be 1 mm and/or a maximum 1 mm cumulative opening at both ends of removable members (0.5 mm each end)

e) Deviation in spacing of brackets: +15 mm.

f) Installation within and/or adjacent to concrete: where work is to be installed within and/or adjacent to concrete, no aluminum structural cladding system components other than built in anchor devices shall be put in place until the concrete work is completed including the removal of all forms, shoring etc.

Anchorage:

a) Anchorage of the aluminium structural cladding system to the structure shall be by approved methods and in strict accordance with approved shop drawings. After the aluminium structural cladding system are properly positioned, all connections so designated on approved shop drawings shall be rigidly fixed by welding or other positive means.

b) All anchorage assemblies and their related components shall be thoroughly scheduled and described on the shop drawings so that anyone can evaluate an installation and ensure its compliance with the contract documents. All primary aluminium structural cladding, anchorage assemblies inclusive of skylight space frames/structural mullion shall receive a 100% inspection.

Welding:

All welding shall be done by skilled mechanics qualified or licensed in accordance with local building regulations. Welds and adjoining burnt areas in prime coated surfaces shall be thoroughly cleaned and painted with one coat of primer. Welds in galvanized steel shall be coated with one coat of zinc rich paint. Special care shall be taken to protect glass and other furnished surfaces from damage and to prevent causing fires.

Use of sealing materials:

a) Sealing materials shall be used in strict accordance with the manufacturer‘s printed instructions and shall be applied only by workmen specially trained or experienced in their use. Before applying sealant, all mortar, dirt, dust moisture and other foreign matter shall be completely removed from surfaces in contact, adjoining surfaces shall be masked when required to maintain a clean and neat appearance. Sealing compounds shall be tooled to fill the joint and provide a smooth finished surface.

b) The manufacturer of the applicable materials shall, when required, render, technical assistance prior to the application of any sealant and witness the first application as well as periodic site inspections performed by the sealant manufacturer, provides close supervision of all workmen used to apply the sealant.

Tensioning of Bolts:

All bolts shall correctly tension. The tension shall be specified on shop drawings. At least 10% of bolts shall be mechanically checked for correct tension.

Sequence of Installation:

If so directed by the PMC, installation of the aluminium structural glazing and cladding shall be postponed in areas as designated by the PMC for a specified period of time so as to facilitate moving materials/equipment into and out of the building and installation of M & E (Mechanical & electrical) fittings during constructions. The contractor‘s work is to proceed along guidelines and schedule as directed by the PMC.

Removal of Debris:

All debris caused by or incidental to the installation work shall be promptly removed from the job site as the work progresses. Weep holes and drainage channels shall be unobstructed and free of dirt, rubbish and sealant.

Protection and Cleaning:

a) The contractor shall adequately protect all aluminium sections, cladding sheets, components and accessories from damage during shipment, storage erection and after completion of the work by use of protective film/foil of approved non-staining quality.

b) At such time as may be directed by the PMC, the contractor shall remove all protective coverings and/or coatings and clean surfaces free of all soil and discoloration. All cleaning agents shall be acceptable to the applicable aluminium, and co manufacturers; and where doubt exists, spot tests shall be made to satisfy the PMC.

CONTRACTOR’S RESPONSIBILITIES

The Contractor‘s responsibilities include but are not necessarily limited to the following items:

a) The Contractors shall provide and install all supplementary parts necessary to complete all items generally implied in the shop drawings and in the specifications though not specifically shown or mentioned.

This shall include the design and sizing of all sections and anchor assemblies to meet the performance and design requirements, furnishing and installation of all inserts fasteners clips. Bracing and framework as required for the proper anchorage of the structural glazing window system elements to the structure.

b) Design Responsibility: Drawings and specifications indicate the required basic dimensions, profiles and performance criteria. The Contractor shall have the option of modification and addition of details provided the visual concept and performance requirements are fulfilled. Proposed modifications shall be clearly shown on shop Drawings as ‗Design Modifications‖ and acceptance of the same will not relieve the Contractor from sole responsibility for performance of the aluminium structural cladding. The Contractor shall be solely and fully responsible for due performance of his installation based on his own design and details.

c) In-plant and job site inspection: The Contractor shall afford the Employer / Architect

/PMC or their authorized agent full access to plants, shops and assembly and finishing of the aluminum structural cladding for this project.

The Architect / PMC will have the right to reject any and all aluminium structural cladding components and assemblies during assembly and erection if the workmanship and intent are not in

strict conformity with the approved shop drawings, structural design calculations, documentation, certifications, samples and mock-up.

d) Glass, sealants and other items or materials procured by purchase shall be back to back guaranteed by the manufacturer.

SHOP DRAWINGS:

• The contractor shall prepare shop drawings by necessary modifications to the preliminary drawings and two (2) copies of all shop drawings A0 size shall be submitted to the Architect for review and approval. The Architect‘s review of all shop drawings will be limited to their conformity to the design concept & specifications. Architect‘s approval of the shop drawings will not relieve the contractor from any of the responsibilities and requirements as stated in contract documents. No work shall be fabricated until the shop drawings and all other related submissions, documentation, certifications, samples and the mock-up for that work have been reviewed and approved by the Architect/PMC.

• Shop drawings shall incorporate scaled and dimensioned plans, elevations, sections

and full size details for all work in this section.

Shop drawings shall indicate the desired dimensional profiles and modules, function, design and performance standards and, in general, delineate the scope of work. The sub-contractor shall verify and co-ordinate these items with all applicable and / or related trades, contract drawings and specifications. The shop drawings shall include a full complete layout of all modular and referenced dimensions for all the Structural Aluminium Composite Cladding, structural glazing and all allied works, at all levels in the building and their related elements, All dimensions, modules, etc., shall be field checked as required. The full size details shall show and specify all metal sections, types of finishes, areas to be sealed and sealant materials; gaskets, direction and magnitude of thermal expansion, direction and magnitude of all applicable construction including fasteners and welds, all anchorage assemblies and components, the fabrication and erection tolerances for the work and applicable related works adjoining, attached to or in some way related to the work covered by these specifications. The location of all static and dynamic anchor assemblies, the direction of thermal and other applicable building movements, co-ordination with concrete works and the sequence of installation shall be designated on the applicable planes, elevations and / or sections. All details shall be subject to Architect‘s approval.

• Profile adjustments in the interest of economy, fabrication, erection, weather ability or ability to satisfy the performance requirements may be made with the written approval of the Architect/PMC, provided that the general design and intent of the drawings and specifications are maintained.

• Four (4) copies plus two (2) rewritable CD print each of all final approved shop drawings shall be submitted to Architect / Consultant / PMC.

STRUCTURAL CALCUALTIONS

• The Contractor shall employ a competent design engineer to design his systems and components. During the design stage, the Contractor shall interact actively with the Structural Consultants concerning all aspects of design and shall obtain all the information from them concerning the structure, probable deflections and other building movements etc. The Contractor shall take full account of all possible building movements as well as the movements of Structural glazing, ACP cladding and their components in his design. The Contractor shall submit his detailed structural calculations for the systems and each of their components and shall guarantee that his design will ensure the structural safety and integrity of all the systems mentioned above against all natural forces, superimposed loads, environments and consequent movements.

The Contractor shall obtain the Structural Consultants approval to his design movements and to the provision made in his design for all the design movements, and shall directly pay fees to the structural consultants for their interaction in a manner such that the Contractor and the structural consultants shall be jointly responsible to the Employer for the correctness of the fixing and interaction of the curtain wall with the structure so as to ensure that all the movements envisaged between the

structure and the curtain wall are fully taken care of however the contractor alone shall be responsible for the workmanship of fabrication and installation and shall indemnify the Employer against all claims due to defects or non performance during the specified 10 years Guarantee period. The provision of this clause shall not in any way limit the Employer‘s rights under other clauses of the Contract.

• The Grade of R.C.C. in the building structure will be as specified in the drawings. The Contractor shall design anchorages for this grade of concrete with adequate safety factor.

• The Contractor shall submit 3 sets of design calculations to the Architect after they are

endorsed by the Structural Consultants for compatibility with RCC and steel structure.

Quality Control documentation:

In-plant and job site quality control procedures shall be documented in writing for

Architect‘s/ PMC review and approval to ensure the design.

Integrity and performance Documentation shall include schedule, detail, isometric and / or schematic explanatory‘ sketches cross-referenced to shop drawings, data sheets. etc. all as required to intelligently witness and assess methods and materials, and to ensure that both the fabrication and installation are in accord with the contract documents.

a) The in-plant quality control procedures shall include but not necessarily be limited to following items:

Fabrication: Tolerances, Joinery Sleeves, etc

Finish Match: Approved finish and controls required for matching the exposed surfaces.

Assembly: Welds, fastener, sealants, gaskets, separators, etc.

Protection: Handling, Protection, Shipping etc.

Quality Control Chart: Quality control charts for glazing and installation to be provided to PMC on a weekly basis.

b) The job site quality control procedures shall include, but not necessarily be limited to

the following items:

Anchorage: Lines, grades and related building tolerances.

Installation: Tolerances finish match, joinery, sleeve, flashing, welds, fasteners, sealants, etc.

Sealing: As recommended by the applicable sealant manufacturer (s)

Protection & Cleaning: As recommended by the applicable material manufacturer

SAMPLES AND MANUALS

The following samples of actual job site materials together with detailed technical data / catalogues shall be submitted in duplicate and in the size noted, for Architect‘s review and approval. Omission of any items, which require the Contractors compliance with these documents do not relieve him from such responsibility.

a) Aluminium composite panel: Each type and thickness, 600 X 600 mm of the specified thickness.

b) Aluminium extrusions: One only of each section, 300 mm long of specified thickness and details of the temper and the alloy.

c) Fasteners and connecting devices: Each type and size inclusive of test reports.

d) Finish samples: After approval of the final finish coating the Architect / Consultants / PMC is to be provided with six (6) approved samples.

e) Flashing and finish samples

f) Samples submitted should also include assembly of a various components forming a typical fixing detail complete with flat sheets, extrusion, fastener, sealants, etc.

Mock-up:

Before the fabrication and site installation is taken up, the Contractor shall put up a mock-up of his proposed window system for 3 modules vide incorporating all types of hardware and fixtures as per specifications and approved samples. A mock-up of 2 curved panels of cladding one above other shall also be installed at one of the demarcated column. The mock-ups are essential for final approval of all materials and installation details by the Architect.

The Contractor shall submit samples and catalogues of door/window for approval, as applicable.

Maintenance Manual:

Contractor shall submit three (3) copies each of detailed procedures for periodic inspection, maintenance and cleaning of all the Structural Glazing and Aluminum Composite Panel Cladding, Aluminium Doors and Windows etc. of all the items covered under this head.

WORK SCHEDULE

• Immediately on receiving work order the Contractor shall submit the final programmed work schedule for the completion of the whole of the works including submittals. Approvals, fabrication, Supply at site & installation with the time schedule acceptable to the Architect /PMC.

• The time schedule shall be prepared in consultation with PMC to suit the overall project schedule and shall be updated from time to time to suit prevailing conditions and co-ordination with other Contractors employed on site.

INSPECTION OF COMPONENTS

• The contractor shall submit a schedule of material specification and procedure for inspection of the quality of components of the Structural Aluminium Composite Cladding, Aluminium Doors, and Windows during the fabrication in the factory.

• The contractor shall submit weekly reports on the results of the inspection of the components, in a format approved by the PMC.

• The contractor shall submit a description of the procedure of delivery, hoisting, storage, handling installation, scaffolding, and temporary working stage or gondola, protection and cleaning.

STORAGE AND PROTECTION

• The contractor shall submit a schedule on the procedure for inspection during installation so as to maintain quality control on the site.

• The contractor shall submit a daily progress report correlating to the bar chart submitted to PMC.

• The Contractor shall submit a detailed method statement for the protection of the surface of the aluminium structural glazing & cladding members during delivery and erection, with description as to when the protection tape can be removed.

• The Contractor shall submit weekly reports on the inspection of erection and installation as directed by the PMC.

• Delivery and Storage and Materials: All materials delivered to site shall be stored in allocated spaces where the stored material will not be exposed to rainwater, moisture damage, and shall permit easy access to handling of the materials shall be stored neatly and properly stacked.

a) Aluminium wall cladding/ Factory made structural units and or their components shall be transported, handled and stored in a manner to preclude damage of any nature.

b) Accessory materials, required for erection at the site shall be delivered to the site in labeled containers by the manufacturer.

c) Remove all units or components, which are cracked, bent, chipped, scratched or

otherwise unsuitable for installation and replace them promptly.

GUARANTEE

The Contractor shall be fully responsible for proper design and performance of his installed system for a period of 10 years from handling over of works. The design and installation shall be to the best international standards and shall specially take account of wind and seismic loads, cyclone, pollution, acoustics, thermal stresses, building movements.

In addition specific 10 year guarantees in approved format shall be given for performance of anodizing, PVDF coating to cladding sheets and sealants. All the Guarantees shall be submitted before final payment and Rs. 50 lakhs out of total security deposit shall be withheld as performance guarantee against the works under this subhead and shall be released in installments of Rs. 5 lakhs (without any interest) at the end of each year till the completion of 10 years guarantee period, and shall not in any way limit any other rights to correction which the Employer may have under the Contract.

MODE OF MEASUREMENT:

- Will be taken as specified in the Bills of Quantities.
- Measurements shall be in square meter of net visible area fixed.

RESPONSE TIME:

- Façade vendor shall resolve the non conformance raised by the Client / PMC / Architect / Façade consultant within the given time frame but not later than 2 weeks. In case of response time failure penalty shall be raised on façade contractor.

SAFETY :

- First aid appliances including adequate supply of sterilized dressings and cotton wool shall be kept in a readily accessible place. An injured person shall be taken to a public/private hospital without loss of time, in cases where the injury necessitates hospitalization. Suitable and strong scaffolds should be provided for workmen for all works that cannot safely be done from ground.
- No portable single ladder shall be over 8 meters in length. The width between the side rails shall not be less than 30 cm. (clear) and the distance between two adjacent rungs shall not be more than 30 cm. When a ladder is used an extra labour shall be engaged for holding the ladder.
- Every opening in the floor of a building or a working platform shall be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be one meter. No floor, roof or other part of the structure shall be so overloaded with debris or materials as to render it unsafe.
- Those engaged in welding works shall be provided with welder's protective eye- shields and gloves.
- Adequate number of fire extinguisher shall be provided by contractor at the period of execution of the site.
- No paint containing lead or lead products shall be used except in the form of paste or readymade paint. Suitable facemasks shall be supplied for use to the workers when the paint is applied in the form of spray or surface having lead paint dry rubbed and scrapped.

Hoisting machines and tackle used in the works, including their attachments, anchorage and supports shall be in perfect condition. The ropes used in hoisting or lowering materials or as a means of suspension shall be of durable quality and adequate strength and free from defects. Those engaged in working at heights shall use safety belts. Provide fully toughened glass on the inner side of the IGU if glass is abutting with floor.

ITEMS TO BE CO-ORDINATED:

- The Contractor shall initiate and manage the design, development, coordination, installation and testing of the interface between other trades, services and systems carried out on site.
- A Manufacturer's certificate of compliance shall be submitted by the contractor upon completion of the works. All works shall be closely coordinated between the Lighting

contractor and the Facade Contractor.

Selection of Materials as per IGBC norms:

The contractor shall ensure that all materials selected for the works under this head i.e. glass, aluminium sections, sealants, paints etc shall fulfill the minimum requirements

laid down by IGBC for green building category.

The right choice of glazing can also lead to significantly lower cost in building energy consumption.

High performance glass:

High performance glass is one which reduces the ingress of heat and at the same time allows higher penetration of daylight. It can result in energy savings to the tune of 35-

40% as compared to conventional glass. It provides access to day lighting which can enhance occupant comfort and productivity. Typical payback period varies from 3-4 years.

Typical values of high performance glass are as below:

Shading coefficient - 0.1-0.4 W/m2 deg K

U-value - 1.7-3.0 W/m2 deg K

Visual Light transmittance - 40-60%

High performance glazing:

High performance glazing is one which can contribute to optimizing energy efficiency and at the same time enhance light penetration. High performance glazing has low U- value, low shading coefficient and High VLT (Visual light transmission) and is the ideal choice for today's energy stressed buildings.

BOQ Specified- Structural Glazing System

Aluminium Frame.

- This shall include Designing, Supplying, fabricating & erection of Aluminium

Frame Work for semi unitized (four side) structural glazing system.

- The system shall be designed to accommodate double glass unit / provision for the openable shutter wherever required / provision single unit glass / provision for insulated panel & ACP cladding, including sub frame work / sach section for glass unit etc complete & as directed by Architect/Engineer.
- Contractor shall follow general specifications as specified above. These works should be got executed through specialized agencies only.

Material: Mullion- aluminium section of 100x60x2.5mm / as per market availability, Transom- aluminium section of 100x60x2mm / as per market availability, Aluminium profile of required sizes i.e. 25X25mm or 25X37mm / as per market availability, etc. All other sections if required shall be of minimum 2mm thickness. All aluminium extrusions shall be of 6063 TS 5/6 alloy confirming to ASTN B 221. Or equivalent as per design consideration.

Application : The system incorporating of aluminium mullion and transom section, Aluminium extrusions, Trims etc shall be duly anodized/ PVDF coated to minimum 20 micron, of approved shade with all necessary fittings, fixtures, S.S. screws , S.S anchor bolts, fastener (304) S.S. nut bolt, M.S. 'L' type bracket with hot dip galvanized 80 micron thick, spacer tape, 15 mm dia backer rod with weather silicon, Gasket and hardware along with silicon sealant shall be used to ensure Stability and water tightness of the structure including necessary fine stoppage, EPDM gasket, clamping system, 6mm X 12mm spacer tape with silicon sealant. The framework shall be fixed by all necessary fittings, fixtures, S.S. screws , S.S anchor bolts, fastener (304) S.S. nut bolt screwed down or knock down into RCC structure / Masonry walls / steel structure etc.

Payment: The actual area of the framework on the external face of the glazing system

(net visible area) shall be measured in sqm. up to two decimal places.

Rates: The rate shall include the cost of all the materials and labour involved in all the operations i.e. cutting, welding, grinding, buffing, polishing, framing and making curvature (wherever required), fixing the aluminium frame work with necessary accessories & stainless steel dash fasteners, stainless steel bolts etc., finishing, scaffolding etc. as described above.

Double Glass Unit:

This shall include designing, supplying, providing and fixing advanced solar control double glass unit (DGU) over aluminium frame work in item no. 14.01.01

Material: Vision Panel: Double glass unit 24mm thick and vacuum sealed comprising of

6mm thick solar control Low E reflective soft coated glass (heat Strengthened) +12 mm thick air gap (Spacer) filled with an inert gas like argon (glasses spaced by 12 mm thick natural anodized Aluminium one piece bent spacer profile) + 6 mm clear heat strengthened glass unit. The glass unit shall comply with LEED Green Building norms. All other sections if required shall be of minimum 2mm thickness.

Application: This DGU unit with primary seal, secondary seal / spacer frame / spacer profile / spacer tape / sealant etc. should be structurally glazed over aluminium profile tube with the help of double tape of approved make. Aluminium profile of required sizes i.e. 25X25mm or 25X37mm etc. will be structurally fixed on aluminium frame work by rivets, fasteners etc. The expansion joint between two glasses shall be filled with 15 mm dia backer rod and weather silicon sealant shall be used to ensure stability and water tightness of the structure including necessary fine stoppage, EPDM gasket, clamping system etc.

Payment: The actual area of the finished glass on the external face of the glazing system (net visible area) shall be measured in sqm. up to two decimal places.

Rates: The rate shall include the cost of all the materials, glass units and labour involved in all the operations, filling expansion joints, finishing, scaffolding etc. as described above. Cost of aluminium base frame work will be paid separately under item no 14.01.01.

Single Glass Unit (SGU)

The specification shall be same as for the item 14.01.02 given above, except that the glass unit will be single glass unit having 6mm thick solar control Low E reflective coated glass, Heat Strengthened with edge arised.

Aluminium Composite Panel Cladding

This shall include designing, fabricating, testing, installing and fixing in position Curtain Wall with Aluminium Composite Panel Cladding, with open grooves for linear as well as curvilinear portions of the building, for all heights and all levels over aluminium frame work detailed in item no. 14.01.01.

Material: The Aluminium composite panel shall be of total 4 mm thickness comprise of Aluminum skin of minimum 0.5mm with fluorocarbon paint finish + 3mm thick mineral core with Fr grade —B‖ (Confirms to EN 13501) + 0.5 mm aluminum skin with service coat. All other sections if required shall be of minimum 2mm thickness.

Application: This DGU unit with primary seal, secondary seal / spacer frame / spacer profile / spacer tape / sealant etc. should be structurally screwed down to aluminium profile tube with the help of SS screws and fixtures of approved make. Aluminium profile of required sizes i.e. 25X25mm or 25X37mm etc. will be structurally fixed on aluminium frame work by rivets, fasteners etc. The expansion joint between two glasses shall be filled with 15 mm dia backer rod and weather silicon sealant shall be used to ensure stability and water tightness of the structure including necessary fine stoppage, EPDM gasket, clamping system etc.

Measurement: For the purpose of payment, only the actual area on the external face of the curtain wall with Aluminum Composite Panel Cladding (including width of groove) shall be taken in sqm correct to two places of decimals.

Rates: It includes cost of all material & labour component, the cost of all mock ups at site, cost of all samples of the individual components for testing in an approved laboratory, field tests on the assembled working curtain wall with aluminium composite panel cladding, cleaning and protection of the curtain wall with aluminium composite panel cladding till the handing over of the building for occupation. Cost of base frame work will be paid separately under item no 14.01.01.

GI Sheet Flashing

This shall include providing and fixing 1mm thick GI Sheet flashing around DGU along granite sill and jamb to close the gap between glazing and wall, as per detail, inclusive of nuts, SS Screws, bolts and sealing of joints at all levels.

Application: Providing and fixing flashing at all floor levels as part of the system (applicable only for continuous Curtain wall/ structural glazing portion) made to profile as shown in the approved drawings

and the profile shall be made out of hot dip galvanized sheet 1mm thick and galvanizing coating thickness shall be in accordance with IS 2629 & 4759. In general, the flashing shall be provided to the entire length of Curtain wall/ structural glazing portion horizontally at all floor levels and at terrace level with a overlap of 100 to 125 mm in plan and the joints shall be sealed with weather silicon sealant and with recessing anchoring system soaked and SS fastening devices in sealant of approved make. Also, the flashing shall be provided at parapet top below the coping to drain the water during any seepage through the sealant joints with overlap of 100 to 125 mm in plan with sealant at joints to make sure that no water leakage through coping / flashing joints.

Provide all required flashings, baffles, trims, capping and the like to prevent the entry of water and weather, and make neat and clean junctions with the base-structure and adjoining work. Where visible, provide matching materials and finishes.

All flashings shall be cut and folded to accepted profiles out of non-corrosive materials, with protective coatings as required. Flashing shall be of adequate stiffness to retain shape and to resist lifting by the wind. Make provision for differential movements and for separation of dissimilar materials. Continuous flashings shall be welded or mechanically fixed to form continuous uninterrupted lengths. Corners shall be accurately scribed and mitered. If the flashing is concealed, flashing joints shall be lapped at least 100mm and sealed. Where flashings are fitted to pre-formed rebates, co-ordinate cast-in grooves as required. Construct weep-holes as required to enable the passage of moisture to the outside of the building. Lap and seal all flashings by accepted methods.

Measurement: Measurement will be taken as the area, where the sheets are fixed and will be measured in sqm up to two correct places of decimals.

Rate: Rates shall be inclusive of all fittings, materials, fixtures, labour etc, as required

Canopy

This shall include designing, providing, erecting, hoisting & placing in position laminated glass canopy on stainless steel spider system (Cantilever 7 meter) suspended designed as specified in BOQ/ detailed drawings or as instructed by the Architect.

Materials: Glass panels of 17.52 mm thick clear laminated in combination of 10mm thick 1.52 mm PVB plus 6mm Clear float glass (tampered) with necessary drill counter with polished edge finish, SS spider system grade 316 with articulated bolt assembly in SS of 316 grade fasteners , SS cables and anchor bolts of 304 grade of approved make, Teflon/nylon bushes and separators to prevent bi metallic contacts, SS 1mm flashing at wall side and sealing with approved weather sealant having drainage gutter at canopy junction.

Application:

Laminated glass often incorporates heat-strengthened or tempered glass to meet the structural performance requirement, so that dead loads and high wind loads can be accommodated by the overhead glazing where the glass is supported by fasteners that pass through holes in the glass. The support structure will be above the glass. The glass in these applications is to be typically designed as a non enclosed structure as the wind load acts both as an uplift on the upper surface and a pressure on the lower surface. Design load will be taken as 1.5 times the wind pressure.

The maximum stress on canopies may not be at the point of maximum bending moment. The holes and fasteners often create large local stresses that must be accounted for. Fasteners must therefore have a flexible capability so that local loads do not develop as a result of deflections.

It is extremely important that the holes are sized to give adequate clearance from fasteners. It is common in laminated glass to experience a small amount of slippage and therefore extra clearance is often used to avoid any problems

Measurement: For payment purpose, top plan area of the canopy will be taken in Sqm up to two correct places of decimals.

Rate : It includes cost of all materials, labours, the cost of all mock ups at site, cost of all samples of the individual components for testing in an approved laboratory of all fittings, fixtures etc. as required and instructed by the Architect.

Structural fixed glazing with SS Spider fittings:

Scope of Work : The scope of work under this contract is limited to design, engineering, manufacturing including installation and maintenance including defect liability period of the Frameless Suspended Glazing systems in the form of toughened glass assemblies, most of which are fixed panels but some of which may be with doors. These glass assemblies are to be fully suspended from the building structure and are to be designed as load bearing material withstanding the stresses inherent in such assemblies for the proposed project building. The scope includes:

Frameless Suspended Glazing System

This shall comprise of the following elements:

1. Suspended glazing system consisting of Suspension brackets with EPDM separator between glass and SS bracket.

2. Concealed achromatized aluminium channel for frameless glazing.

3. Stainless Steel 316 grade Spider Fittings of Dorma make approved for the 12mm &

19mm glass components.

4. 12mm & 19mm Toughened Glass of Approved make with predrilled holes to accept the through bolts of the Spider fittings assembly.

5. Chemical Inserts in concrete for the anchorage of all work under this section if required.

6. All steel structural brackets and beam supports, anchors and attachments required for the complete installation of the whole system.

7. All caulking, sealing and flashing including sealing at junctions wherever required.

8. Doors where indicated, inclusive of all accessories, iron mongeries etc.

9. Sealants within and around the perimeter of all work under this section.

10. Separators, EPDM gaskets, trims etc.,

11. Isolation of dissimilar metals and moving parts.

12. Engineering proposals, drawings and data.

13. Shop drawings, engineering data and structural calculations of the framing, fasteners and claddings stamped by a professional structural engineer approved by the Employer.

14. Scheduling and monitoring of the work.

15. Co-ordination with work of Main Contractor and other trades.

16. All final exterior and interior cleaning of the SUSPENDED systems.

17. Cost of all hoisting, staging and temporary services.

18. Guarantees.

19. Maintenance manuals.

General Specifications: Contractor for the Suspended System shall fabricate, supply and erect and install in position the glazing forming uninterrupted structural glazed surface in accordance with architectural elevation and layout drawings. The glazed surface shall be formed by a frameless system, which shall be of structurally and mechanically designed technology for fabrication and erection with grid sizes indicated in the drawing. Each Panel is to be suspended with adjacent panes being jointed at the panel corners by spider fittings bolted together through specially designed holes or notches in the glass. Each tier of panel except the top is to be suspended from the tier above and the whole assembly, except the doors, is to be suspended from and rigidly connected to a substantial structural member of the building, which is capable of fully supporting the dead weight of the assembly in addition to the forces due to wind load. The perimeter of the frames shall be structurally integrated to form air and waterproof movement joint on all four sides of each panel. Design and sealing of such joints shall ensure that there is no penetration of rainwater through these joints under heavy wind pressures. The contractor must comply with all relevant Indian Standards, Code of Practice and technical literature relating to best practice pertaining to frameless suspended Glazing. The equivalent International Standards may be used where these are not lower. Nothing in this clause shall relieve the contractor of his obligation to provide a higher standard where required and directed.

Glass: The façade shall be of toughened glass not less than 12mm thick and shall be supported against wind loads by fins, stiffeners, of toughened glass of 19mm thick clear float make. The fins shall be attached to the façade glass by spider fittings, and shall be attached to the building structure in such a way as to provide the façade with support against wind loads.

Toughening of Glass: The rolling direction shall be parallel to the width of the glass panel, such that waviness if any if parallel to the horizontal and no waviness parallel to the vertical and to ensure that such waviness is of negligible order.

Performance Criteria: The Contractor shall be responsible for the quality and efficiency of the design and application of the technology offered. The system offered shall be structurally sound, capable of withstanding loads and thermal and structural movements indicated with failure, aesthetically pleasing and pretested in accredited overseas laboratories certifying performance of the whole spider glazing system in accordance with International Standards.

The contractor shall submit detailed calculations of the structural design of the main system, holding brackets, factory formed glazed units and fixing by nuts/ bolts and with standing strength of glass to meet with all the design parameters and requirements contained these specifications.

Limiting Factor on Height: The main limiting factor to be considered on the height of the suspended assembly is the ―Pullout strength‖ of the holes of the Top tier panels. It is the responsibility of the Contractor to adequately check the Limiting conditions prior to fabrication and approval on the same is to be acquired from the architect in this regard.

Fail-Safe Requirements: The design of the toughened glass assembly shall be such that the breakage of any component of the assembly will not initiate progressive collapse of the remainder.

Glass Design Stress: The glass façade panels and the stiffener fins, and the fixing points to the building shall be designed to withstand wind loading in accordance with A.S 1288 or equivalent approved I.S. codes.

The maximum design for the toughened glass fins for wind loading shall be as per the codes.

Provision for Expansion and Structural Movement: Provision shall be made for downwards thermal expansion of a fully suspended façade by providing a rebate in the floor or sill edge of the glass. The rebate shall be deep enough to provide edge cover of 1 to 1.5 times the glass thickness plus clearance of not less than 12mm between the lower edge of the façade glass and the bottom of the rebate.

Rebate at each end of the façade or other adequate provision such as silicone butt jointing shall be provided to allow for horizontal thermal expansion of the glass façade.

Component of Anchor Fasteners, Bolts Etc: Fixing bolts, screws and nuts shall be manufactured from stainless steel grade 316. All bolts, anchors and other fastening devices shall be self locking unless otherwise noted and shall be torque tightened to achieve maximum torque tension where required. Brackets shall be Galvanized MS of adequate size to meet design parameters. The brackets joint shall be flexible to allow for all movements, deflection and expansion/contraction. All metal to metal joints shall be separated by tough high impact and both side smooth membrane of Teflon of minimum 1.0mm thickness. Anchor bolts shall be of Hilti, fisher or equivalent.

Sealants: Imported silicone adhesive sealant having excellent properties of adhesion, elasticity, long life and of approved make one part silicone shall be used. Directions of the manufacturer of the sealant shall be strictly followed: -

The tenderer shall furnish details and technical information's on all the above requirements. Contractor shall study carefully and provide report on all materials that will be in contact with the imported silicone sealant and provide for compatibility testing and report of proper adhesion. (Adhesion with materials like glass, finished metal, surfaces, masonry, spacers etc.)

Adhesion testing and compatibility test shall be carried out by the imported sealant manufacturers on prototype to ensure fulfillment of values and quality required for approval prior to use with corresponding materials and surface finishes in the beginning. As it is expected that the entire materials required will be supplied in lots at regular intervals of times, the Contractor is required to state in details how it will be ensured by them that the samples of every lot undergo the adhesion and compatibility testing meeting with the requirement of the imported sealant manufacturer and approval.

The Structural glazing contractor will ascertain from the manufacturer of structural silicone adhesive sealant, the sealant selection procedure and obtain their services for exercising the following controls:

Technical and commercial support for use of silicone adhesive sealant in proposed system and details regarding properties of the silicone adhesive in respect of:

(i) Water absorption.

(ii) Resistance to water, fungi and oxidation.

(iii) Density and hardness.

(iv)Compressible stress and tensile stress.

Mode of Measurement:

Length and breadth of the superficial area of the finished work shall be measured centre to centre of the grooves on the external surface viewed externally correct to a centimeter under the respective items. Areas shall be calculated in a square meter correct to two places of decimal.

Rate: Quoted rate shall include the cost of all materials, labour, machinery and scaffolding etc. involved in all the operations as specified above.

Smoke & Fire Seal

Providing and fixing Smoke seal / Fire stop using extruded aluminium channel with cap for continuous structurally glazed framing system with required thickness as per site and in general the thickness of channel and cap shall be 2mm and to a width as required between transom and sill finish material and it shall be 63400(H9) grade conforming to IS8147, finished with AC25 grade Architectural quality electrolytic colour anodic coating conforming to IS1868 of approved colour. Aluminium colour anodized

extruded Channel shall be supported with the help of Aluminium bracket as designed and this bracket to be fixed on the wall /RCC surface with necessary SS anchor bolt and fastener of approved make. This channel with cap shall be provided between Sill finish Material and Curtain wall /structural glazing member at sill level and between RCC member face and structural glazing member at soffit level /false ceiling and etc complete. All the Joints between the capping channel and any other finish material at both sill and soffit level shall be sealed with in tumescent sealant of 3M, Hilti or approved make.

Also, close the gap on the vertical surface between the face of column /wall /partition and structural glazed frame /glass by using extruded aluminium channel with cap with anodized finish aluminium bracket supported on the column /wall /partition and in general the thickness of channel and cap shall be as mentioned above and of approved matching colour to the Mullion & transom.

The fire stop for 4 hr Fire rating with smoke seal at all floor slab levels required as per local fire authority. 100mm thick and 60 Kg/m3 density of Loose Rockwool slab with

2mm GI flashing to hold the assembly shall be fixed in compressed form with necessary PVC sleeves, SS screws etc, between the gap as per the specified drawings / Building RCC and Curtain wall system at soffit / Floor level. Fire Stop Mineral Wool to be compressed by 33% in installed state leaving no voids and assuring a tight seal. Smoke seal intumecent of 10mm shall be applied in the gap of top side GI flashing and curtain wall assembly. The whole assembly also to act as acoustic assembly between the floors. The fire stop assembly shall run vertical side where there is a shear wall condition or break in horizontal fire stop. The floor closure shall be provided continuously at floor level with 2mm thick GI flashing .The complete assembly to be tested for performance as instructed by the Architect / Engineer-in-charge. Contractor shall submit test result for all Fire rated material.

Measurement: Measurement will taken as the length of the linear edge of seal applied.

Rate: Quoted rate shall include the cost of all materials, labour, machinery and scaffolding etc. involved in all the operations as specified above.

Logo

This shall include designing, providing, erecting, hoisting, placing and fixing in position SEEPZ's Logo made up of 15mm thick Acrylic sheets fixed with Vinyl sheet of 2mm thick over and above the acrylic sheets with SEEPZ approved colored PVC translucent film cut in design of the SEEPZ Logo. It is to be done over radial structural steel framework complete having overall diameter of 11000mm, as per detailed drawing. The logo shall be back-lit with LED lighting running along the circumference at regular intervals. The peripheral gap space between front side and the backing shall also be covered with acrylic sheets, having a width of 500mm. Rate to include cost of steel framework and LED lighting

Contractor shall prepare and submit the detailed shop drawings for the item and the work is to be commenced only after the approval from Architect / SEEPZ's Engineer. There will be 2 identical logos one on front & one on back side of the building to be fixed as per detailed drawings / instructions of the architect.

Measurement: The number of logos to be fixed in the building having the dimensions as detailed in drawings will be payable under this item.

Rates : Quoted rate shall include the cost of all materials i.e. Structural steel framework, Acrylic sheets, Vinyl sheets, PVC translucent films, LED lighting and fixtures, fittings, steel nuts and bolts etc., labour, machinery and scaffolding etc. involved in all the operations as specified above.

External Film

This shall include providing, placing and fixing in position Acrylic Glass Film in Milky White color, applied superfluously over glazed façade with a backing of acrylic pressure sensitive adhesive. The film strips shall be 150mm wide and between 0.2 to 0.3 mm thick, and shall be applied over glass surface as per product specification (3M Fasara , San Marino or equivalent approved make) and guides and in the profile as per the specified drawings.

Measurement: For payment purpose, actual length of Film visible on facade shall be measured.

Rates: Quoted rate shall include the cost of all materials, labour, machinery and scaffolding etc. involved in all the operations as specified above.

46. E-DECK PLANTER WITH INTEGRATED SEATING

(Industrial Building – Tower, E-Deck Landscape Zone)

Supply, fabrication, installation, and commissioning of RCC planter with integrated timber-clad seating edge on E-Deck, including waterproofing, drainage, soil media, root barrier, and landscape planting, as per approved architectural drawings and site conditions suitable for industrial building usage.

WORKING SECTION – BUILD-UP DETAIL

A. STRUCTURAL PLANTER BODY

Layer	Specification
Planter Wall	230 mm RCC wall, M30 grade, with integral waterproofing admixture (Fosroc / Sika / Pidilite approved)
Reinforcement	12 mm Ø Fe500 bars @ 150 c/c both ways, double mesh
Planter Base	150 mm RCC slab, M30 with 12 mm Ø @ 150 c/c BW
Height (above FDL)	600 mm (planter) + 450 mm (seating top)
Internal Clear Depth	900 mm min. (for shrubs); 1200 mm at tree pit locations

B. WATERPROOFING SYSTEM (Critical for Deck)

Cementitious base primer

2-component polyurethane waterproofing membrane, 2 mm DFT (Sika / BASF / Fosroc)

Root barrier membrane – HDPE 1 mm thick, heat-welded joints

40 mm cement protection screed with fibre mesh

15-year waterproofing warranty from applicator

C. DRAINAGE LAYER

30 mm HDPE dimpled drainage cell (e.g., Geoplas / Zinco / Rooflite)

150 gsm non-woven geotextile filter fabric

75 mm washed gravel (20 mm size) drainage bed

Ø75 mm UPVC drain outlet connected to E-Deck storm water line, one per 3.0 m run of planter

Overflow weep hole 50 mm below planter rim

D. PLANTING MEDIA

750–1000 mm engineered lightweight soil mix:

40% garden soil

25% organic compost

20% coarse river sand

10% perlite / cocopeat

5% vermicompost

Density: not exceeding 1400 kg/m³ (to suit deck loading)

E. TREE PIT (Where indicated on plan)

1500 × 1500 × 1200 mm deep pit

Root deflector barrier – 1000 mm deep HDPE

Ø100 mm perforated PVC aeration pipe with SS grating cap

SS underground tree anchoring system (guy strap type)

SEATING EDGE DETAIL

A. SEAT SUBSTRUCTURE

100 × 50 × 5 mm MS box section framework, hot-dip galvanized (85 microns) + epoxy powder coated RAL 7022

Anchored to RCC planter wall with M12 SS 316 chemical anchors @ 450 c/c

B. SEAT TOP FINISH (Industrial Grade)

50 mm thick IPE / Merbau / WPC (Wood Plastic Composite) battens
(Recommended: WPC for industrial context – low maintenance, UV stable, termite proof)

Batten size: 90 × 40 mm, with 8 mm gap

Fixed with SS 304 concealed clips

Anti-slip grooved top finish

C. SEAT DIMENSIONS

Parameter	Dimension
Seat Height	450 mm from FDL
Seat Depth	500 mm
Overhang from Planter Face	100 mm
Backrest (Planter Wall)	600 mm above seat
End Rounded Corners	R75 mm

D. EDGE PROTECTION

6 mm SS 304 satin-finish edge trim along seat nosing

Chamfered anti-injury edges as per industrial safety norms (IS 4963)

E-DECK FLOOR BUILD-UP (Adjacent to Planter)

20 mm anti-skid vitrified / porcelain deck paver (R11 rated)

20 mm cement-based adhesive bedding

50 mm screed with slope 1:100 towards drain

Waterproofing membrane (continuous with planter WP)

Protection screed 40 mm

RCC deck slab (structural)

MATERIAL SCHEDULE

Item	Specification	Approved Make
Cement	OPC 53 Grade	UltraTech / ACC / Ambuja
Waterproofing	PU Membrane	Sika / Fosroc / BASF
Drainage Cell	30 mm HDPE	Geoplas / Zinco
Geotextile	150 gsm NW PP	Terram / Maccaferri
WPC Battens	90×40 mm, UV stable	Duroply / Kridovin / Ecoste
SS Fixings	SS 316 grade	Hilti / Fischer
Root Barrier	1 mm HDPE	DeepRoot / Zinco
Planter Coating (Internal)	Cementitious crystalline	Xypex / Krystol

WORKMANSHIP & TESTING

Ponding test: 72-hour water retention test on planter before soil filling

Load test: Deck to sustain planter dead + live load (min. 5 kN/m²)

Slip test: R11 rating for adjacent deck paver

All welded joints of MS frame – ground smooth, primer + 2 coats epoxy paint

All exposed concrete edges – chamfered 15 mm

Curing – minimum 14 days water curing for RCC elements

MEASUREMENT & PAYMENT

Item	Unit
RCC Planter (with WP, drainage, soil)	Rmt
Integrated Seating (with substructure + WPC top)	Rmt
Tree Pit with aeration + anchoring	Nos
Deck Paver adjacent to planter	Sqm

WARRANTY

Waterproofing – 15 years from applicator

WPC seating top – 10 years UV & termite warranty

SS hardware – 5 years against corrosion

Planting – 1-year defect liability + maintenance

47. Façade Access Monorail System & Telescopic Suspended Cradle (BMU)

1. MONORAIL SYSTEM FOR FACADE ACCESS

Item Description

Design, supply, fabrication, installation, testing, commissioning, certification and handing over of permanent façade access monorail system comprising continuous monorail track, support brackets, trolleys, anchors, embedded plates, corrosion protection and all associated accessories complete as per approved drawings, manufacturer's requirements and project specifications.

Scope of Work

The scope shall include:

Design calculations and shop drawings, Structural load verification

Fabrication and supply of monorail track system, Trolley assemblies

Support brackets and fixing arrangements, Anchor fasteners and embedded plates

Corrosion protection treatment, Installation and alignment

Testing and certification, Warranty and handover

Monorail Track

Material

Monorail track shall be manufactured from:

Structural steel conforming to IS 2062 E250/E350 or equivalent, or

Extruded aluminium alloy 6061-T6 / 6063-T6

Track Requirements

Continuous running track system

Minimum Safe Working Load (SWL): 500 kg

Designed for cradle load, operators, equipment and dynamic loads

Smooth trolley movement without obstruction

Track joints shall be machined and aligned

All bends and transitions shall be factory fabricated

Support Brackets

Support brackets shall:

Be fabricated from structural steel

Be designed to resist operational and wind loads

Be hot dip galvanized

Be fixed using approved anchor systems

Accommodate thermal movements

Bracket spacing shall be as per structural design but generally not exceeding:

1500 mm to 2500 mm c/c

Embedded Plates and Anchors

Embedded Plates

Minimum 10 mm thick steel plate

Hot dip galvanized finish

Properly coordinated with RCC works

Anchor Fasteners

Stainless steel SS316 or approved equivalent

Chemical anchor system

Pull-out testing to be conducted

Trolley Assembly

Each trolley assembly shall include:

- Heavy-duty trolley wheels
- Sealed bearings
- Anti-derailment mechanism
- Suspension attachment points
- Corrosion-resistant finish
- Minimum load capacity:
- 500 kg per trolley

Corrosion Protection

Steel components shall receive:

Option A

Hot Dip Galvanization, Minimum 80 Micron Zinc Coating

Option B

Epoxy Zinc Rich Primer + Intermediate Epoxy Coat + Polyurethane Top Coat

Design Criteria

System shall be designed considering:

Dead load

Live load

Dynamic load

Wind load as per IS 875 Part-3

Building movement

Thermal expansion

Minimum Factor of Safety:

3.0

Testing & Certification

Contractor shall conduct:

Factory Testing

Material inspection

Fabrication inspection

Dimensional verification

Site Testing

Alignment checks

Operational checks

Load test at 125% SWL

Third-party certification shall be submitted.

Warranty

Minimum:

2 Years Defect Liability Period

2. TELESCOPIC SUSPENDED CRADLE (BMU)

Item Description

Design, manufacture, supply, installation, testing, commissioning and certification of telescopic suspended cradle (Building Maintenance Unit - BMU) for façade cleaning, inspection and maintenance complete with platform, hoisting machines, wire ropes, safety systems, electrical controls and accessories.

General Requirements

The BMU shall be suitable for:

Glass cleaning

Façade inspection

Maintenance works

Silicone replacement works

System shall safely access complete façade coverage.

Cradle Platform

Construction

Aluminium alloy or galvanized steel construction

Anti-skid floor deck

Guard rails on all sides

Toe boards

Dimensions

Adjustable telescopic platform:

Minimum Length: 2.5 m

Maximum Length: 6.0 m

Platform Width:
700 mm – 800 mm

Safe Working Load
Minimum Platform Capacity:
250 kg to 300 kg
Suitable for:
Two operators
Cleaning equipment
Maintenance tools

Hoisting System
Each cradle shall be provided with:
Electric Hoists
Twin independent hoists
Electro-mechanical braking
Self-locking gearbox
Operating Speed:
8–10 m/min
Power Supply:
415V, 3 Phase, 50 Hz

Wire Rope System
Main Rope
Galvanized steel wire rope
Minimum diameter: 8 mm
Safety Rope
Independent safety wire rope
Separate anchorage system
Wire ropes shall conform to relevant IS standards.

Safety Devices
The BMU shall incorporate:
Safety Lock System
Automatic fall arrest safety lock.
Anti-Tilt Device
Stops operation if excessive platform inclination occurs.
Upper Limit Switch
Prevents over-travel at roof level.
Lower Limit Switch

Prevents excessive lowering.

Emergency Stop

Emergency stop button at operator station.

Emergency Descent System

Manual emergency lowering arrangement.

Overload Protection

Prevents operation beyond SWL.

Wire Rope Failure Protection

Independent safety locking system.

Electrical System

Control Panel

Weatherproof enclosure:

IP65 Minimum

Features:

Start/stop controls

Emergency stop switch

Phase failure protection

Overload protection

Motor contactors

Control transformer

Suspension Mechanism

The cradle shall be compatible with:

Monorail system

Roof carriages

Traversing trolleys

All suspension fittings shall be designed to withstand:

Minimum 4 times working load

Performance Requirements

System shall withstand:

Operational wind conditions

Dynamic loading

Building movements

Operation shall remain smooth throughout full travel length.

Testing and Commissioning

The following shall be carried out:

Load Test

125% Safe Working Load

Functional Testing

Hoist operation

Safety lock operation

Emergency descent operation

Limit switch operation

Certification

Third-party certification shall be submitted before acceptance.

Codes & Standards

The complete BMU and Monorail System shall comply with:

EN 1808 – Suspended Access Equipment

IS 875 – Wind Loads

IS 2062 – Structural Steel

IS 800 – Steel Design

IS 3696 – Safety Requirements

Factory and Site Safety Regulations

Applicable Building Codes

BOQ Measurement

Item 1 – Monorail System, Unit : Running Meter (Rmt)

Rate shall include:

Track, Brackets, Trolleys, Anchors, Corrosion protection, Testing, Certification

Item 2 – Telescopic Suspended Cradle (BMU)

Unit : Each (No.)

Rate shall include: Cradle platform, Hoists, Wire ropes, Control panel, Safety devices, Testing, Commissioning, Certification, Training and handover

This specification is suitable for inclusion in commercial high-rise, IT park, hospital, airport and premium façade tender packages.

48. Street Light Electrical Pole

Pole Specification

Pole Type

- Hot Dip Galvanized Octagonal Pole.
- Suitable for pedestal mounting.
- Single arm bracket arrangement.
- Overall height: 6.0 m above finished ground level (FGL).
- Conforming to IS 875, IS 2062 and relevant lighting pole standards.

Material

- Fabricated from HT steel sheet conforming to IS 2062 grade.
- Polygonal/octagonal section continuously tapered.
- Longitudinal weld by automatic welding process.

Galvanization

- Hot dip galvanized inside and outside.
- Average zinc coating thickness minimum 65 microns.

Pole Door

- Weatherproof flush type inspection door.
- Concealed vandal-resistant locking arrangement.
- Suitable for mounting MCB, terminal connector and astro timer.

Pole Base Plate

- MS base plate welded to pole.
- Suitable for foundation bolt mounting.
- Complete with anchor bolts, nuts and washers.

2. Foundation

The scope shall include excavation, PCC, RCC foundation and grouting complete.

Foundation Components

- Excavation as per approved drawing.
- PCC 1:4:8 levelling course.
- RCC foundation minimum M25 grade concrete.
- Anchor/Foundation bolts with template.
- Curing, backfilling and disposal of surplus earth.

Pole Erection

- Pole shall be erected perfectly vertical.
- Alignment to be checked before final tightening.
- Non-shrink grout to be used below base plate wherever required.

3. LED Street Light Fitting

Luminaire Type

- Integral LED street light fitting.

Wattage

- 80 Watt

Housing

- Die cast aluminium pressure die-cast housing.

Optical System

- High efficiency PMMA/Polycarbonate lenses.
- Uniform road lighting distribution.

Protection

- Minimum IP65.

LED Driver

- Constant current electronic driver.
- Input Voltage: 140V–270V AC.
- THD less than 10%.
- Power Factor ≥ 0.95.

LED Performance

- System efficacy minimum 120 lm/W.
- LED life L70 ≥ 50,000 burning hours.
- CCT: 5700K ± 500K.
- CRI ≥ 70.

Surge Protection

- Minimum 10 kV external/internal surge protection.

4. Single Arm Bracket

- MS tubular arm suitable for 80W LED luminaire.
- Length: 1.0 m to 1.5 m.
- Hot dip galvanized.
- Powder coated finish matching pole.

5. Pole Junction Box (Concealed)

Junction Box

The pole shall be provided with concealed junction box consisting of:

- Bakelite mounting plate.
- 6A SP MCB.
- Suitable terminal connectors.
- Cable glands.
- Ferrules and lugs.
- Internal wiring accessories.

Connector

- Suitable for incoming and outgoing cable connection.
- Rated for 4C x 25 sq.mm Aluminium/Copper cable.
- Screw type insulated terminals.

6. Internal Pole Wiring

Supply and laying of:

Cable

- 3C x 2.5 sq.mm Copper Flexible FRLS cable.

Scope

- Wiring from pole junction box to LED fitting.
- Complete with cable lugs, ferrules, glands and terminations.

Standards

- IS 694/IS 8130 approved cable.

7. Astro Timer

Each pole shall be provided with:

Astro Timer

- Digital programmable astro timer.
- Automatic ON/OFF operation based on sunrise and sunset timings.
- Battery backup memory retention.
- Voltage range 180–270V AC.
- DIN rail mounting type.

Features

- Latitude/Longitude programming.
- Automatic annual adjustment.
- Manual override facility.

8. Earthing

Pole Earthing

Each pole shall be independently earthed.

Earthing Conductor

- 8 SWG GI wire.

Connections

- Earth wire from earth pit to pole.
- Earth termination through GI nuts, bolts and washers.

Earth Resistance

- Maximum earth resistance shall not exceed 5 Ohms.

Scope Includes

- Earth electrode (where specified).
- Earth chamber and cover.
- All excavation, backfilling and connections.

9. Testing & Commissioning

The contractor shall carry out:

- Continuity test.
- Insulation resistance test.
- Earth resistance test.
- Functional testing of LED luminaire.
- Astro timer operation test.
- Voltage and current measurement.
- Complete commissioning of the street lighting system.

10. Measurement

The item shall be measured per complete set (Each) comprising:

- 6.0 m octagonal pole
- Foundation
- Base plate and anchor bolts
- Single arm bracket
- 80W LED street light
- Junction box
- 6A SP MCB
- Terminal connectors
- Internal wiring (3C x 2.5 sq.mm Cu cable)
- Astro timer
- Earthing with 8 SWG GI wire
- All mounting hardware and accessories
- Testing and commissioning

54. Bollards Lights for E Deck

1. Scope of Work

The work shall include providing, supplying, installing, testing and commissioning of 750 mm (2.5 feet) high decorative LED Bollard Light Fitting complete with die-cast aluminium housing, LED light source, driver, mounting arrangement, foundation fixing accessories, internal wiring, earthing, testing and commissioning including all materials, labour, tools, tackles and accessories required for satisfactory operation.

2. Applicable Standards

The bollard light and associated accessories shall conform to the latest editions of:

- IS 10322 – Luminaire Standards
- IS 16107 – LED Lighting Products
- IS 16104 – LED Driver Requirements
- IEC 60598 – Luminaire Safety Requirements
- IEC 60529 – Degree of Protection (IP Rating)
- National Electrical Code (NEC)
- Relevant CPWD General Specifications

3. Bollard Light Construction

Housing

- Housing shall be manufactured from high-quality pressure die-cast aluminium.
- Corrosion-resistant construction suitable for outdoor installation.
- Robust vandal-resistant design.
- Surface finish shall be smooth and free from defects.

Finish

- Electrostatic polyester powder-coated finish.
- Powder coating thickness: minimum 60–80 microns.

- Colour as approved by Architect/Engineer.
- UV-resistant and weatherproof coating.

Height

- Overall height: 750 mm (±25 mm) above finished ground level (FGL).

Diffuser

- UV-stabilized Polycarbonate/Acrylic diffuser.
- High impact resistant.
- Uniform light distribution without glare.

4. LED Light Source

Wattage

- LED Wattage: 10W to 20W as approved in design.

Performance

- Minimum Luminaire efficacy: 100 lumens/Watt.
- Colour Rendering Index (CRI): Minimum 70.
- Correlated Colour Temperature (CCT):
    - 3000K (Warm White) or
    - 4000K (Neutral White) or
    - 5700K (Cool White) as specified by Architect.

Life Span

- LED Life: Minimum 50,000 burning hours (L70).

5. LED Driver

Driver Characteristics

- Integral electronic constant current driver.
- Input Voltage: 140V–270V AC.
- Frequency: 50 Hz.

Performance

- Power Factor ≥ 0.95.
- THD ≤ 10%.
- Short circuit protection.
- Over-voltage protection.
- Overload protection.

Surge Protection

- Inbuilt surge protection minimum 4 kV.

6. Protection Rating

Ingress Protection

- Complete luminaire shall have IP65 Protection Rating or better.

Impact Resistance

- IK07 or higher preferred.

7. Mounting Arrangement

Mounting Base

- Heavy-duty mounting base plate factory fitted with luminaire.

Fasteners

- Stainless Steel (SS304) anchor fasteners.
- Nuts, bolts and washers shall be corrosion resistant.

Installation

- Bollard shall be rigidly fixed over PCC/RCC pedestal or foundation block.
- Alignment shall be checked before final tightening.

8. Internal Wiring

Cable

- FRLS Copper flexible cable.
- Minimum size: 3C x 1.5 sq.mm or as specified.

Accessories

- Cable glands.
- Lugs.
- Ferrules.
- Terminal connectors.

All wiring shall be neatly dressed inside the bollard and secured to avoid mechanical damage.

9. Earthing

Earthing Conductor

- Minimum 8 SWG GI wire or equivalent copper conductor.

Connection

- Dedicated earthing terminal shall be provided inside the bollard.
- Earthing connection shall be made from the earth conductor to bollard body using suitable fasteners.

Requirement

- Earth continuity shall be maintained throughout the installation.
- Earth resistance shall be within permissible limits as per IS standards.

10. Foundation

The scope shall include fixing of bollard over foundation/pedestal complete with:

- Foundation bolts.
- Anchor fasteners.
- Base plate fixing.
- Grouting where required.
- Alignment and leveling.

11. Testing & Commissioning

After installation, the following tests shall be carried out:

- Visual inspection.

- Insulation Resistance Test.
- Earth Continuity Test.
- Polarity Check.
- Functional Test of LED fitting.
- Voltage Measurement.
- Illumination verification.

The system shall be commissioned only after satisfactory completion of all tests.

12. Measurement

The item shall be measured on Per Each Basis and shall include:

- Decorative LED Bollard Light.
- LED driver.
- Diffuser.
- Die-cast aluminium housing.
- Mounting base plate.
- Anchor fasteners.
- Internal wiring.
- Earthing connection.
- All accessories.
- Testing and commissioning.

49. Baffle Ceiling

Providing and fixing Armstrong/USG Knauf or equivalent approved make Vertical Linear Baffle Ceiling System comprising suspension of secondary C-Channels of size 40 mm x 0.80 mm thick having flanges of 15 mm and 20 mm, suspended from the structural soffit at maximum 1200 mm centre-to-centre spacing using adjustable level clips of size 85 x 31 x 0.60 mm, suspended through 4 mm diameter GI rods connected to soffit cleats of size 37 x 27 x 25 x 1.6 mm with 8 x 35 mm fasteners or approved equivalent. The suspension framework shall support 0.50 mm thick galvanized steel baffle carrier profiles of size 34 x 23 mm, fixed perpendicular to the C-channel framework at maximum 1200 mm centres using approved self-tapping screws and accessories. The ceiling shall incorporate 50 x 150 mm wooden finish baffle panels manufactured from 0.70 mm thick powder-coated aluminium, finished with polyester coating of 50–60 microns thickness, complete with 5 mm interlocking lips. The baffle panels shall be securely fixed to the carrier profiles by interlocking the panel lips into the carrier lock profile at regular intervals of approximately 100 mm. The work shall also include providing and fixing matching top caps and end caps at all exposed edges and ends of each baffle panel to achieve a neat and finished appearance. The complete ceiling system shall be installed true to line, level and alignment, including all suspension arrangements, connectors, fasteners, cutting, fitting, scaffolding, wastage, labour, tools and accessories required for proper installation. The work shall be carried out strictly in accordance with the manufacturer's specifications, approved shop drawings and the directions of the Architect/Engineer-in-Charge. Measurement for payment shall be based on the plan area treated in square metres, and the rate shall include the complete ceiling system with all materials, fittings, accessories and installation charges necessary for satisfactory completion of the work.

50. Rolling Shutter

Providing and fixing rolling shutters of approved make manufactured from 80 mm wide and 1.25 mm thick M.S. laths, machine rolled and interlocked throughout their entire length, securely jointed at the ends with end locks and suitable wind locks wherever required. The shutter curtain shall be mounted on a specially designed steel pipe shaft of adequate diameter, supported on heavy-duty steel brackets complete with side guides, bottom locking arrangement and all necessary accessories. The shutter

shall be provided with arrangements for smooth manual push-and-pull operation, including inside and outside locking mechanism complete in all respects. Necessary 27.5 cm long helical wire springs, manufactured from high tensile steel wire conforming to IS 4454 (Part-I) and of adequate size and strength to ensure smooth and balanced operation of the shutter, shall be provided and installed. The roller assembly shall be enclosed with a 1.25 mm thick M.S. top cover hood of approved design. Side guide channels shall be fabricated from suitable M.S. sections and securely fixed in position. All steel components shall be properly aligned, assembled and finished true to line and level. The work shall include all labour, materials, fittings, fasteners, welding, cutting, erecting, transportation and incidental charges required for complete installation. The steel surfaces shall be cleaned of rust and scale and provided with one coat of approved red oxide zinc chromate primer before fixing. The rolling shutter shall be complete in every respect and installed as per the manufacturer's specifications and the directions of the Engineer-in-Charge.

Measurement: The rolling shutter shall be measured in square metres of clear opening area.

51. LANDSCAPE WORKS

1. VITRIFIED TILE FLOORING (800x800 mm Matt / Anti-Skid)

Technical Specification

Providing, supplying and laying premium quality Glazed Vitrified Tiles (GVT)/Full Body Vitrified Tiles of size 800 mm x 800 mm, minimum 9-10 mm thick, matt/anti-skid finish, rectified edges, water absorption less than 0.08%, conforming to IS 15622, ISO certified and approved make such as Kajaria, Simpolo, H&R Johnson, Somany, Nitco, Orientbell, Nexion or equivalent.

Tiles shall have:

- Minimum breaking strength of 1300 N.
- Scratch resistance Moh's hardness ≥ 6.
- Anti-skid coefficient suitable for commercial/public areas.
- Shade variation V1/V2.
- Recycled content and low environmental impact compliant with IGBC Gold requirements.

The substrate shall be thoroughly cleaned and prepared. Tiles shall be laid over 20 mm thick cement mortar bed (1:4) using approved polymer modified tile adhesive where required. Laying shall be carried out using tile leveling system comprising notch trowels, spacers, wedges, clips and rubber mallet to achieve perfectly level finished surface.

Tile cutting shall be done only using diamond edge zero-chipping cutting machines. Joints of 2 to 3 mm width shall be filled with polymer modified stain-resistant tile grout of approved colour matching the tile finish.

The work shall include checking levels, alignment, curing, protection till handing over, cutting around openings/services, wastage, labour, tools, testing and all incidental works complete.

2. INTERLOCKING CONCRETE PAVER BLOCKS (60 mm Thick)

Technical Specification

Providing, supplying and laying 60 mm thick M-30 grade Interlocking Concrete Paver Blocks manufactured under factory-controlled conditions using hydraulic vibro-press technology conforming to IS 15658:2021.

Approved makes: Nitco, Pavit, Ultra Tile, KK Manhole & Tiles, Bharat Tiles, RPC Group, CST or equivalent.

Pavers shall have:

- Minimum compressive strength: 30 MPa.

- Water absorption less than 6%.
- Abrasion resistance as per IS standards.
- Uniform colour throughout thickness.
- Colour fast UV resistant inorganic oxide pigments.

The work shall include:

- Preparation and compaction of subgrade.
- Providing 50 mm thick coarse river sand bedding layer.
- Mechanical laying and alignment.
- Mechanical vibration compaction using plate compactor.
- Filling joints with fine screened sand.
- Cutting edge pieces with mechanical cutter.
- Final compaction and cleaning.

The paver layout pattern shall be approved by Architect/PMC. All materials shall conform to IGBC Gold Rating requirements including regional procurement and recycled content wherever feasible.

3. PRECAST RCC KERB STONE

Technical Specification

Providing, supplying and fixing Precast RCC Kerb Stones manufactured using wet-cast vacuum dewatering technology from approved BMC registered manufacturer.

Kerb dimensions:

- Length : 500 mm
- Height : 325 mm
- Thickness : 165 mm
- Profile : Half Batter / Full Batter / Bull Nose as approved.

Kerbs shall be manufactured in M-25 grade concrete, reinforced where necessary, using OPC/PPC cement and UV-resistant colour pigments.

Surface finish:

- High visibility pimple finish.
- Smooth edges and corners.
- Uniform texture and colour.

The work shall include:

- Excavation in all kinds of soil except rock.
- Providing 100 mm thick M-15 PCC/RMC bedding.
- Laying true to line, grade and curve.
- Jointing in cement mortar 1:2.
- Backfilling and compaction.
- All cutting, alignment, labour and incidentals.

Kerb stones shall be capable of withstanding vehicular impact loads and shall comply with relevant IRC, CPWD and MCGM standards.

4. PAVIT PEDESTRIAN WALKWAY PAVING TILES

Technical Specification

Providing, supplying and laying PAVIT Precast Concrete Paving Tiles of size 200 mm x 200 mm x 15 mm thick in approved colour, texture and pattern, manufactured as per relevant IS standards and approved by the Architect.

Approved make:

- PAVIT
- Ultra Tile
- Nitco Outdoor
- KK Tiles
- Equivalent approved manufacturer.

Tiles shall possess:

- Minimum compressive strength 35 MPa.
- Slip resistant textured surface.
- UV resistant colour pigments.
- Uniform dimensions and finish.
- Water absorption < 7%.

The work shall include:

- Preparation and compaction of sub-base.
- Providing 25-50 mm thick bedding layer of coarse sand.
- Laying tiles to required line, level and pattern.
- Joint filling using clean dry sand.
- Cutting edge tiles using mechanical cutter.
- Mechanical compaction.
- Final cleaning and finishing.

The finished surface shall be even, free from rocking, cracks and irregularities.

5. EXCAVATION FOR LAWN / SHRUBS / GROUND COVER / CREEPERS / CLIMBERS

Detailed Technical Specification

The work shall consist of excavation of existing soft soil for preparation of landscaped areas intended for planting of lawn, shrubs, ground covers, creepers and climbers to a minimum depth of 300 mm below finished grade level. The excavation shall be carried out manually or mechanically without disturbing adjacent structures, underground utilities, hardscape elements, retaining walls, kerbs, paving or drainage systems.

The excavated area shall be cleared of:

- Debris, construction waste and foreign materials.
- Stones larger than 25 mm.
- Roots, weeds and vegetation.
- Unsuitable soil, clay pockets and organic waste.

The excavated surface shall be dressed to proper lines, grades and slopes as per landscape drawings. Surplus excavated material shall be transported and disposed off outside the site premises

in approved dumping locations. The contractor shall maintain site safety, prevent erosion and ensure proper housekeeping throughout the operation.

6. PREPARATION OF GROUND FOR PLANTING

Detailed Technical Specification

After excavation, the planting area shall be prepared by supplying, spreading, mixing and compacting approved quality Red Hill Soil and well-decomposed Cow Dung Manure in the proportion of 2 parts Red Earth : 1 part Cow Dung Manure to a compacted depth of 300 mm.

Red Hill Soil Requirements

- Free from stones above 25 mm size.
- Free from roots, weeds and construction debris.
- pH value between 6.0 and 7.5.
- Good drainage characteristics.
- Suitable for horticultural applications.

Cow Dung Manure Requirements

- Well decomposed.
- Minimum 6 months old.
- Free from insects and weed seeds.
- Screened through 20 mm sieve.
- Free from harmful chemicals.

The planting mixture shall be thoroughly blended using mechanical rotavators or approved manual methods. The finished bed shall be levelled, watered and compacted lightly before plantation.

7. CARPET LAWN (KOREAN / MEXICAN / AMERICAN / ZOYSIA)

Detailed Technical Specification

Providing and laying healthy carpet grass obtained from approved nurseries including Korean Grass (Zoysia tenuifolia), American Grass, Mexican Grass or equivalent approved species.

Grass Requirements

- Dense root network.
- Minimum 95% live turf coverage.
- Uniform colour and texture.
- Weed free.
- Pest and disease free.
- Moisture content suitable for transplanting.

Installation

The prepared bed shall be watered thoroughly before laying turf.

Grass shall be laid:

- In staggered pattern.
- Without gaps.
- With tight edge joints.
- True to line and level.

The completed lawn shall be rolled using lightweight lawn rollers. Necessary watering shall be carried out immediately after laying.

Maintenance Period

Contractor shall maintain lawn for minimum 90 days including:

- Regular watering.
- Weeding.
- Fertilizer application.
- Gap filling.
- Disease control.

The lawn shall achieve complete establishment before handing over.

8. Aglaonema Snow White Hybrid.

Planting Aglaonema Snow White Hybrid (Three-in-One arrangement) of height 450 mm to 600 mm, healthy, well-established and supplied in a minimum 250 mm diameter nursery pot or as approved by the Engineer-in-Charge.

Plant Requirements

- Dense and compact foliage with characteristic white-green variegated leaves.
- Minimum 3 healthy stems/plants grouped in one planter forming a Three-in-One arrangement.
- Uniform growth and symmetrical appearance.
- Well-developed and healthy root ball.
- Free from pests, diseases, insect infestation, leaf damage, discoloration and mechanical injury.
- Nursery-grown, acclimatized and hardened for indoor/semi-indoor conditions.
- Plants shall have a minimum spread of 300 mm to 450 mm.

Planter Requirements

- Decorative FRP, ceramic or approved planter of minimum 350 mm to 450 mm diameter and suitable depth.
- Planter shall be free from cracks, warping and manufacturing defects.
- Adequate drainage holes shall be provided.
- Decorative pebbles/mulch layer of approved colour to be provided on top surface.

Potting Media

Potting mixture shall consist of:

- 40% screened good earth.
- 30% cocopeat.
- 20% well-decomposed organic manure/vermicompost.
- 10% river sand.

The growing medium shall be porous, fertile, weed-free and capable of retaining adequate moisture.

Planting Method

- Bottom drainage layer of gravel/expanded clay aggregate to be provided.
- Plants shall be positioned centrally and vertically within the planter.
- Root ball shall remain intact during planting.

- Potting media shall be compacted lightly around roots to eliminate air gaps.
- Decorative pebbles shall be spread uniformly after planting.
- Plants shall be watered immediately after plantation.

Maintenance Requirements

- Regular watering as per plant requirement.
- Removal of dried or damaged leaves.
- Periodic application of fertilizer and micronutrients.
- Pest and disease control treatment as required.
- Replacement of dead or unhealthy plants during maintenance period at contractor's cost.

9. Rhapis Palm

Planting Rhapis Palm (Rhapis excelsa) specimen plant having overall height of 1.50 m to 1.65 m, with 40 to 50 lush green healthy suckers, supplied in minimum 400 mm diameter pot/challi/tray, complete as per approved landscape drawings and directions of the Engineer-in-Charge.

Plant Requirements

- Plant height between 1.50 m and 1.65 m measured from finished soil level.
- Minimum 40 to 50 healthy suckers/canes per clump.
- Dense, well-developed and symmetrical growth habit.
- Fresh, mature, dark green foliage with healthy fan-shaped leaves.
- Uniform appearance with no broken, dried or yellow leaves.
- Well-established root system with intact root ball.
- Free from pests, diseases, fungal infection and mechanical damage.
- Nursery-grown, hardened and acclimatized for outdoor/semi-indoor conditions.
- Plant shall be true to species and capable of immediate establishment after planting.

Planter / Planting Requirements

For planter installation:

- Decorative FRP, ceramic, stone-finish FRP or approved planter of suitable dimensions.
- Minimum planter diameter: 500 mm to 600 mm and depth as required.
- Adequate drainage holes and drainage layer to be provided.

For ground planting:

- Planting pit size: 600 mm × 600 mm × 600 mm.

Growing Medium

The planting mixture shall consist of:

- 50% screened good earth.
- 30% red soil.
- 20% well-decomposed organic manure/vermicompost.

The soil mixture shall be free from stones, weeds, debris, termites and harmful salts.

Planting Method

- Bottom drainage layer comprising gravel or broken brick aggregate shall be provided.

- Plant shall be carefully removed from pot/challi/tray without disturbing the root ball.
- Plant shall be positioned vertically and centrally within the pit/planter.
- Excavated pit shall be backfilled with approved soil mixture and lightly compacted.
- Finished surface shall be dressed with approved decorative pebbles or mulch wherever specified.
- The plant shall be watered thoroughly immediately after planting.

Maintenance Requirements

- Regular watering and soil moisture maintenance.
- Removal of dried, damaged or diseased leaves.
- Periodic application of organic manure and micronutrients.
- Pest and disease control treatment as required.
- Replacement of dead, damaged or unhealthy plants during maintenance period at contractor's cost.
- Routine cleaning and upkeep to maintain healthy appearance.

10. Areca Palm

Placing Areca Palm (Dypsis lutescens) having overall height of 2.40 m to 2.70 m, with 12 to 14 healthy suckers, well-developed, fresh and healthy with dense lush green foliage, supplied in 350 mm diameter bucket-type cement pot, complete as per approved landscape drawings and directions of the Engineer-in-Charge.

Plant Requirements

- Plant height shall be between 2.40 m and 2.70 m measured from finished soil level.
- Minimum 12 to 14 healthy suckers/canes per plant cluster.
- Dense, symmetrical and well-branched growth habit.
- Fresh, healthy and vibrant green fronds free from yellowing and scorching.
- Minimum 20 to 25 well-developed fronds.
- Strong and healthy root system with intact root ball.
- Free from pests, diseases, insect infestation, fungal attack and mechanical damage.
- Nursery-grown, hardened and acclimatized for indoor/outdoor landscape conditions.
- True to species and capable of immediate establishment after placement.

Pot Requirements

- Bucket-type cement pot of 350 mm diameter or as specified.
- Pot shall be free from cracks, honeycombing, edge damage and manufacturing defects.
- Uniform finish and approved colour.
- Adequate drainage holes shall be provided at the bottom.
- Pot shall be capable of safely supporting the mature plant and growing medium.

Growing Medium

The planting mixture shall consist of:

- 50% screened good earth.
- 30% red soil.
- 20% well-decomposed organic manure/vermicompost.

The growing medium shall be fertile, porous, well-drained and free from weeds, stones and harmful contaminants.

Planting Method

- A drainage layer of gravel, broken brick aggregate or approved material shall be provided at the base of the pot.
- The plant shall be carefully transferred without disturbing the root ball.
- The Areca Palm shall be positioned vertically and centrally within the cement pot.
- Potting media shall be compacted lightly around the root zone to eliminate air pockets.
- Decorative pebbles or mulch shall be provided on the top surface wherever specified.
- The plant shall be watered immediately after installation.

Maintenance Requirements

- Regular watering and moisture management.
- Pruning and removal of dried, damaged or discoloured fronds.
- Periodic application of organic manure and micronutrients.
- Pest and disease control treatment as required.
- Cleaning and maintenance of cement pots.
- Replacement of dead, damaged or unhealthy plants during the maintenance period at contractor's cost

11. Tradescantia

Placing Tradescantia spp., full of fresh, healthy and dense foliage, well-established and supplied in approved 150 mm diameter Earthen Pot / Plastic Pot, complete as per approved landscape drawings and directions of the Engineer-in-Charge.

Plant Requirements

- Healthy, vigorous and well-grown Tradescantia plant with dense trailing foliage.
- Minimum 10 to 15 well-developed stems/runners per pot.
- Uniform growth with attractive green, purple or variegated foliage as specified.
- Full, compact appearance with adequate leaf density.
- Fresh and healthy leaves free from yellowing, drying, scorching or physical damage.
- Well-developed root system firmly established in potting medium.
- Free from pests, diseases, insect infestation and fungal infection.
- Nursery-grown, acclimatized and hardened for indoor or semi-outdoor conditions.
- Minimum plant spread of 200 mm to 300 mm.

Pot Requirements

- Earthen pot or plastic pot of 150 mm diameter.
- Pot shall be free from cracks, chips, deformation and manufacturing defects.
- Adequate drainage holes shall be provided.
- Pot colour and finish shall be as approved by the Architect/Engineer-in-Charge.

Growing Medium

The potting mixture shall consist of:

- 40% screened good earth.

- 30% cocopeat.
- 20% well-decomposed organic manure/vermicompost.
- 10% river sand.

The growing medium shall be fertile, well-drained, porous and free from weeds, stones and harmful contaminants.

Installation Method

- A drainage layer of gravel or coarse sand shall be provided at the base of the pot.
- Plant shall be carefully transferred without damaging roots and stems.
- Potting medium shall be lightly compacted around the root zone.
- Plant shall be centered within the pot and arranged to achieve a full and attractive appearance.
- Decorative pebbles or mulch shall be provided on the top surface wherever specified.
- The plant shall be watered immediately after installation.

Maintenance Requirements

- Regular watering to maintain optimum soil moisture.
- Removal of dried, damaged or diseased leaves and stems.
- Periodic pruning to maintain compact growth and appearance.
- Application of organic manure and micronutrients at regular intervals.
- Pest and disease control treatment as required.
- Replacement of dead, damaged or unhealthy plants during the maintenance period at contractor's cost

12. Asparagus sprengeri

Placing Asparagus Sprengeri of height 300 mm to 450 mm, full of healthy leafy branches with dense foliage, well-established and grown in approved 200 mm diameter Earthen Pot / Plastic Pot, complete as per approved landscape drawings and directions of the Engineer-in-Charge.

Plant Requirements

- Plant height shall be between 300 mm and 450 mm measured from soil level.
- Dense, bushy and vigorous growth with cascading feathery foliage.
- Minimum 10 to 15 healthy leafy branches per pot.
- Fresh, lush green foliage with uniform growth and spread.
- Well-developed root system firmly established in the growing medium.
- Free from pests, diseases, insect infestation, yellowing, drying and mechanical damage.
- Nursery-grown, hardened and acclimatized for indoor and outdoor landscape conditions.
- Minimum plant spread of 250 mm to 400 mm.

Pot Requirements

- Approved earthen pot or plastic pot of 200 mm diameter.
- Pot shall be free from cracks, chips, deformation and manufacturing defects.
- Adequate drainage holes shall be provided at the base.
- Pot colour and finish shall be as approved by the Architect/Engineer-in-Charge.

Growing Medium

The potting mixture shall consist of:

- 40% screened good earth.
- 30% cocopeat.
- 20% well-decomposed organic manure/vermicompost.
- 10% river sand.

The growing medium shall be fertile, porous, well-drained and free from weeds, stones and harmful contaminants.

Installation Method

- A drainage layer of gravel or coarse sand shall be provided at the bottom of the pot.
- Plant shall be carefully transferred without disturbing the root ball.
- The plant shall be positioned centrally within the pot and firmly supported by the growing medium.
- Potting media shall be lightly compacted around the root zone to eliminate air pockets.
- Decorative pebbles or mulch shall be provided on the top surface wherever specified.
- The plant shall be watered immediately after installation.

Maintenance Requirements

- Regular watering and moisture management.
- Removal of dried, damaged or diseased foliage.
- Application of organic manure and micronutrients at regular intervals.
- Pest and disease control treatment as required.
- Pruning and grooming to maintain healthy and compact growth.
- Replacement of dead, damaged or unhealthy plants during the maintenance period at contractor's cost.

14. OPHIOPOGON JABURAN VARIEGATED

Placing Ophiopogon jaburan (Variegated), full of healthy variegated strap-like leaves, well-established and nursery-grown, supplied in approved 200 mm diameter Earthen Pot / Plastic Pot, complete as per approved landscape drawings and directions of the Engineer-in-Charge.

Plant Requirements

- Dense and compact growth with attractive green leaves having cream/white variegated margins.
- Minimum plant height: 300 mm to 450 mm.
- Well-developed clump with minimum 15 to 20 healthy shoots/leaves per pot.
- Fresh, healthy and vigorous foliage free from yellowing, scorching and mechanical damage.
- Uniform growth and appearance suitable for landscape and interior planting.
- Strong, well-developed root system firmly established in the potting medium.
- Free from pests, diseases, insect infestation and fungal infection.
- Nursery-grown, hardened and acclimatized for outdoor and semi-shaded conditions.

Pot Requirements

- Approved earthen pot or plastic pot of 200 mm diameter.
- Pot shall be free from cracks, chips, deformation and manufacturing defects.

- Adequate drainage holes shall be provided at the base.
- Pot colour and finish shall be as approved by the Architect/Engineer-in-Charge.

Growing Medium

The potting mixture shall consist of:

- 40% screened good earth.
- 30% cocopeat.
- 20% well-decomposed organic manure/vermicompost.
- 10% river sand.

The growing medium shall be fertile, porous, well-drained and free from weeds, stones, harmful salts and contaminants.

Installation Method

- Provide a drainage layer of gravel or coarse sand at the bottom of the pot.
- Carefully place the plant without disturbing the root ball.
- Potting medium shall be compacted lightly around the root zone to eliminate air pockets.
- Plant shall be positioned centrally to achieve a neat and symmetrical appearance.
- Decorative pebbles or mulch shall be provided on the top surface wherever specified.
- The plant shall be watered immediately after installation.

Maintenance Requirements

- Regular watering and moisture management.
- Removal of dried, damaged or diseased leaves.
- Application of organic manure and micronutrients at regular intervals.
- Pest and disease control treatment as required.
- Maintenance of healthy variegated foliage and overall appearance.
- Replacement of dead, damaged or unhealthy plants during the maintenance period at contractor's cost.

15. TRENCHING FOR LANDSCAPE AREAS

Detailed Technical Specification

Trenching shall be carried out to a depth of 600 mm in ordinary soil for shrub beds and plantation zones.

Scope Includes

- Excavation.
- Removal of weeds and roots.
- Breaking soil clods.
- Flooding with water.
- Refilling with approved earth-manure mixture.
- Final dressing and levelling.

The trench shall be thoroughly loosened to improve aeration and root penetration.

16. SUPPLY OF GOOD EARTH

Detailed Technical Specification

Providing and stacking horticultural grade good earth obtained from approved sources.

Specifications

- Free from stones, debris and weeds.
- Organic matter content > 2%.
- pH: 6.5-7.5.
- Suitable for landscape use.
- Transport lead up to 5 km.

Earth shall be tested and approved prior to use.

17. SUPPLY OF SCREENED COW DUNG MANURE

Detailed Technical Specification

Providing and stacking screened and matured cow dung manure from approved source.

Quality Requirements

- Fully decomposed organic manure.
- Moisture content below 25%.
- Screened through 20 mm IS sieve.
- Free from weeds and contaminants.
- Rich in organic nutrients.

The manure shall be used for preparation of planting beds, pits and lawn areas and shall be IGBC-compliant organic material.

18. SOLAR STREET LIGHT (80W) WITH 6 M HIGH HOT DIP GALVANIZED POLE

Detailed Technical Specification

Scope of Work

Providing, supplying, installing, testing and commissioning of integrated Solar LED Street Lighting System complete with 80W LED luminaire, 6.0 m high hot dip galvanized street light pole, solar photovoltaic modules, lithium battery system, MPPT charge controller, astro timer, mounting brackets, outdoor junction box, earthing system, RCC foundation, interconnections and all accessories required for satisfactory operation of the system.

The entire system shall comply with latest MNRE Guidelines, IS Standards, CPWD Specifications, NBC, IEC Standards and IGBC Gold Rating requirements.

A. LED Street Light Luminaire

The luminaire shall be high-efficiency outdoor LED type suitable for road and landscape illumination.

Technical Requirements

- Wattage : 80 Watts
- System Efficacy : Minimum 130 lm/W
- Luminaire Output : Minimum 10,400 Lumens
- Colour Temperature : 3000K / 4000K / 5700K as approved
- CRI : ≥70

- Input Voltage : Suitable for solar DC operation
- Surge Protection : Minimum 10 kV
- Power Factor : ≥0.95
- THD : ≤10%
- Housing Material : Pressure Die-Cast Aluminium
- Lens : UV Stabilized Polycarbonate Lens
- Protection Class : IP65 Minimum
- Impact Resistance : IK08 Minimum
- Operating Temperature : -10°C to +50°C
- LED Life : L70 > 50,000 Hours

Approved Make:

- Philips
- Havells
- Wipro
- Bajaj
- Crompton
- Schreder
- Equivalent Approved

B. Solar PV Module

Technical Parameters

- Mono-Crystalline PERC Technology
- Minimum Capacity: 180 Wp to 250 Wp
- Module Efficiency: ≥20%
- Tempered Glass Front
- Aluminium Anodized Frame
- PID Resistant
- IEC 61215 & IEC 61730 Certified
- Junction Box IP67

Approved Makes:

- Waaree
- Adani Solar
- Vikram Solar
- Tata Power Solar
- RenewSys
- Equivalent

C. Battery System

Technical Parameters

- Lithium Ferro Phosphate (LiFePO4)
- Capacity: Suitable for minimum 2 days autonomy
- Depth of Discharge: 80%
- Battery Backup: Minimum 12 Hours Operation
- Battery Life: Minimum 5-7 Years
- Protection:
    - Overcharge
    - Deep Discharge
    - Reverse Polarity
    - Short Circuit

Battery enclosure shall be weatherproof.

D. MPPT Charge Controller

- Inbuilt MPPT Technology
- Automatic Dusk-to-Dawn Operation
- Battery Management System
- Overload Protection
- Reverse Current Protection
- LED Status Indication
- IP65 Rated Enclosure

E. Pole Specification

Providing and erecting 6.0 m high octagonal/conical tubular steel pole.

Technical Details

- Mounting Height: 6.0 Meter from FGL
- Material: Mild Steel
- Sheet Thickness:
    - 3 mm at top
    - 4 mm at bottom
- Hot Dip Galvanization:
    - Minimum 80 Microns
    - As per IS 2629 & IS 4759

The pole shall be supplied with:

- Single Arm/Dual Arm Bracket
- Base Plate
- Anchor Bolts
- Pole Door
- Junction Box
- Foundation Hardware

- Cable Entry Arrangement

F. Foundation

Providing RCC foundation for street light pole.

Foundation Size

Minimum:

- 600 x 600 x 1200 mm depth

or

As per manufacturer's design.

Foundation shall comprise:

- PCC 1:4:8 Levelling Course
- RCC M25 Grade Concrete
- Reinforcement Steel Fe500D
- Anchor Bolt Cage
- Formwork
- Backfilling

The foundation shall withstand wind velocity up to 180 km/hr.

G. Junction Box

Pole-mounted weatherproof Junction Box.

Features

- FRP/Polycarbonate Housing
- IP65 Protection
- Bakelite/Hylam Mounting Plate
- Power Connectors
- Brass Glands
- Neutral Link
- Earthing Stud

H. MCB

Providing 6A SP MCB.

Specifications

- C Curve
- 10 kA Breaking Capacity
- ISI Marked
- Mounted on Bakelite Plate

Approved Makes:

- Schneider
- Legrand

- Siemens
- Hager
- L&T

I. Internal Cabling

Providing and laying 3C x 2.5 sq.mm flexible copper cable.

Specifications

- FRLS Copper Cable
- 1100 Volt Grade
- IS 694 Compliant

Approved Makes:

- Polycab
- RR Kabel
- Finolex
- KEI

The cable shall be terminated using brass glands, copper lugs and approved connectors.

J. Earthing System

Providing complete earthing system.

Earthing Includes

- GI Pipe Electrode
- 8 SWG GI Earth Wire
- Test Link
- Earth Pit Chamber
- Salt & Charcoal Filling

Earth Resistance:

- Not more than 5 Ohms

K. Astro Timer

Providing inbuilt Astro Timer.

Features

- Sunrise/Sunset Programming
- Seasonal Adjustment
- Battery Backup
- Automatic Operation

Testing & Commissioning

Testing shall include:

- Insulation Resistance Test

- Earth Resistance Test
- Lux Level Measurement
- Battery Backup Test
- Functional Testing

The contractor shall submit:

- Warranty Certificates
- Test Certificates
- MNRE Compliance Documents
- O&M Manual

19. DECORATIVE LED BOLLARD LIGHT (750 MM HEIGHT)

Detailed Technical Specification

Scope

Providing, supplying, installing, testing and commissioning decorative outdoor LED Bollard Lighting Fixture complete with luminaire, foundation, mounting arrangement, internal wiring, earthing, accessories and connections.

Bollard Housing

Technical Parameters

- Height: 750 mm
- Material: Heavy Duty Die-Cast Aluminium
- Finish: Polyester Powder Coating
- Colour: RAL Shade as approved
- Corrosion Resistant
- UV Resistant

Minimum coating thickness:

- 80 Microns

LED Light Source

Technical Requirements

- Wattage: 10W to 20W LED
- System Efficacy: ≥110 lm/W
- Colour Temperature:
    - 3000K Warm White
    - 4000K Neutral White
- CRI: ≥80
- Power Factor: ≥0.95
- Lifetime: 50,000 Hours

Approved Makes:

- Philips
- Wipro

- Havells
- Bajaj
- Crompton
- iGuzzini
- Schreder

Diffuser

- Impact Resistant Polycarbonate
- UV Stabilized
- Anti-yellowing
- Uniform Light Distribution

Driver

- Constant Current LED Driver
- BIS Approved
- Surge Protection 4 kV Minimum
- IP65 Protected

Electrical Protection

- IP65 Protection Minimum
- IK08 Impact Resistance
- Class-I Earthing

Mounting Arrangement

The bollard shall be mounted on RCC pedestal/foundation using:

- MS Base Plate
- SS304 Anchor Fasteners
- Grouting Compound
- Alignment Fixtures

Foundation

Foundation shall consist of:

- PCC Bed
- RCC M20 Concrete Block
- Anchor Bolt Assembly

Minimum Foundation Size:

- 300 x 300 x 450 mm

or as recommended by manufacturer.

Internal Wiring

The scope shall include:

- 3C x 2.5 sq.mm FRLS Copper Cable
- Brass Cable Glands
- Copper Lugs
- Junction Connectors

Approved Makes:

- Polycab
- RR Kabel
- Finolex
- KEI

Earthing

Providing earthing connection from bollard to nearest earth system using:

- 8 SWG GI Wire or
- 2.5 sq.mm Green Copper Wire

complete with termination accessories.

Testing & Commissioning

The work shall include:

- Insulation Test
- Earth Continuity Test
- Functional Test
- Lux Level Verification
- Trial Run

IGBC Gold Requirement

All materials incorporated in the works shall comply with latest CPWD Specifications, NBC, relevant IS Codes and IGBC Gold Rating requirements. Materials shall preferably contain recycled content, locally sourced materials within prescribed radius, low embodied carbon products, low VOC adhesives/grouts/sealants and environmental product declarations wherever available. Contractor shall submit product samples, technical datasheets, laboratory test certificates and IGBC compliance documentation for approval prior to procurement and installation.

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TECHNICAL SPECIFICATIONS

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Imputation:Project No. W.004717

RESTRICTED

Client: **Development Commissioner, SEEPZ-SEZ, Mumbai**

Project : **Preparation of Detailed Master Plan for 30 years & Detailed Architectural model building for SEEPZ-SEZ, Mumbai**

Subject: **PACKAGE 2, KD 1: Electrical Technical Specifications of Model Building NEST-3**

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TECHNICAL SPECIFICATIONS – ELECTRICAL WORKS

1. CODES AND STANDARDS

The following codes and standards (latest edition/revision) will be followed during the designing of electrical installation:

Table 1-1 Applicable Codes and Standards

S.No	Code	Abbreviation
a.	B.I.S.	**Bureau of Indian Standards**
b.	I.E.C.	**International Electro Technical Commission(applicable where B.I.S. is not available)**
c.	I.E.R.	**Indian Electricity Rules**
d.	BS	**British Standards**
e.	NEC	**National Electric Code**
f.	NEMA	**National Electrical Manufacturer Association**
g.	UL	**Underwriters Laboratories, Inc.**
h.	BEE	**Bureau of Energy Efficiency**
i.	ECBC	**Energy Conservation Building Code**
j.	NBC	**National Building Code**

2. SCOPE OF WORK

The scope of work includes the design, supply, installation, testing, and commissioning of the complete electrical distribution system for the facility. The works cover 11 kV VCB switchgear, DG sets, transformers, LT panels, AMF/PLC panels, ACBs, MCCBs, busducts, active PFC panels, UPS systems, distribution boards, surge protection systems, HT/LT cable networks, cable trays, and internal electrification works. The scope also includes earthing and lightning protection systems, solar power system integration, lifts, safety equipment, fire-stop solutions, signages and lighting fixtures, along with all associated pipes, fittings, accessories, and approved makes. All installations shall be carried out in accordance with applicable standards, specifications, and statutory requirements, including testing, commissioning, and handing over of a fully operational system.

3. ENERGY CONVERSATION

Electrical services proposed for this project shall be as per the guidelines of green buildings; hence following features shall be kept in mind while designing the project;

To economize on the use of energy, following main systems are proposed to be adopted

i) Adequate design to limit the losses in transmission and distribution system.

ii) Use of energy efficient devices like light sources such as LED lamps.

iii) Use of insulation on rooftop to reduce air-conditioning load.

iv) Use of capacitors at load centers to improve voltage and power factor to reduce distributional losses and to avoid penalty by state electricity authority.

v) All high efficiency motors will be used in the building.

vi) Variable Frequency Drives are proposed to be installed for hydro-pneumatic system for water supply and necessary chilled water system.

4. LOAD FORECASTING

The Built-up Area, considering growth plans & Population density of various clusters are used in assessment of the power demand and infrastructure planning of electrical power system. The main objective of carrying out the demand assessment for complete site is to estimate the power demand, identify the right source for feeding the power and to select the correct voltage levels for T&D purposes.

Different loading like lighting, power, Lift, HVAC, Common area/Parking, Utilities, Roads etc. is taken under consideration for arriving at power demand of the site.

Relevant norms for calculating the power demand for different product mixes inside project boundary are being reproduced here as under which forms the basis for power demand calculations, as per Electricity norms.

Table 4-1 Applicable Terms for Load Forecasting

S.No	Product Mix	Power Demand norms	Basis for Norms Adopted
1	**Lighting load**		
(i)	Commercial	15 W/ Sqmtr.	ECBC-2009 (Energy conservation building code)
(ii)	Residential- Group & EWS housing	7.5W/ Sqmtr.	
(iii)	Institutional	14 W/Sqmtr.	
(iv)	Offices/Public / Semi Public	10.8 W/ Sqmtr.	
(v)	Transportation	10.8 W/ Sqmtr.	
(vi)	Utilities/services area	15.1W/ Sqmtr.	
(vii)	Mandatory areas (Green / pedestrian NMT / open area)	2.15W/ Sqmtr.	NBC 2016 (National building codes)
2.	**Common area/parking load**		
(i)	Commercial	2.2 W/ Sqmtr.	ECBC-2009 (Energy conservation building code)
(ii)	Residential- Group & EWS housing		
(iii)	Institutional		
(iv)	Public / Semi Public		
3.	**HVAC Load**		
(i)	Commercial	40 W/ Sqmtr.	As per CPWD Guidelines for substation and power distribution system of buildings it is 40W/ sqmtr. As per past project experience, power engineers hand book and ASHRAE energy standard 1Ton/18.58sqmtr. Considering power consumption 0.8kW/ton, it will be 43.05W/ sqmtr.
(ii)	Institutional		
(iii)	Public / Semi Public		
4	**Demand Load office and commercial buildings**		
(i)	Electrical load for power excluding HVAC works(medium load intensity building)	25-30 W/ Sqmtr.	Guidelines for substation and power distribution system of buildings, CPWD 2019,

(ii)	Electrical load for HVAC works	40 W/ Sqmtr.	Guidelines for substation and power distribution system of buildings, CPWD 2019,

5. DISTRIBUTION SCHEME

Based on the prevailing Electricity rules, the power supply to meet this requirement, from the local electric supply board shall be made available at 11 KV as per requirement.

5.1. Selected Transformers Ratings

Transformer shall be provided with ON LOAD circuit taps in the range of + 5% to -15%. There will be ON load tap changer on the H.T. winding controlled by automatic voltage regulator to maintain constant voltage in specified range of variation and shall have losses as per ECBC compliant as per IS amended up to date. The transformers will be provided with all the necessary protection and earth.

5.1.1. 11KV/433V, TRANSFORMER – OIL FILLED (ONAN)

5.1.1.1. GENERAL

- This section covers design, manufacturing, testing and delivery of the oil immersed, Oil Natural Air Natural (ONAN) outdoor type, three phase, 50Hz Transformers with/without 'On Load-Tap Changer' (OLTC) as per specification.
- The equipment offered shall be complete with all parts necessary for their effective and trouble-free operation. Such parts will be deemed to be within the scope of the supply irrespective of whether they are specifically indicated in the commercial order or not.
- The transformer shall
  - Be located out-door at an altitude not more than 1000Meters above mean sea level; else de-rated suitably.
  - Be designed such that the risk of accidental short-circuit due to birds or vermin is obviated. All apparatus, including bushing insulators and fittings shall be so designed that water cannot collect at any point. Marshaling kiosks, boxes etc. shall be adequately ventilated to prevent condensation of moisture and treated internally to prevent growth of fungi on any coils, wires and insulating materials used.
  - Operate with minimum noise and vibration.
  - Be designed to suppress harmonic voltages, specially the third and fifth, so as to eliminate distortion in wave-form and circulating currents between the neutrals at different transformer stations (as applicable).
  - Have the magnetic circuit designed to minimize eddy-current and hysteresis losses in the core.
  - Operate without injurious heating at the rated KVA at any voltage within ± 10% of the rated voltage of that particular tap.
  - Be designed for 110% continuous over-fluxing withstand capability.

5.1.1.2. STANDARDS

The transformers shall conform to the requirements of the latest edition of:

- I S: 1180, 2014 : Consolidated revised guide-lines for certification of Out-door type Oil Immersed Distribution Transformers up to and including 2500kVA, 33kV.
- I S: 2026, pt-1, 1997/ IEC Pub. 76: Design of Power Transformers-General.
- I S: 2026, pt-2, 1997/ IEC Pub. 76: Design of Power Transformers-Temperature rise.
- I S: 2026, Pt-3 : Power Transformer-Insulation level and dielectric

tests

- I S: 2099 : Transformer Bushings.
- I S: 6600 : Guide lines for loading of oil immersed Transformers.
- I S: 335 : Transformer insulating oil.
- I S: 1271 : Classification of insulating materials
- I S: 2099 : High Voltage Porcelain bushing screen.
- I S: 2705 (Part I & III) : Current Transformers
- I S: 3202 : Code of practice for climate proofing
- I S: 3639 : Power transformer fittings and accessories
- Star rating as per Bureau of Energy Efficiency

5.1.1.3. SYSTEM PARAMETERS

The transformer shall be suitable for continuous operation at rated KVA under the following conditions:

- Nominal voltage (Primary) : 33,000/11,000 Volts ± 10% (refer BOQ)
- Maximum voltage (Primary) : 36,000/12,000 volts (refer BOQ)
- Frequency : 50Hz ± 5%
- Secondary voltage : 433volts ± 10%
- All material used shall be of best quality and of the class, most suitable for working-under the conditions specified.
  - They shall withstand the following without distortion or deterioration or setting up of undue stresses in any part and without affecting the strength and suitability of various parts for the work which they must perform:
    - The short-circuit current as per relevant standards between phases & between phase to ground with full voltage maintained at the other side without any injury to the transformer. The duration of the short circuit shall be as called for in the relevant standard (Refer IS: 2026 Part-I clause 8 & 9).
    - The variations of temperature and atmospheric conditions.
    - Overloads, over-excitation, short-circuits as per specified standards.
  - Transformer shall be of proven design.

5.1.1.4. TECHNICAL REQUIREMENT

- Type : Indoor / out-door type, oil immersed, naturally cooled (ONAN) with core type construction (Refer BOQ).
- Winding : Copper / Al winding with Class 'A' insulation on vertical limbs of laminated Core of CRCA steel sheets (Refer BOQ).
  : The HT & LT winding terminals shall be terminated in separate Terminal Boxes.
  : Neutral of the winding shall be terminated in a separate Terminal Box.
- Vector Group : Dyn11 or as specified (Refer BOQ).
- Temperature rise : The maximum temperature rise over an ambient of 50°C shall be:
  : Winding (measured by Resistance): 55° C

: Oil (measured by thermometer) : 45° C

- Tapping : On H T Winding for voltage variation of ± 2.5% and ± 5% through 'Off-Load' / 'ON-LOAD' Tap Changer (lockable) (Refer BOQ).
- %age Impedance : As per I S: 2026 or as specified.
- Load Loss : With-in the Tolerance limits as per I S: 2026.

5.1.1.5. CONSTRUCTION

➢ <u>TANK & RADIATER TUBES (WITH OIL CONSERVATOR TANK)</u>

- Tank shall be made from good commercial grade low carbon steel of adequate thickness, electrically welded and properly cleaned inside and outside.
  - All seams shall be properly welded to withstand the required impact without damage or distortion.
  - The welding joints shall be stress relieved.
  - The tank construction shall be rigid so as to resist any damage/deformation due to mechanical shock during transportation or filling of oil.
- The tank cover shall be fixed to the tank with weatherproof hot oil resistant, non-deteriorating, resilient gasket in between for complete tightness.
  - All access holes, manholes/inspection holes shall be designed to prevent any ingress of moisture into the tank or leakage of oil from the tank.
  - Suitable lifting lugs, jacking pads, pulling lugs shall be provided to facilitate movement of the transformer.
  - At least two numbers earthing pads shall be provided for connection to the earth.
- Radiator tubes shall be electrical resistance welded type, round, elliptical or rectangular. They may be welded to the transformer tank or in case of very large sizes; detachable radiator banks connected through intermediate leak proof valves. Detachable radiator banks shall have top and bottom headers with flanged connections with drain and vent fittings.
- Tanks shall be thoroughly cleaned, degreased and sand blasted inside and outside. A coat of rust & oil resistant primer shall immediately be given on outside surface. Inside surface shall be painted with rust & oil resistant non-fading enamel paint of specified shade.
- Steel bolts and nuts exposed to atmosphere shall be galvanized however; surfaces of the transformer or other parts of the transformer or auxiliary equipment which are in contact with oil shall not be galvanized.
- The tank shall be mounted on an undercarriage. The tank; together with radiators, conservator, bushings and other fittings shall be designed to withstand the following conditions without permanent distortion:
  - Full vacuum of 760mm of Hg for filling oil by vacuum.
  - Internal gas pressure of 0.35Kg/sq. cm with oil at operating level.
  - Valves shall not leak nor any welded joints sweat under above conditions.
- Tank and radiators shall be hydraulically pressure tested. Tanks shall also be tested for full vacuum.

➢ <u>HERMETICALLY SEALED TANK & RADIATER TUBES</u>

- Tank shall be robust construction, hermetically sealed corrugated type, built-up of electrically tested welded MS plate of thickness 4 to 5mm for bottom & top, tolerance as per IS 1852.
  - All welded joints shall be stress relived.

- Tank shall be designed with corrugated fins & oil shall be completely filled in vacuum chamber in the tank till top of the bushing without leaving any space for dry air, moisture or nitrogen inside.
- All gaskets shall be non-deteriorating, hot oil resistant, weather- proof & nitrile resistant gasket confirming to type C as per IS : 4253.
- Tank shall not be deformed & joints shall not yield due to the system short-circuit allowable as per IS: 2026.
- Tank should be tested for salt spray test for validating paint surface area for 1000 hr. to ensure paint strength towards anti corrosive paint as per ISO 9227.

5.1.1.6. CORES

Transformer shall be of core or shell type.

- The magnetic circuit shall be built of double wound, core type with low loss, non-ageing, high permeability prime grade CRGO with M4 Grade or better; perfectly insulated and clamped to minimize noise and vibrations.
- Stampings shall be insulated from each other with material having high inter-lamination insulation resistance and rust inhibiting property, capable of withstanding pressure, mechanical vibration and action of heat and oil, thus reducing the possibility of sludge formation to a minimum.
- Laminations shall be annealed to remove any strain caused by shearing and punching. The core lamination shall be pressed and tightly held together to reduce hum and eliminate vibration. Transformer shall be of BOLTLESS core design
- The assembled core shall be securely clamped on the limbs and the yoke, to build up a rigid structure. The clamping pressure shall be uniform over the whole core to minimize noise and vibration in the core when the transformer is in service. The framework and the core bolts shall be efficiently insulated from the core so as to reduce the circulating currents to a minimum.
- Core legs and yokes shall be of uniform and identical cross section throughout. Adequate ducts shall be provided through the cores for liberal oil circulation. Suitable lifting devices such as the rods of core clamping plate shall be provided.
- Lifting eyes shall be provided on the frame for removal of core assembly from the tank. Completed core shall be flash tested for insulation with 2500 Volts between the core and each of the clamps or core bolts (core being connected to earth).
- All the core frames shall be bonded together with two metallic strips and connected to the tank for earth to ensure operation of protective gear in the event of a fault.

5.1.1.7. WINDINGS

- Transformer winding shall be flat in shape, made of continuous and smooth, tinned or enameled electrolytic copper conductor of 99.9% pure electrolytic grade / 99% pure Aluminum, insulated with high grade paper of class ‘A’ insulation; shall be of proven design, withstand impulse and power frequency voltage as per IEC 76 (latest amendment).
- The spacers shall be locked securely in place to prevent movement of windings during transportation / under short circuit.
- Windings shall be provided with liberal cooling ducts to ensure cooling by circulation of oil to avoid the hot spots of the winding.
- The windings shall be fully dried, pre-shrunk by vacuum process and impregnated.
- All the leads from the windings to the terminal box and bushing shall be rigidly supported to prevent injury from vibration during transportation or short circuit stresses.
- The end turns on the high voltage winding shall have reinforced insulation to take care of the

voltage surges likely to occur during switching or any other abnormal system condition.

- Internal earthing: The framework and clamping arrangement of core and coil shall be securely earthed inside the tank by copper strap connection to the tank.

5.1.1.8. TAPPING

- Tapping shall be provided on HV winding as specified.
- The transformer shall be capable of operation at the rated KVA at any tap position provided the voltage variation is limited to ± 10% of the voltage corresponding to the tap. The variation in impedance shall be minimal over the tapping range.

5.1.1.9. TAP CHANGER

OFF-LOAD TAP CHANGER

- Off-load tap change shall be effected by an external 3 phase gang operated tap changing switch.
- The operating shaft of the 'Tap Changer' shall be brought out of the tank and provided with a hand wheel at a convenient height.
- A visual indicator to indicate the position of tapping in use shall be provided.
- It shall be possible to padlock the handle in each tap position. A suitable arrangement shall be provided so that padlocking is not possible unless the tapping contacts are properly engaged & are in the same position for all the three phases.

ON LOAD TAP CHANGER (OLTC)

➢ DESIGN FEATURES:

- The OLTC gear shall be designed to complete successfully tap changes for the maximum current to which transformer can be loaded i.e. 150% of the rated current. Devices shall be incorporated to prevent tap change when the through current is in excess of the safe current that the tap changer can handle. The OLTC gear shall withstand through fault currents without injury.
- When a tap change has been commenced; it shall be completely independent of the operation of the control relays and switches. Necessary safeguard shall be provided to allow for failure of auxiliary power supply or any other contingency which may result in the tap changer movement not being completed once it is commenced.
- Oil in compartments which contain the making and breaking contacts of the OLTC shall not mix with oil in other compartments of the OLTC or with transformer oil. Gases released from these compartments shall be conveyed by a pipe to a separate oil conservator or to a segregated compartment within the main transformer conservator. An Oil surge relay shall be installed in the above pipe. The conservator shall be provided with a prismatic oil level gauge.
- Oil, in compartments of OLTC which do not contain the 'make and break' contacts, shall be maintained under conservator head by valve pipe connections. Any gas leaving these compartments shall pass through the Buchholz relay before entering the conservator.
- Oil filled compartments shall be provided with filling plug, drain valve with plug, air release vent, oil sampling device, inspection opening with gasketted and bolted cover with lifting handles.

➢ DRIVE & CONTROL

- OLTC driving mechanism and its associated control equipment (local) shall be mounted in an outdoor, weatherproof cabinet with IP 55 protection which shall include:

o Driving motor (415V, 3-phase, 50Hz. AC squirrel cage).

o Motor starting contactor with Motor Protection Circuit Breaker, isolating switch and HRC fuses.

- Control switch: Raise/off/lower (spring return to normal type).
- Remote/local selector switch (maintained contact type).
- Mechanical tap position indicator showing rated tap voltage against each position and resettable maximum and minimum indicators.
- Limit switches to prevent motor over-travel in both directions and final mechanical stops.
- Brake or clutch to permit only one tap change at a time on manual operation.
- Emergency manual operating device (hand crank or hand wheel).
- A five digit operation counter.
- Electrically interlocked reversing contactors (preferably also mechanically interlocked).
- 240V, 50Hz. AC space heater with switch and HRC fuses.
- Interior lighting fixture with lamp door switch and HRC fuses.
- Gasketted and hinged door with locking arrangement.
- Terminal blocks, internal wiring, earthing terminals and cable glands for power and control cables.
- Necessary relays, contactors, current transformers etc.

- Control requirements for OLTC shall be as follows:
  - Positive completion of load current transfer, once a tap change has been initiated, without stopping on any intermediate position, even in case of failure of external power supply.
  - Only one tap change from each tap change impulse even if the control switches or push button is maintained in the operated position.
  - Cut-off of electrical control when manual control is resorted to. Cut-off of a counter impulse for a reverse tap change until the mechanism comes to rest and resets the circuits for a fresh operation.
  - Cut-off of electrical control when it tends to operate the tap beyond its extreme position.
  - Automatic Control of OLTC shall include the following items:
    - Voltage setting device.
    - Voltage sensing and voltage regulating devices.
    - Line drop compensator with adjustable R and X elements.
    - Timer 5-25 seconds for delaying the operation of the tap changer in the first step for every tap change operation.
    - Adjustable dead band for voltage variation.

➢ OLTC remote control panel shall:

- Be suitable for 30V DC supply,
- Be housed in an indoor sheet cubicle to be located in a remote control room.
- Comprise of rigid welded structural frames made of structural steel section or of pressed and formed cold rolled steel and frame enclosures, doors and partitions shall be of cold rolled steel of thickness 2 mm. Stiffeners shall be provided wherever necessary.
- All doors, removable covers and plate shall be gasketted all around with neoprene gaskets.
- Panel shall be dust, weather and vermin proof providing degree of protection of IP54, color of finish shade for interior and exterior shall be Powder Coated RAL7032 respectively.
- Earth bus shall be of 25 x 6 mm copper.

- o Control switch : Raise/Off/Lower (spring return to normal type)
- o Auto/manual selector switch: (Maintained contact type)
- o Tap position indicator.

- Fascia type alarm annunciator with 'accept' and 'lamp test' facilities shall show:
  - o A.C. supply failure
  - o Drive motor auto tripped
  - o Tap change delayed

➢ <u>AUXILIARY RELAYS, METERS & INDICATIONS</u>

- Lamp indications for:
  - Tap change in progress
  - Lower limit reached
  - Upper Limit reached
  - Cable glands for power and control cables
  - 240 V rated panel space heater with ON-OFF switch
  - LED type interior lighting fixture and door switch
  - HRC fuses
  - Terminal blocks
  - Internal wiring
  - Earth terminal
  - Supply ON Indication Lamp.
  - Labels for Accessories.
  - Automatic Voltage Regulating Relay.
  - Heater Switch (Rotary Type)
  - Control Supply Switch (Rotary Type)
  - Hooter for fascia annunciator (230V AC)
  - Time Delay Relay for 'Tap Change Delayed' (110V AC)
  - H.V. Voltmeter (Digital Type)
  - H.V. Voltmeter Selector Switch (Rotary Type)
  - L.V. Voltmeter (Digital Type)
  - L.V. Voltmeter Selector Switch (Rotary Type)

➢ <u>PT for AVR</u> for the OLTC shall have the following:

- o The OLTC gear shall be designed:
  - To complete tap change for the maximum current to which transformer can be loaded i.e. 150% of the rated current.
  - To prevent tap change when the through current is in excess of the safe current that the tap changer can handle.

- To withstand through fault currents without injury.

o When a tap change has been commenced:

- It shall be independent of the operation of the control relays and switches.
- Necessary safeguard shall be provided to allow for failure of auxiliary power supply or
- Any contingency resulting in the tap changer movement not being completed once it is commenced.

o Compartments which contain the making and breaking contacts of the OLTC:

- Shall not mix its oil with oil in other compartments of the OLTC or with transformer oil.
- Gases released from this compartment shall be conveyed by a pipe to a separate oil conservator or to a segregated compartment within the main transformer conservator.
- An Oil surge relay shall be installed in the above pipe.
- The conservator shall be provided with a prismatic oil level gauge.

o Oil, in compartments of OLTC which do not contain the make and break contacts, shall be maintained under conservator head by valve pipe connections. Any gas leaving these compartments shall pass through the Buchholz relay before entering the conservator.

o Oil filled compartments shall be provided with filling plug, drain valve with plug, air release vent, oil sampling device, inspection opening with gasketted and bolted cover with lifting handles.

o OLTC driving mechanism and its associated control equipment (local) shall be mounted in an outdoor, weatherproof cabinet with IP 55 protection which shall include:

- Driving motor (415V, 3-phase, 50 Hz. AC squirrel cage).
- Motor starting contactor with Motor Protection Circuit Breaker, isolating switch and HRC fuses.
- Control switch: Raise/off/lower (spring return to normal type).
- Remote/local selector switch (maintained contact type).
- Mechanical tap position indicator showing rated tap voltage against each position and resettable maximum and minimum indicators.
- Limit switches to prevent motor over-travel in either directions or final mechanical stops.
- Brake or clutch to permit only one tap change at a time on manual operation.
- Emergency manual operating device (hand crank or hand wheel).
- A five digit operation counter.
- Electrically interlocked reversing contactors (preferably also mechanically interlocked).
- 240V, 50 Hz. AC space heater with switch and HRC fuses.
- Interior lighting fixture with lamp door switch and HRC fuses.
- Gasketted and hinged door with locking arrangement.
- Terminal blocks, internal wiring, earthing terminals and cable glands for power and control cables.
- Necessary relays, contactors, current transformers etc.

➢ CONTROL REQUIREMENTS FOR OLTC:

The following electrical control features shall be provided:

o Positive completion of load current transfer, once a tap change has been initiated, without stopping on any intermediate position, even in case of failure of external power supply.

- Only one tap change from each tap change impulse even if the control switches or push button is maintained in the operated position.
- Cut-off of electrical control when manual control is resorted to. Cut-off of a counter impulse for a reverse tap change until the mechanism comes to rest and resets the circuits for a fresh operation.
- Cut-off of electrical control when it tends to operate the tap beyond its extreme position.
- Automatic Control of OLTC shall include the following items:
  - Voltage setting device.
  - Voltage sensing and voltage regulating devices.
  - Line drop compensator with adjustable R and X elements.
  - Timer 5-25 seconds for delaying the operation of the tap changer in the first step for every tap change operation.
  - Adjustable dead band for voltage variation.

5.1.1.10. COOLING

- Transformer shall be naturally cooled, the oil passing through the radiators - mounted directly on the tank.
- Insulation oil shall conform to I S: 335.
- Transformer shall be supplied with first fill of oil in leak proof containers with 10% additional quantity.
- Test certificates for the oil shall be furnished before dispatch of transformer and acceptance by owner.

5.1.1.11. CONSERVATOR

A detachable conservator of liberal capacity; equipped with oil level indicator, drain valve & detachable cover at one end shall be provided. The conservator shall be connected to the tank with necessary piping and valves.

5.1.1.12. VALVES

The following oil valves of high quality gun metal shall be provided for each transformer:

- Drain valve and oil sampling valve for the tank
- Conservator drain valve.
- Flanged valve between Bocholt relay and conservator.

5.1.1.13. TERMINAL ARRANGEMENT

- Transformers shall be fitted either with bushing insulators or with cable boxes / cable box with disconnecting chambers.
  - Bushing shall confirm to I S: 2099 and preferably have non-ferrous flanges and hardware.
  - The Cable Boxes shall be suitable for termination of required runs and size of XLPE cables.
- The neutral of the star-connected winding shall be brought out to a separate bushing terminal. The neutral bushing shall be provided on the tank top side to facilitate lead of the earth conductor.

5.1.1.14. HV CABLE CONNECTION

<u>HV CONNECTION</u>: <u>CABLE</u>

- 33,000/11,000volts (refer BOQ) terminals of the transformer shall be brought out through side wall bushing to HT bushing for a cable end box with self-supporting disconnection chamber.

- The cable end box shall be self-supporting, weather-proof type suitable for end termination of XLPE cable of specified voltage & size.

HV BUSHING ARRANGEMENT

- Bushings shall have a minimum Creeping distance of 41mm/kV to ground.
- 33,000/11,000volts (refer BOQ) terminals of the transformer shall be brought out through top cover of the tank to HT bushing for over-head termination.
- The terminals shall be suitable for connection with specified ACSR conductors.

415 VOLTS CABLE CONNECTION

- 415V three phase + Neutral terminals for cable connection to be done on the LT side; shall be brought out suitably to receive cables of appropriate section and size. Enough spacing shall be provided for proper termination of the cable sections.
- LT Neutral shall be brought out separately through a bushing mounted at the top of the enclosure. This neutral shall be connected to the earth station (for neutral earth) through copper strips of adequate size (min. 2x4x40mm).

415 VOLTS BUS DUCT CONNECTION

- 415V three phase + Neutral terminals for Bus Duct connection on the LT side; shall be brought out to a flanged bushing connection to suit the PURCHASER'S bus-duct. Enough spacing shall be provided for proper termination of the bus bar sections.
- LT Neutral shall be brought out separately through a bushing mounted at the top of the enclosure. This neutral shall be connected to the earth station (for neutral earth) through copper strips of adequate size (min. 2x4x40mm).

TERMINAL DISCONNECTING CHAMBER

- The disconnecting chamber shall be air insulated with seal off bushing as required or removable flexible connectors / links and removable covers. It shall be possible to remove the transformer without a need to disconnect the bus duct / cables.
- Phase to phase and phase to ground clearances within the chamber shall enable either the transformer or cable to be subjected to HV test.
- The physical position of terminals and their marking shall be as per I S: 2026 (Latest edition).

5.1.1.15. BUSHING CURRENT TRANSFORMERS

- When specified, bushing shall be supplied with current transformers.
- Secondary leads, including tapping, shall be brought to a weatherproof terminal box near the bushing.
- Bushing C.T. nameplate shall be mounted on the tank adjacent to the terminal box.

5.1.1.16. MARSHALLING BOX

o A marshalling box of adequate size shall be tank mounted, outdoor, weather-proof having IP-54 degree of enclosure protection as per I S: 2147 (latest edition), sheet-steel (2 mm thick) enclosed, with hinged door having padlocking facility. All doors, covers and plates shall be fitted with neoprene gaskets. Bottom shall be at least 600 mm from floor level and provided with gland plate and cable glands as required. Top surface shall be sloped.

o All the control terminals meant for the safe operation of the transformer; such as optional fittings (e.g. temperature indicators with auxiliary contacts, Buchholz relay) and bushing CT, shall be terminated on a terminal strip of 'Elmax' type suitable to terminate 10sq. mm. wire. It shall be in the Vendor's scope to provide:

- The interconnection cabling between the marshalling box and the accessory devices by PVC insulated armored cable. Wiring shall be with stranded, copper conductors of sizes not

smaller than 1.5 sq.mm for control and 2.5 mm for C.T. circuits. C.T. terminals shall be provided with shorting facility.

- Necessary compression type, brass cable glands at the marshalling box for the above mentioned cables as well as for terminating the Purchaser's incoming cables from remote panels to the Marshalling box.
- All contacts for alarm, trip and indication circuits shall each be potential free, wired for auxiliary D.C. supply as specified and brought out to separate terminals at the terminal blocks in the marshalling-box.
- Anti-condensation heater controlled by thermostat, a switch and illumination fixture etc.

5.1.1.17. ACCESSORIES & FITTINGS (WITH OIL CONSERVATOR TANK)

Following accessories shall be provided for oil immersed type transformers:

1. Rating and diagram plate of weatherproof material bearing the data specified in the I S: 2026-1977. A diagram plate showing the internal connections and also the voltage vector relationship of the several windings and a plan view of the transformer giving the correct physical relationship of the terminals.
2. Plain oil level gauge with minimum marking*,
3. Top filter valve*,
4. Drain cum bottom sampling / filter valve with plug or cover plate,
5. Oil filling pipe with cover,
6. Pressure relief device of sufficient size for rapid release of any pressure that may be generated within the tank and which might result in damage to the equipment,
7. Off-circuit/On-circuit Tap changing switch (refer BOQ),
8. Lifting lugs for lifting complete transformer with oil and lifting core and coils,
9. Conservator with drain plug*,
10. Silica gel breather (for transformers 25KVA and above)*,
11. Earth terminals (2 numbers),
12. Radiators with shut-off valves*,
13. Skid type under-base with bi-directional roller,
14. Buchholz relay with double float with trip and alarm contacts; conforming to I S: 3637-1966*,
15. Dial type oil temperature indicator with alarm and trip contacts*.
16. Winding temperature indicator with trip and alarm contacts*,
17. Magnetic oil level indicator*,
18. Marshalling box.
19. Jacking Lugs (Transformers weighing above 3000 Kg)
20. The under-base provided with channels for fixing on a platform or plinth.

* Marked items are not applicable to hermetically sealed transformers. For monitoring of gas, pressure and temperature DGPT2: Protection Relay with necessary auxiliary contacts shall be provided

5.1.1.18. GAS AND OIL ACTUATED (BUCHHOLZ) RELAYS

Buchholz relay shall be provided for the transformers for the following function:

- Oil actuated relay equipment shall conform to I S: 3637-1966 and shall be double float type having contacts which close following oil surge or under incipient fault conditions.

- Each gas and oil actuated Buchholz relay shall be provided with a test cock to take a flexible pipe connection for checking the operation of the relay.
- The design of the relay mounting arrangements & associated pipe work shall be such that mal-operation of the relay shall not take place under normal service. The pipe work shall be so arranged that the gas arising from the transformer shall pass through the Buchholz relay. The oil circuit through the relay shall not form a delivery path in parallel with any circulating oil pipe nor shall it be tied into or connected through the pressure relief vent.
- All wiring connections, terminal boards, fuse and links etc. connected with Buchholz relay shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil; shall have oil resisting insulation and the bared ends of stranded wire shall be sealed together to prevent creepage of oil along the wire. There shall be no possibility of oil entering connection boxes used for cables or wiring.

5.1.1.19. . TESTS

ROUTINE TESTS

Routine tests shall be conducted on all transformers in the factory as per latest edition of I S: 2026.

I S: 2026 (Part1)	:	a)	Measurement of winding resistance
	:	b)	Measurement of voltage ratio and check of phase displacement
	:	c)	Measurement of short-circuit impedance (principal tapping, when applicable) and load losses at 50% and 100% load.
	:	d)	Measurement of no-load loss and current.
	:	e)	Measurement of insulation resistance.
I S: 2026 (Part 3)	:	f)	Induced over-voltage withstand test.
	:	g)	Separate-source voltage withstand test.
	:	h)	Pressure Test.
	:	i)	Oil Leakage Test.

TYPE TESTS

Type tests and Special tests, as agreed, shall be conducted in accordance with I S: 2026 in the works before dispatch.

I S: 2026 (Part 2)	:	a)	Temperature-rise test.
I S: 2026 (Part 3)	:	b)	Lightning impulse test.
I S: 2026 (Part 5)	:	c)	Short-circuit withstand test (up to 200 kVA).
	:	d)	Pressure test.

SPECIAL TESTS

I S: 2026 (Part 5)	:	a)	Short-circuit withstand test (above 200 kVA).
I S: 2026 (Pt 10)	:	b)	Determination of sound levels.
	:	c)	No load current at 112.5 percent voltage.
I S: 335	:	e)	BDV and moisture content of oil in the transformer.
ASTM: D3359	:	d)	Paint adhesion tests. The test is performed as per Standard Test: Methods for measuring adhesion by Tape test).

5.1.1.20. LOSSES

Preferred losses shall be in accordance with I S: 1180 & ECBC.

S.NO.	RATING (KVA)	IMPEDANCE (%)	ENERGY EFFECIENCY LEVEL 1 (50% LOAD)	ENERGY EFFECIENCY LEVEL 1 (100% LOAD)
1	16	4.5	150 W	480 W
2	25	4.5	210 W	695 W
3	63	4.5	380 W	1250 W
4	100	4.5	520 W	1800 W
5	160	4.5	770 W	2200 W
6	200	4.5	890 W	2700 W
7	250	4.5	1050 W	3150 W
8	315	4.5	1100 W	3275 W
9	400	4.5	1300 W	3875 W
10	500	4.5	1600 W	4750 W
11	630	4.5	2000 W	5855 W
12	1000	5	3000 W	9000 W
13	1250	5	3600 W	10750 W
14	1600	6.25	4500 W	13500 W
15	2000	6.25	5400 W	17000 W
16	2500	6.25	6500 W	20000 W

All the measurement of losses shall be carried out by digital meters of class 0.5 or better accuracy and should be certified by the manufacturer.

- If the losses measured are found to be out of tolerance band as stated in Standard and guaranteed losses declared by manufacturer, the same shall be attributed to the manufacturer as per capitalization formula till the end of warranty period.
- In extreme conditions the customer has got absolute rights to get the replacement of transformer free of cost from the transformer supplier.

For the purpose of evaluation of bids, the quoted load losses and iron losses shall be increased to take into consideration tolerance as permitted by applicable standard.

Should the losses as measured on the transformer after manufacture; be found in excess of the values of the guaranteed losses with plus tolerance indicated in the proposal, VENDOR shall pay penalty to the PURCHASER based on the charges decided by user.

GENERAL INSULATION LEVEL

VOLTAGE LEVEL	ONE MIN POWER FREQUENCY WITHSTAND VOLTAGE (KV)	IMPULSE WITHSTAND
11KV	28KV	75KV Peak
22KV	50KV	125KV Peak
33KV	75KV	175KV Peak

INSTALLATION AND COMMISSIONING

Transformers shall be installed and commissioned as per the requirements of I S: 1886 (latest edition) and regulations of local authorities.

a) The transformer shall be lifted by lugs or shackles or by any other suitable means (such as dragging on rollers) and mounted on the concrete plinth prepared for the purpose. Care shall be taken to see that transformer is not tilted during lifting and erection of transformer. The roller shall be checked to prevent movement of the transformer after being positioned on the plinth. Adequate and necessary clearances from walls, other equipment, etc. shall be provided as indicated on the drawing.

b) All the accessories and parts such as conservator tank Bocholt relay, breather, explosion vent, thermometer etc. should be mounted on the transformer. Tighten all bolts and nuts and check for any leakage. Any leakage shall be rectified. (Not applicable to hermetically sealed transformer).

c) Check the oil level and top it up, if necessary, with new oil. Dielectric strength of oil shall be tested as per IS/BS specifications with an electrode gap of 4mm ñ 0.02 mm polished electrodes of 12.5mm dia. using three samples of oil drawn from the oil drain valve of the transformer. The test voltage shall be raised from 15KV to 60KV in about 10 seconds. At least two samples of oil must withstand 40KV voltage for one minute. (Not applicable to hermetically sealed transformer).

d) The insulation resistance of the winding shall be measured with 100V DC megger and results shall correspond to the factory test results.

e) If dielectric strength of oil is not as per the requirement, the drying of oil shall be done with the help of suitable streamline oil treatment plant. While drying of oil is being done, the transformer shall be provided with suitable lagging all around. The temperature of oil in the spray tank shall not exceed 80°C during the purification process. After treatment, the oil must conform to the conditions laid down in IS specifications. (Not applicable to hermetically sealed transformer).

f) Phasing out test with 433 Volts applied to HV windings and voltage across LV windings shall be checked.

g) Measurement of neutral and body earth resistance with earth testing megger:

The values shall not exceed 1 to 2 ohms as required.

h) Functioning of Buchholz relay, thermometer, oil level indicator (in conventional transformer) shall be checked and adjusted, if necessary. The transformer shall be charged only after the above tests are conducted and approval of local authorities is obtained. The earthing of neutral and body of the transformer shall be done as per IE regulations and the requirements of local authorities. However, general mode of earthing arrangements is indicated on the drawings. The contractor shall supply all the material and labor for erection and commissioning of transformers.

EARTHING

- Neutral of the transformer shall be connected to two separate and distinct earth stations through double run of copper tapes of suitable size.
- The body of the transformer shall be provided with effective earth through double run of G I Strips of suitable size as per N E C, the drawings and specifications.

PRE-COMMISSIONING TESTS

The following pre-commissioning tests shall be carried out on the transformer:

i. Position and inclination of the transformer Buchholz relay shall be checked.

ii. General inspection of bolts, nuts, gaskets and checking of all accessories and checking of transformer oil level.

iii. Dielectric strength test of transformer oil with three oil samples taken from the bottom of transformer tank.

iv. IR values on HV and LV windings shall be tested with 1000 V DC Megger.

v. Voltage ratio on each step of tap changer to be checked.

a) With 415V applied on high-voltage side, measure the voltage between all phases on the low-voltage side for every tap position.

b) To check phasing, measure volts across:

A to a, b and c.

B to a, b and c.

C to a, b and c.

Where: A, B & C are the terminals of three phases on high voltage side and a, b & c are the corresponding terminals on low voltage side.

c) Magnetic balance test.

vi) Secondary injection on all transformer protection relays.

vii) Primary injection: Tests on:

a) Operation and stability of earth (to be repeated at fault relays on high voltage side).

b) Over current relays on low voltage side.

c) Operation and stability of earth fault relays on low voltage side.

d) Operation of standby earth fault relays on low voltage side.

e) Over-current relay on high voltage side (when CTs are not in transformer bushings).

f) Voltage compensation.

viii) Tripping tests:

a) High voltage.

b) Low voltage.

- Inter-tripping tests.
- Winding temperature trips.

ix) Calibrate earth resistance.

x) Tap changing tests to check mechanism.

xi) The power frequency test voltage for the secondary winding shall be 2.5kV R.M.S.

The transformer shall be charged only after the tests are conducted and approval of local authorities is obtained.

INDICATION, BUZZER, LAMP, ETC.		
1) Insulation tests	a)	On high and low voltage windings.
	b)	On current and voltage transformers,
		circuits, etc.
2) See that neutral earth switches are closed before making live.		
3) Check Transformers on equal taps before Switching in		
	a)	For Transformer in a bank
	b)	For Transformers in a parallel
4) Set down relays before closing in, advise control		
5) Load tests	a)	Voltmeter, ammeters, etc., on high and low voltage sides
	b)	Over current
	c)	No spill in high voltage star point.
	d)	No creeping of contacts on both high and low voltage earth fault relays.
	e)	Voltage on relays.

5.1.1.21. DOCUMENTATION

Four copies of manual of complete instructions for the installation, operation, maintenance and repairs circuit diagrams, foundation and trenching details shall be provided with the transformers. List of spare parts shall also be indicated.

Two copies of the drawings incorporating the following particulars shall be submitted with the offer for preliminary study:

- Transportation / shipping dimension with weight.
- Foundation plan and loading.
- General arrangement drawing showing enclosure, core-coil assembly, terminal arrangement, marshalling box terminal details.
- Rating and connection diagram
- Data sheet
- Type and routine test reports.

5.1.1.22. DATA SHEET OF TRANSFORMER (ONAN)

- o Nos. required : (refer BOQ)
- o Capacity : -------- KVA (refer BOQ)

- o Type of Cooling : Oil Immersed, Self-cooled
- o Rated voltage :
  - Primary : 11,000Volts
  - Secy. : 433V between phases and 240V between phase & Earth
- o Rated supply frequency : 50Hz per second
- o No. of Phases : Three (3)
- o No. of windings : Two (2)
- o Winding connection : Primary Delta, Secondary-Star with fully insulated neutral brought out to secondary terminals
- o Material of Winding : Copper
- o Vector Group : DYn11 to I S: 2026 (latest edition) (Refer BOQ)
- o Voltage taps : Off-load / 'On-load' taps on primary for +5%, +2½%, -2½% and -5% (Refer BOQ)
- o Tap Changer : Off circuit / On-load tap changer on H V side to cater to the input voltage variation. (Refer BOQ)
- o Tank : Sheet steel tank.
- o Standard Fittings : As per I S: 2026.
- o Additional Fittings : Dial type oil temperature indicator with WTI.
- o Temperature Rise : As per I S: 2026 (latest edition)
- o Impedance : Suitable value to limit the fault level to 31MVA at 415V, 3 phase, 50 Hz, A C Supply.
- o Protections : Buchholz relay for gas pressure with Alarm and trip control.
  - Winding temp with Alarm and trip control.
  - Oil temperature with Alarm and trip control.
- o Primary side connection : -----mm^2 XLPE cable through a cable end box with self-supporting disconnection chamber. (refer BOQ)
- o Secy. Side connection : -------- cables through a cable end box having liberal space for proper cables' termination. (refer BOQ)
- o Under Carriage : Suitable under carriage with Bi-directional rollers with edges designed to permit sliding the transformer when required without damaging the floor.
- o Marshalling Box : To facilities connections of all protection devices like oil temperature Indicator, winding temperature indicator etc.
- o Transformer Oil : To be supplied with first fill of oil conforming to IS 335 (latest edition).

5.1.1.23. SOAK PIT AND DRAIN PIT (WHEREVER REQUIRED)

Soak pit and drain pit shall be provided as per I S: 10028-2 wherever required, if the oil volume in the transformer ≥ 2000 liter.

- The transformer's foundation shall be surrounded by a suitable soak pit enclosed by a 150mm high non-combustible curb.
- This soak pit shall be filled with coarse crushed stones about 25mm in diameter to a minimum depth of 300mm. The volume of the soak pit minus the volume of the stones should be sufficient

to contain the entire oil content of the transformer if the oil content is ≤ 5 kl.

- In case the oil content is > 5 kl, the volume of soak pit minus the volume of stones shall be sufficient to contain at least one third of the total oil content. The excess shall be led through two or more Hume /concrete pipes (min. 150mm dia.) from bottom of pit to a central remote burnt oil tank.

5.2. HT Panel

The H.T. Panel shall consist of HT panel board consists of suitable Nos. of VCB shall be located near transformers.

VCB shall be outdoor type floor mounted metal clad, 11 KV VCB panel, horizontal draw-out, horizontal / vertical isolation type breaker.

5.2.1. HT SWITCHGEAR UNIT WITH VCB- 11KV

5.2.1.1. SCOPE

- Supply, manufacture, installation, testing & commissioning of integrated cubicle, horizontally draw out type / Cassette type front operated 11kV switchgear as per specifications in the following paragraphs.
- The 11kV switchgear shall be IEC 61850 protocol compliant for communication with SCADA system.
- All the equipment shall be suitable for satisfactory operation in tropical climates and dry dust laden atmosphere prevailing at site.
- 11kV Panel shall be made by the manufacturer of the VCB.

5.2.1.2. GENERAL

The panel shall be integrated cubicle type, floor mounted, free standing extensible sheet steel enclosed, front operated indoor type 11 kV switch board as per specifications given below:

- Power supply system:

- Rated voltage : 11 kV, 3phase (earthed system)
- Rated frequency : 50 cycles
  - Fault Level withstand : 25kA at 11 KV for 3sec sec or as specified in the B.O.Q

- Site climatic conditions:

- Ambient temperature : 400 C. maximum, 0oC minimum (as per IEC).
- Relative humidity (max) :100%
- Altitude : 500 m above MSL

- The switchgear panel shall be suitable to operate without any capacity de-ration at the climatic condition listed above and IEC 61850 protocol compliant for communication with SCADA system.

5.2.1.3. STANDARDS

The 11 K V. V CB (Vacuum Circuit Breaker) Panel and components shall conform to the latest edition of the I S Specifications as under:

- I S: 13118, 1991/ IEC 62271-100 : Specification for Vacuum Circuit Breaker.
- IEC 62271-200 : Internal arc testing of switch gear.
- I S: 13327 / IEC 60298 / 60694 : Specification for AC Circuit Breaker Panel; design & testing.

- IEC 61850 : 11kV switchgear protocol compliance for communication with SCADA system.
- IEC 60529 : Degree of protection for H T Switch Gr Panel.
- I S: 3231 / I S: 8686 / IEC 60255 / IEC 61000 : Electrical Relays for Power System Protection.
- I S: 2705 / IEC 61869-1, 2 : Current Transformers.
- I S: 3156 / IEC 61869-1, 3 : Potential Transformers
- I S: 375 : Marking and arrangements for Switch-Gear Bus-Bar main connections & auxiliary wiring.
- I S: 1248 : Direct acting electrical Instruments.
- I S: 6875 : Control switching for voltages up-to & including 1000V A C and 1200V D C.
- I S: 722 / I S: 3779 : A C Electricity Meters.

All electrical works for installation shall be carried out in accordance with the provisions of Indian Electricity Act, 2003 and the Indian Electricity Rules, 1956 amended up to date.

5.2.1.4. H.V. PANEL BOARD

5.2.1.4.1 DESIGN ASPECTS

- The HV panel board shall be designed such that the switchgear, instruments, relays, bus bars, small wiring etc. are housed in separate compartments on the front of the cubicle, arranged and mounted with due consideration for the following:
  - Facility for inspection, maintenance and repairs of terminal boards for ease of external connection.
  - Minimum noise and vibrations.
  - Risk of accidental short circuits and open circuits.
  - Secured and vibration-proof connections for power and control circuits.
  - Risk of accidental contact and danger to personnel due to live connections.
  - Mountings at approachable height.
- The Panel board shall:
  - Be compact, integrated, indoor, metal-clad, floor mounted, free standing, sheet steel enclosed.
  - Be of totally enclosed design, dust & vermin proof and extensible type. The degree of Protection shall be IP4X as per IEC 60529.
  - Be complete with all supporting frame work, mounting channels, foundation bolts etc. and designed to ensure complete inter-changeability of components from one panel to another.
  - Be of compartmentalized design having separate compartments for Breaker, Bus-bars, Cable & CT, Instrument & relays and control switches.
  - Be ‘internal arc’ type tested for 25kA.
  - Have the draw-out type VCB mounted on its own trolley on wheels which can be ‘drawn-out’ & ‘racked-in’ as required or else have the ‘Cassette type VCB’ provided with common earthing trolley/truck (separately for each substation) on which the cassette can be withdrawn and carried out of the panel.
  - Have PT of adequate VA burden & accuracy class; housed in a separate chamber,
  - Have ‘Earth switch’ in a separate chamber or in cable chamber.

- Have 'Instrument testing plug' provided for testing the meters.
- Have 'Surge arresting device' for protection against lightning and switching-over-voltage.
- Fulfill detailed requirements in accordance with the BOQ.

- RATING: All panels assembled to form a board shall be:
  - Suitable for the nominal operating voltage and rupturing capacity as specified.
  - Rated as specified with a minimum of 630 Amps and,
  - Suitable for operation on 11KV, 3 phase 50Hz system with,
  - Suitable for fault current withstand capacity of 25KA.

5.2.1.5. CONSTRUCTION

Circuit breaker, instrument transformers, bus bars, cable etc. shall be housed in different compartments as required. All relays, switches, lamps, etc. comprising the control, indication and protective devices; shall be housed in a separate compartment on the front of the cubicle.

5.2.1.5.1 SWITCHGEAR PANEL

The switchgear panel shall:

- Be made from 2 mm thick M S sheet steel; folded and braced as necessary to provide a rigid support for all components. The sheet steel shall be cleaned using 7 Tank process, passivated and Powder coated with acceptable shade. Alternatively, 2mm thick pre-galvanized sheet steel or Aluzinc sheet may be used.
- Be rigid without using any external bracings. Hardware shall be zinc plated and passivated. Required number of Lifting Lugs for each shipping section shall be provided.
- Be modular in design and comply with relevant latest revision of IS/IEC. It shall be designed for easy operation & maintenance. Construction of the switchgear shall provide a degree of protection IP-4X and shall permit extension at either end.
- Form a continuous, dead front line up of free standing vertical cubicles. Each cubicle shall have a lockable front hinged door and a removable bolted back cover. All covers and doors shall be provided with neoprene or equivalent quality gasket.
- Have separate compartments provided for circuit breakers, bus bars, relay & instruments, CT & PT and cable boxes, fully and effectively segregating these from one another so that fault in any one compartment does not cause damage to equipment(s) in other compartment(s).
- Have the housing of bolted construction to ensure compact and rigid structure, presenting a neat and pleasing appearance. The sheet steel body shall be earthed.
- Have space heater with thermostat control and 'On/Off' MCB protection in each cubicle.
- All the high voltage compartments must have pressure discharge flap for the exit of gas due to internal are to ensure operator's safety. The HV compartment design shall ensure conformity to IEC-62271-200 and must be type tested for 'Internal Arc Test' for one second.

5.2.1.5.2 BUS BAR COMPARTMENT

Bus bars of copper conductor as per I S: 1897, insulated, covered shall be supported on rigid epoxy support insulators. Bus bars shall be:

- Capable of connecting one switchgear panel to other through proper insulated arrangement such that it does not decrease the insulation strength of the bus bar at the point of connection between two panels.
- Made of hard drawn, high conductivity, electrolytic copper and shall be air insulated.

- Mounted on support insulators suitable to withstand full short circuit and rated for 500MVA for 3seconds and provided at the rear with or without inter-panel barriers (as per IEC standards).
- Provided with separate supports for each phase. The bus system shall withstand the specified impulse voltage level and shall be rated to withstand all dynamic and thermal stresses for the full length of the switchgear.
- Sized as per Current ratings and shall be provided with the minimum clearances in air as per applicable standards for 33kV, 3 phase system.
- Provided with joints complete with high tensile steel bolts, Belleville washers and nuts. Bus bars shall be thoroughly cleaned at the joint locations and suitable contact grease shall be applied just before making a joint.

5.2.1.5.3 BREAKER COMPARTMENT

➢ THE BREAKER SHALLI:

- Be able to be drawn out in horizontal position at ground level.
- Be drawn out when none of the live components inside the switchgear panel shall be accessible as the safety shutters shall automatically cover the live components.
- Have three distinct positions inside the cubical; i.e. service, test and isolated.
- Have complete interlocking arrangement at the fully inserted and fully drawn out and test positions:
  - Withdrawal of the breaker shall not be possible in ON position,
  - It shall not be possible to close the circuit breaker in service unless the entire auxiliary and control circuit are connected.
- Built-in/separate trolley mounted earthing switches for incomer and outgoing cables shall be provided.

➢ BREAKER CARRIAGE:

The breaker carriage shall be fabricated from steel, providing a sturdy vehicle for the circuit breaker and its operating & tripping mechanism. The carriage shall be mounted on wheels moving on guides, designed to align correctly and allow easy movement of the circuit breaker and for removing the carriage for inspection and maintenance purposes.

The circuit breaker truck shall have:

- Rack-in / rack-out mechanism.
- Isolating plugs and sockets.
- Mechanical inter-lock and safety shutters.
- Mechanical ON/OFF indicator.
- Minimum of 4NO and 4NC auxiliary contacts directly operated by the circuit breaker. Additional 'NO & NC contacts' shall be provided with auxiliary contacts.
- Anti-condensation space heaters suitable for operation on 240V, 1φ, 50Hz AC supply for each panel.
- Suitable tripping arrangement of the breaker.
- Mechanical counter to assess the total number of operations of the breaker.

➢ CIRCUIT BREAKER WITH VACUUM INTERRUPTER:

- Technical Particulars (Ref BOQ):

S.NO.	DESCRIPTION	11KV
A	Rated Current	630 / 800 / 1250A
B	Rated Voltage	12kV
C	Rated Frequency	50Hz
D	Rated Short Circuit breaking Current	25 / 40kA
E	Rated short circuit making current (KAp)	65.75 / 100 kA
F	Insulation level (KVrms / KVp)	28 / 75
G	Breaker operating sequence	0-0.3s-CO-3m-CO

- Vacuum interrupters shall be hermetically sealed and designed for minimum contact erosion, fast recovery of dielectric strength, maintenance free vacuum interrupter, suitable for auto-reclosing and mounting inside an indoor cubicle.
- Vacuum Circuit Breaker (VCB) shall be mounted in draw out truck with front plate covering the cubicle when the breaker is in service position. Draw out mechanism shall be horizontal. Construction of breaker shall be such that the points, which require frequent maintenance, shall be easily accessible.
- The circuit breakers shall be spring operated, motor/manually charging of the spring feature. VCB shall have spring closing mechanism for 3 pole simultaneous operation. The speed of closing operation shall be independent of the speed of hand operating lever. The indication device shall show the OPEN and CLOSE position of breaker visible from the front of cubical.
- The front plate shall be provided with:
  - View glass to facilitate observation of mechanical ON / OFF indication of Circuit breaker, spring charged / discharged indication and operation counter.
  - Suitable orifice for manual charging of the springs.
  - ON / OFF push button for opening and closing of the circuit breaker.
- The draw out truck shall have two positions for the circuit breaker:
  - Isolated / Test position &
  - Service position.

- <u>DESIGN FEATURES</u>:

  The breakers shall be capable of making and breaking the short time current in accordance with the requirement of I S: 13118, 1991 / IEC 62271-100 (latest amendment) and shall have three phase rupturing capacity of 500MVA at 11KV.

  - The break/make time shall be not more than 4 cycles for break
  - CB shall be 'Trip-free' provided with electrically operated spring closing mechanism.
  - CB 'closing mechanism shall be suitable for operating on 230 or 110V AC and & tripping' mechanism on 30 or 24V DC. System (Ref BOQ).
  - The cradle of the CB shall have following positions of the breaker:
    - Operating position : Both mains and secondary isolating contacts in service.
    - Test position : Main isolating contacts separated and secondary contacts in service.

- Isolated position : Both; main and secondary isolating contacts isolated.

- INTERLOCKS AND SAFETY DEVICES:

A. INTERLOCKS:

The following interlocks shall be provided for the CB and Breaker Carriage:

- It shall be possible to bring the CB to operating / test / isolated position with the CB compartment door closed.
- It shall not be possible to:
  - Withdraw the CB in 'closed' position. An attempt to isolate it will trip the CB.
  - Open Safety shutter with CB 'closed'.
  - Close the CB except when it is correctly positioned.
  - Close the CB without completion of control circuitry.
  - Disconnect the low voltage 'control plug and socket' in any position except test/isolated position of the VCB.
  - Move the VCB truck inside the panel when the low voltage 'control plug and socket' are disconnected.
  - Switch ON the Earth switch when the truck is inside the panel.
  - Open the Rear door until the VCB is in isolated position.

B. SAFETY DEVICES:

The following Safety devices shall be provided for operator's safety:

- Individual explosion vents shall be provided for breaker chamber / bus bar / cable chambers on the top of the panel to let-out the gases under pressure generated in case of fault inside the panel.
- Cubicle with front plate; to withstand the pressure for internal arc fault for 0.1 second as per IEC standards.
- Circuit breaker and sheet metal enclosure shall be fully earthed.
- Self-locking shutters shall be provided which shall close automatically when the truck is withdrawn to 'Test position' and no separate padlocking of the shutter shall be required.
- Protective earth: The earth connection between the Earth truck and the cubicle shall be by means of sliding contacts so that the truck is earthed in the 'isolated position' when inserted and remains earthed when the truck is pushed further into the 'connected position' or when the truck is being withdrawn until the truck has moved to the 'isolated position'.

- ISOLATION

a) POWER CONTACTS

The breaker isolating contacts shall consist of two parallel flat silver plated copper bars with ball point contacts to give a vertical tolerance of ±10 mm.

b) CONTROL CONTACTS (LOW VOLTAGE PLUG AND SOCKET CONNECTOR)

A twenty pin plug and socket connection along with flexible leads shall be provided to connect control, instrumentation and interlock circuits on the breaker truck and in the panel. The plug and socket assembly shall be suitably interlocked with the truck positions like service and test/isolated position.

➢ CT AND CABLE COMPARTMENT

At the rear of the panel, sufficient space shall be made available to accommodate three numbers epoxy CT's of double core and two numbers three core cable terminations. The cable entry shall be from the bottom.

- o A single breaker panel shall have separate incoming and out-going cable boxes suitable for XLPE armored, aluminium conductor cable of specified size.
- o A multiple breaker panel shall have individual out-going cable terminations suitable for XLPE armored, aluminium conductor cable of specified size.
- o An adequately sized continuous earth bus of copper shall be provided through-out the length of the panel.

5.2.1.5 INSTRUMENT COMPARTMENT

- o The instruments and relays would be housed in a separate compartment located above the CB carriage compartment and accessed from the front side of the panel.
- o The meters and the indicating lamps shall, however, be mounted on the CB carriage and visible on the front side of the panel.

METERING & PROTECTION & INSTRUMENTATION

➢ CURRENT TRANSFORMER (CT)

1 GENERAL REQUIREMENTS

- Accommodation shall be provided in the Power Cable compartment to mount one set of duel ratio CT. Access to the CTs for cleaning, testing or changing shall be from the back of the panel.
- All current transformers shall be earthed through a separate earth link.

2 RATING

- o The CTs of suitable voltage and current ratings shall conform to relevant Indian / International Standards.
- o The design and construction of the CT shall be:
  - Dry type, epoxy resin cast,
  - Robust to withstand thermal and dynamic stresses during short circuits.
  - CT terminals shall be shorting type.
- o Current & voltage circuit wires shall be laid in separate wire ways.
- o Secondary terminals of CTs shall be brought out to a test terminal block which will be easily accessible for terminal connections in the front side of the panel.
- o Duel ratio CTs shall have:
  - VA burden (each) : ≥ 10VA
  - Secondary current : 1 or 5Amps
  - Instrument Security Factor (ISF) : ≤ 5.
- o CT'S shall have 2 Nos. of cores for following application:
  - Core -1 : for metering
  - Core -2 : for over current & earth fault protection.
  - Class of accuracy for winding
    : Metering class : 0.5

: Protection class : 5P10

➢ POTENTIAL TRANSFORMER (PT)

o Standards:

- I S: 3156 / IEC 61869-1, 3 : Potential transformers.
- I S: 9385 / IEC 60282 : HT HRC Control fuses.
- I S: 8828 / IEC 60898 : Miniature Circuit breaker

o The primary windings of the PT shall be insulated for the system voltage and shall be of the cast resin type.

o PT shall be mounted on a draw out trolley and housed in separate compartment, shall have control fuses on the HV side and a MCB on the LV side of the windings.

o Padlocking facilities shall be provided for both; service and isolated positions.

o The potential transformer shall be as specified below:

- Ratio : 11000 /√3 / 110 / √3 / 110 V
- V A Burdon : 50VA for 100 / √3 winding
- Class : CL–1 for both the windings.
- Basic Insulation level : 75 KV.
- Over voltage factor : 1.2 Continuous

o Single phase PTs shall be connected in Star / Star.

➢ METERING

Metering shall be provided as per specific requirements in addition to the following:

o CTs and PT of suitable rating and class as specified.

o Ammeter with selector switch.

o Voltmeter with selector switch.

o 3 nos. Phase indicating lamps-LED based.

o Tri-vector meter (optional).

o Phase rotation relay (optional).

➢ METERING: INCOMING FEEDER

Digital type 'Tri-vector meter' of approved make (Smart demand controller) shall be provided on the incomer feeder (as per BOQ) with following Specifications:

o Accuracy : Class 0.5, compliant to revenue class certification.
: Real time measurement per phase & average.

o V, I, PF, KW, KVAR, KVA : Peak demand, sliding window. Protected.
: V & I unbalance, phase reversal.
: Time of use (TOU).

o Power Quality Measurement : Total Harmonics.

o Logging & recording for all measurements:
: Interval/event-based, 32 channel measurement & recording.
: Event logging

	:	"Bust" data recording
	:	Min/ Max recording
o Alarm	:	Over/under measurement detection by 24 set point fcns.
o Multiport Communication	:	One each of RS 485 and RS 232 ports.

➢ INSTRUMENTATION

- o Digital type Voltmeter of class 1.0 accuracy and 96 x 96 mm² in size as per I S: 1248 shall be provided at incomer panel with selector switch. The instrument shall be calibrated for the ranges specified.
- o Digital type Ammeter of specified range to class 1.0 accuracy and 144 x 144 mm² in size as per I S: 1248 shall be provided at both incomer and outgoing panels along with necessary selector switches.
- o Digital type frequency meter of class 1.0 accuracy conforming to I S: 1248 shall be provided at incomer panel.
- o Digital type Power factor meter of class 1.0 accuracy conforming to I S: 1248 shall be provided at incomer panel.

➢ INDICATING LAMPS

The following minimum indication lamps (LED based) shall be provided in the front of cubicle:

- Breaker open / closed / tripped,
- Spring charged,
- Trip circuit healthy and
- Control supply healthy.

NOTES:

1. Lamps shall be clustered LED type and trip circuit supervision scheme shall be of continuous supervision type.
2. After meeting all necessary control and indication requirements, 2 nos. NO and 2 nos. NC auxiliary of the breaker shall be made available for the owner, wired up to terminal block.
3. Separate MCBs shall be provided for lamps, heaters and other instrumentation etc. on each panel.
4. Anti-condensation space heaters; suitable for operation on 240V single phase, 50Hz AC; for each cubicle and with thermostat control, one incandescent lamp with switch and 3 pin 5A plug socket shall be provided.

PROTECTION AND TRIPPING ARRANGEMENT

- Protection relays shall be provided depending on the feeder's use as follows:
  - o These relays shall be furnished, installed, connected and coordinated to suit the requirement of the protection, operation and interlock of the equipment connected to the switch-gear. Relays shall be draw-out type, flush/semi-flush mounted on the respective cubicle. Relays shall be factory wired.

All protection relay shall be numeric type of approved make.

- o The protection and tripping arrangement of circuit breaker shall be provided as per BOQ & as mentioned below:

Numeric	TYPE OF PROTECTION	DEVICE NO	RANGE	REMARKS

--do--	Instantaneous short circuit	50	500 – 2000%	On all phases
--do--	Over current protection	51	50 – 200%	On all phases
--do--	Ground fault protection	50	20 – 80%	

- o Surge Arrestor: Lockout and trip supervisory relays etc. shall be provided with manual reset facility.
- o Auxiliary relay for transformer fault.

- Type of protection used shall broadly be as follows for various feeders:

  - o INCOMER FEEDER
    - 1X3 Pole Inverse time over current relay (51) for bus/ feeder fault,
    - 1x1 pole Inverse time over current relay (51N) for ground fault at Bus/feeder,
  - o STEP-DOWN TRANSFORMER FEEDER
    - 1X3 Pole Inverse-Time-Over-Current relay with Instantaneous trip attachment (50/51) for transformer over current and short circuit,
    - 1x1 pole Instantaneous relay of low rating (50N) for ground fault,
    - The Inverse-Time-Over-Current unit shall be discriminated with transformer LV side protection to act as a protection against transformer secondary side fault.
    - The Instantaneous relay (50) shall operate on short circuit on HT side of the transformer. This setting shall be high enough to over-ride transformer Switching surge and LT side fault on the transformer.
  - o MOTOR FEEDER

    Motor protection relay shall protect against:
    - Instantaneous short circuit & earth fault (IDMT relay),
    - Over loading,
    - Unbalancing,
    - Stalling.

- NUMERICAL RELAYS

  The Numerical Relays shall comply with the following requirements:
  - o The numerical relays shall be completely with Protection elements realized using software algorithm. Hardware based measurement shall not be acceptable.
  - o All the relays shall belong to a common platform and shall be of single make with Electro-mechanical relays in draw-out casing**.**
  - o The relay shall have following digital contacts:
    - At least 3 nos. digital inputs and 6 nos. output contacts.
    - The digital inputs and outputs shall be freely configurable.
  - o It shall be possible to energize the numerical relay from either AC or DC auxiliary supply. Relay shall have:
    - In-built breaker failure protection as local breaker backup.
    - Built-in 'Trip Circuit Supervision' to ensure healthy trip circuit.

- The relay shall have a comprehensive local MMI for interface. It shall have the following minimum elements to enable viewing and setting the relay locally:
  - 2 x 16 digit backlit LCD display unit
  - 4 fixed function LEDs (for trip, Alarm, Relay available & Relay out of service)
  - At least 4 programmable LEDs
  - 7 key tactile keypad for browsing and setting the relay menu
- The relay shall have the following communication ports:
  - A RS232 front communication port to connect a local PC/Laptop for setting and viewing the data.
  - A RS485 rear port for connecting relay in multi-drop fashion to a remote master (SCADA/DCS)
  - At-least two standard communication protocols (viz. MODBUS & IEC-870-5-103) in addition to any proprietary protocols.
- The relays shall have the following tools for fault diagnostics:
  - Fault record: The relay shall have the facility to store at-least 5 last fault records with information on cause of trip, date, time, trip values of electrical parameters.
  - Event record: The relay shall have the facility to store at least 75 sequence of event records with 1ms resolution.
  - Disturbance records: The relay shall have capacity to store at least 5 disturbance record waveforms with at-least 3s duration each.
- The relays shall have the following features:
  - A battery backed real time clock for providing accurate time reference.
  - Settings provided with adequate password protection.
  - Comprehensive self-diagnostic feature to continuously monitor the healthiness of all the hardware and software elements of the relay. Any failure detected shall be annunciated through an output watchdog contact. The fault diagnosis information shall be displayed on the LCD and also through the communication port.

- FOR I/C FEEDER:

  Numerical type relays with O/C, S/C and Earth Fault Protection:
  - 1 No – Over Voltage Relay
  - 1 No – Master Trip Relay VAJH 13 or equivalent.

    (ABB RE Series / Areva Micom-122 / Siemens 7 SJ 62).
- FOR O/G FEEDERS:

  Numerical relays with O/C, S/C and Earth Fault protection:
  - 1 No – Master Trip Relay VAJH 13 or equivalent.
  - Triple pole hand reset auxiliary check alarm relay type VAA-33 or eq.

    (ABB RE Series / Areva Micom-122 / Siemens 7 SJ 62).
- The Numerical Relays shall be provided with 1 Set of common support software compatible with both; Windows 2000 / XP which will allow easy setting of relays in addition to uploading of event, fault, disturbance records and measurements. The relay settings shall also be changed from local or remote using the same software.

➢ CONTROL WIRING

- The control wiring shall be carried out with 1.5 sq. mm. (potential) / 2.5 sq. mm. (CT) PVC insulated copper conductor cables.
- The wiring shall be securely fixed and neatly arranged to enable easy tracing of wires.
- Identification PVC ferrules shall be fitted to all wire terminals to render easy identification and facilitate checking in accordance with I S: 5578 and I S: 11353.

➢ CONTROL SUPPLY

The 'Control Supply' to the Panel Circuit breakers shall be made available through a 'POWER PACK' when the DC supply shall be at 110V DC or through a chargeable battery bank when the DC supply shall be at 24V DC (Ref BOQ).

DC POWER SUPPLY

DC Power shall be supplied through a set of Batteries and Battery Charger suitable to charge the battery and supply required DC power.

➢ DC BATTERY

- CODES AND STANDARDS (latest edition) :

- I S: 1146 : Rubber and Plastic container for Lead acid storage batteries.
  - I S: 1651 : Stationary cells and batteries, Lead acid type.
  - I S: 8320 : General requirements & method to test lead acid storage batteries.
  - I S: 1248 : Electrical Indicating meters.
  - I S: 694 : PVC insulated cables.

- TECHNICAL REQUIREMENT
  - A set of 15 series connected cells for a normal battery rating of 30V DC with 40Amp.Hr rating at 10Hr discharge rate shall feed DC power to the control circuit of the 11K V circuit breaker.

- Lead Acid storage Battery shall conform to the I S standard (latest edition) mentioned above.
- Battery rack shall be made of seasoned Teak wood; painted with 3 coats of anti-acid paint. Rack shall be free standing, rigid, mounted on porcelain insulators. Each battery cell shall be number tagged for identification. The out-going cable shall be clamped to the rack.

➢ BATTERY CHARGER

- It shall be able to feed continuous D. C. power for the fixed and impulse load and also float charge the connected set of batteries.
- The charger shall Boost -charge the battery at 2.15 V per cell and float -Charge at 2.75 V per cell. The charger shall be able to charge a fully discharged battery to a state of full charge in 8 Hrs. with 25% spare capacity.
- Manual control for coarse and fine voltage variation shall be provided. Float charger shall have built-in load limiting feature.
- Static type single phase full wave bridge rectifier with ripple limiting to 5 % to get smooth D C voltage shall be provided.
- Charger shall be provided with Out-put Voltmeter & Ammeter.

5.2.1.6. EARTHING

- The earthing of the breaker body and moving parts shall be arranged to earth the non-current carrying structure to the frame earth bar before the main circuit breaker plugs enter the fixed

house sockets.

- The entire panel board shall have a common tinned copper earth bar of suitable section with 2 earth terminals for effectively earthing metallic portion of the panels. The frame earthing of panel shall be in accordance with Section 7 of the I S specifications.

5.2.1.7. INSTALLATION

- The installation work shall cover assembly of panels lining up, grouting the units etc. In the case of multi panels switch boards, after connecting up the bus bar, all joints shall be insulated with HV insulation tape or with approved insulation compound. A common earth bar shall be run at the back of the switch board; connecting all the sections for connecting the earth system. All protection, indications & metering connections and wirings shall be completed.
- Where trip supply battery is installed, the unit shall be commissioned, completing initial charging of the batteries. All relay instruments and meters shall be mounted and connected with appropriate wiring. Calibration checks of units as necessary and required by the licensee like CTs, VTs Energy Meters etc. shall be completed before pre-commission checks are undertaken.

5.2.1.8. TESTING AND COMMISSIONING

Commissioning checks and tests shall include in addition to checking of all small wiring connections, relays calibration and setting tests by secondary injection method and primary injection method. Primary injection test will be preferred for operation of relay through CTs. Before HT panel is commissioned, provision of the safety namely fire extinguishers, rubber mats and danger board shall be ensured. In addition; all routine megger tests shall be performed.

Checks and test shall include following:

- Operation checks and lubrication of all moving parts.
- Interlock function checks.
- Continuity checks of wiring, fuses etc. as required.
- Trip test and protection gear tests.
- Insulation tests of secondary of CTs and VT to earth shall be conducted using 500V megger.
- The complete panel shall be tested with 5000V megger for insulation between poles and poles to earth.
- Any other tests as may be required by the Licensee / Inspector shall be conducted.
- Where specified, the entire switch board shall withstand high voltage test after installation.

5.2.1.9. QUALITY ASSURANCE

A detailed quality assurance plan shall be submitted indicating all activities step-by-step at various manufacturing/fabrication stages to meet the requirement of this specification and various standards/regulations/practices to enable comprehensive assessment of its merits and reliability.

5.2.1.10. PARTICULAR REQUIREMENTS FOR VACUUM CIRCUIT BREAKER

- Breaker type : Fully draw-out VCB, trip-free with shunt trip / closing coil, motorised spring-charged closing mechanism, operation counter and 4 N/O+ 4 N/C spare auxiliary contacts in addition to contacts necessary for functional requirements & interlocks.
- Voltage system : 12KV, 3 Phase, 50Hz.,
- Earth system : Unearthed
- Rated Short Circuit breaking Current (3 Secs.) : 25 / 40KA (Ref BOQ)
- Rated short circuit making current : 65.75 / 100KA

- Rating : 630-2000A (refer BOQ)
- Quantity : --- No. (refer BOQ)
- Use : To energise a Transformer.
- Breaker
- Duty cycle : O–0.3sec–CO-3min-CO.
- Insulation levels :
- PF withstand voltage (dry) : 28 K V r m s.
- Impulse withstand Voltage : 75 K V peak
- Operating Voltage :
- Trip coil (Volts) : 110 / 24 V DC (Ref BOQ)
- Closing coil (Volts) : 110 / 24 V DC (Ref BOQ)
- Spring charging motor (Volts) : 230 V AC
- Tinned copper bus bars with colour coding. : 1 Set rated for 630 A
- Flush mounted non-lockable breaker control - switch (pistol grip handle & spring return) : 1 No.
- Anti-pumping relay. : 1 No.
- Set of Lamps to show :
- Panel illumination : 1 No. lamp.
- Breaker ON/OFF indication : 1 set of lamps.
- Auto trip indication : 1 No. lamp.
- Spring charged indication : 1 No. lamp.
- `Trip circuit healthy' indication with Test push button. : 1 No. lamp
- Resin cast C T of (CL.1.0 / 5P10 accuracy) : 75/5-5A, 15A, 3 Nos.
- Single phase resin cast P T, Class 1.0 accuracy. : 11000/√3/110/√3V, 100VA/phase burden
- Combined digital meter comprising of Ammeter,Voltmeter, Tri-vector Meter &Frequency Meter. : 1 No.
- TP Non-directional IDMT relay: 2 O/C and 1 E/F with instantaneous units. : 1 No.
- Master trip relay : 1 No.

Cable termination box suitable for XLPE Al.

Armoured cable. : 3C x 150 Sq. mm.

Copper bus bar for earth. : 1 Set

5.2.1.11. TECHNICAL DATA SHEET TO BE FILLED BY VENDOR

S. No	Description	To be Filled by Vendor

1	IP Rating	
2	Indoor / Outdoor Type	
3	Operating Voltage	
4	No. of Panels	
5	Breaker – Type / Operation	
6	Fault Withstand Rating	
7	Type of Bus bars: Aluminium / Copper.	
8	Type of CTs for Metering & Protection - CT Ratio - VA burden - Accuracy Class	
9	Type of PT's & - Voltage Ratio	
10	Metering & Indications Details	
11	Details of Auxiliary Contacts & Annunciation Panel	
12	Type & Details of Relays	

Note: Provide Data Sheet for each panel i.e. Incoming & Outgoings.

5.3. L.T. Panel And Power Distribution Panels

5.3.1. L. T. PANELs / PLC Panels/ MDBs/ ACBs/ MCCBs

5.3.1.1. GENERAL

- All the LV switchboard: LT Panel / PCC / MCC / MDB / PLC-panel shall be of identical height and built by the repute authorised panel builders – OEM approved for TTA/ PTTA panels when kept in one place.
- LV Switchboards shall be certified by 3rd party Certification body as per IEC 61439-1. The Certifying Authority shall be qualified under ISO/IEC 17065 as per IEC 61439-1.
- Certified design of switchboards shall be proven design from OEM (Original Equipment/ Switchgear Manufacturer). OEM name should be mentioned on top of each column of switchboard. Also, OEM Partnership Certificate shall be furnished by Panel builder. Switchboards must have mechanical impact level of IK10.
- Design of LV Switchboard shall be such that Phase and Neutral busbars should be together in same compartment. Also, the Neutral busbar shall always be in front to ensure safety, even when covers are open.
- To enhance Sustainability, LV Switchboards shall have Green Premium Certification with eco production, with product design in accordance with RoHS & Reach directives and with End of Life Instructions.
- The LV switchboard shall be Totally Type Tested (TTA) as per the standards IEC 60439-1.

When main incoming switchgear rating are above 300Amp.

- The switchboard and the associated equipment including switchgear, control gear, bus-bar supports, bus-bar orientation, Bus-bar links etc. shall be identical in construction to the assembly which has undergone the type test.
- The drawings of the type-tested assemblies shall be made available for inspection.
- The TTA design of LV switchboard with Aluminium Bus-bars is mandatory for qualification. CU otherwise also acceptable as per OEMs recommendation.
- The enclosures shall be designed to take care of normal stress as well as abnormal electro-mechanical stress due to short circuit conditions.
  - All covers and doors provided shall offer adequate safety to operating persons and shall have ingress protection of IP 42 unless otherwise stated.
  - Ventilating openings and vent outlets, if provided, shall be arranged such that ingress protection of IP 42 is retained.
- The design shall have undergone Internal Arc tests for different types of feeders. Switchboards shall conform to IEC 61641: Internal arc containment for fault level of 65kA / 0.3s at system design fault level on HBB, VBB and cable chamber.
- Switchboards shall be manufactured & assembled only by the original manufacturer of ACB's, MCCB's or License franchisee & approved by the client. In any case the standard tested design of each compartment for fault level; got done by manufacturer of ACB/MCCB; shall be followed. To ensure this, the working drawings of Switchboards, as submitted by contractor for approval, shall be signed & stamped by the OEM of the tested design along with the letter of conformance.
- LT Panel / PCC shall be of draw-out / non-draw-out type (as per the 'specific Technical Requirement' / design / SLD), in multi-tiers arrangement with modular and compartmentalized construction. However, the ACB shall be draw-out type. The panel shall be lockable with key-lock (as required).
- A unique identifier QR shall be employed for each switchboard to enable quick access to switchboard details including but not limited to switchboard drawings, wiring diagrams, list of spares, Switchboard BOM etc. A maintenance schedule shall be provided by the manufacturer for switchboard and major components inside.
- Fire Suppression system shall be considered for electrical panels having i/c switchgear ratings of 630Amp and above.
- For operator safety IP2 X (Touch proof) protection shall be available even after opening the feeder compartment door. The switchboard shall follow the requirements of form 4B.
- For form of separation, only metallic covers shall be used, Hilum / PVC sheets shall not be allowed.
- The Panel shall be suitable for use on 415 Volts, 3 phase, 50 Hz electric power system with a fault current withstand capacity of specified value (KA rms. symmetrical).
- The Equipment shall be designed to operate 'Indoor' with high ambient temperature (50°C) with temperature rise limited to 35°C above ambient).
- All the equipment shall be suitable for satisfactory operation:
  - In tropical climates and dry dust laden atmosphere prevailing at site.
  - With automatic fire suppression with suitable approved gas system by engg. in charge.

- The switch-board shall accommodate the components as per respective single line diagram.
- Digital ammeter, Voltmeter & Phase (R, Y, B) Indication LED lamps shall be provided for In-comer feeder (invariably) and out-going feeders as per design /SLD.

5.3.1.2. STANDARDS

5.3.1.2.1 List of (latest editions) of applicable National / International standards, Electricity Rules and Regulations as follows:

- IEC 61439-1/IS: 8623 : General rules & Specification for Low Voltage Power switchgear & Control-gear Assemblies; Requirement for Type Test for TTA & PTA assemblies.
- IEC 60947/IS: 13947, 1993: General requirements of Switchgear and Control Gear for Voltage not exceeding 1000 / 1200V AC.
  - Part I : General rules
  - Part II : Circuit Breakers (ACB / MCCB)
  - Part III : Switches, dis-connector, switch dis-connector and fuse combination units
  - Part IV : Contactors and Motor starters
  - Part V : Control circuit devices and switching elements
- IEC 60529/IS: 2147 : Degree of Protection of Enclosures for low voltage switchgear.
- IEC 62262 : Degree of protection against mechanical impact shall be IK10
- IEC 61641 : Internal arc tests
- IS: 5082 : Electrolytic Aluminium Bus-bar, Trunking system, Rod tubes & sections for Electrical purposes.
- IS: 1897 : Specification for copper strips for electrical purposes.
- IS: 11353 : Guide for uniform system of marking & identification of conductors & apparatus Terminals.
- IS: 5578 : Guide for marking of Insulated conductors.
- IS: 6005 : Code of Practice for phosphating of Iron & Steel.

Panel shall meet all other statutory regulations including that of the local authorities.

5.3.1.2.2 INDIVIDUAL EQUIPMENT

Individual equipment mounted in the panel board; shall conform to the requirements of following I S Specifications (latest edition):

- IS: 13947-4-1 : A C Motor starter of voltage not exceeding1100V.
- IS/IEC: 60947-2, 2003 : A C Circuit Breakers not exceeding 1000 V
  : MOULDED case Circuit Breaker
- IS/IEC: 60898-1, 2003 : Miniature Circuit Breaker
- IS/IEC: 60947-4-1, 2003 : A C Contactor of voltage not exceeding 1000 V.
- IS: 13947-4-1 : Bimetal over load relays.
- IS/IEC: 60947-3, 2003 : Air brake SFU / FSU, not exceeding 1000 V.
- IS: 13703, pt-2, IEC 60269-2: Low voltage fuses
- IS: 694 & IS: 8130 : PVC insulated Cables for voltages up to 1100V with Copper and Aluminium conductor).
- IEC 61869-1, 2, IS: 2705 : Current Transformer.
- IEC 61869-1, 3 : Potential Transformer.
- IS: 1248 : Direct acting electrical indicating Instruments.

- IS: 3231 : Electrical Relays for Power system protection.
- IS: 13947 : Control Switches and Push Buttons.
- IS: 13010 : A C electro-mechanical meters.
- IS 13779 1999 : AC Electric Meters / Static Meters.

5.3.1.3. ENVIRONMENT CONDITIONS

The LV panel will be located indoors and designed to operate satisfactory at rated load under the service conditions as specified in the Project Requirements.

- Location : Indoor,
- Altitude above mean sea level: ≤500M above sea level.
- Design ambient temperature :45º C.
- Temperature rise : As per IEC 61439.
- Relative Humidity (Min/Max) :10% / 95%,Relative-humidity does not exceed 50% at a maximum temperature of + 450 C.
- Pollution : Up to Degree of pollution-3.

5.3.1.4. DESIGN ASPECTS

- The LV panel shall be of 'Total Type Tested (TTA) above 320A Rating. and others shall be Partially Type Tested (PTTA) type as per design. The LV panel:
  - When PTTA type, it shall be type tested as per the I S: 8623 standards for PTTA panel.
  - When TTA type, it shall be type tested as per the IEC: 61439-1standard for TTA panel and with automatic fire suppression with NOVEC 1230 or eqv. Approved gas system.
- The panel and the associated equipment including switchgear, control gear, bus-bar supports, bus-bar orientation, bus-bar links etc. shall be identical in construction to the assembly which has undergone the 'type test'. The drawings of the type-tested assembly shall be made available for inspection. The Panel shall:
  - Have 'short circuit withstand' capacity as per Schedule of Quantities and drawings.
  - Be designed for normal as well as abnormal electro-mechanical stress due to short circuit conditions. All covers and panel-doors shall offer adequate safety to operating personnel.
  - Have ingress protection of IP-42 unless otherwise stated. Ventilating openings and vent outlets, if provided, shall be arranged such that ingress protection of IP-42 is maintained (Test certificate to be provided).
  - Be inspected in OEM/franchisee's manufacturing facility.
    - Have undergone Internal Arc test (Test certificate to be provided).
    - Be tested for 'Seismic withstand' condition (Test certificate to be provided).
  - Be of the type-tested design along with ACBs and connections & shall be tested at an independent test house for short circuit, temperature rise, protective earth short circuit and dielectric tests of the ratings required (Test certificate to be provided).
  - Have necessary 'Earthing' arrangements for the ACB truck in the 'TEST' and 'SERVICE" positions. The earth connection shall 'make' before the main power and control contacts; 'break' after the power and control contacts are disconnected. Earthing connection shall have silver plated draw-out contacts.
  - Have the main incomer contacts shrouded with spring loaded safety shutters soon after the feeder module is withdrawn to ISOLATED position.

- Have all components like, circuit breakers, switches etc. compatible with the short-circuit levels.
- Have Bus bars of high conductivity Aluminium (E91E grade). Main bus bar and vertical bus bar shall be of same material or else in case of bi-metal, silver plating must be done at joints.
- Have all exposed live terminals in the cable alley and incomer terminals inside modules covered or shrouded. All barriers used shall be manufactured from fire retardant / non-inflammable & non hygroscopic materials of V0 grade. There shall be support arrangements made available for cables in the cable-alley.
- Have, for operator safety, IP2X (Touch proof) protection even after opening the feeder compartment door. The compartmentalization shall be achieved by using metal separators, use of PVC / Hilum sheets are not allowed.
- Be of 'single front' execution with maintenance access from front only where back access is not available.

5.3.1.5. CONSTRUCTIONAL FEATURES

5.3.1.5.1 L T PANEL / MDB:

➢ **FABRICATION:**

Switchboards shall be:

- Indoor type, metal enclosed, floor mounted (free standing), made up of requisite vertical sections coupled together to form continuous dead front board in Single front / double front configuration as required. CR Metal sheet shall be provided between the adjacent vertical sections running to the full height of the switchgear except for the horizontal bus-bar compartment.
- Switchboards construction shall employ the principle of compartmentalization and segregation for each circuit.
- With a rigid base (preferably of ISMC 100) to support the entire shipping section for floor mounting and/or on the suitable structural supports across the cable trench:
  - The front framed structure of rolled / folded sheet steel channel section of minimum 2 mm thickness; welded / bolted together; shall be mounted on the base frame.
  - The doors, made of CR steel sheet of min. 2 mm thickness, shall be hinged (concealed & removable) type. Front and rear doors shall be provided with dust-excluding neoprene or double lip type gaskets with fasteners or any improved type gasket; designed to ensure their proper compression.
  - Doors shall be provided with full gasket and a quarter turn lock such that the door presses the gasket; when locked; to make it dust-proof.
  - All fixing bolts, screws etc. appearing on the panel; shall be so arranged as to present a neat appearance.
- The metal work shall be degreased and cleaned of all dirt and rust using 7 or 9 tank process and passivated. Two coats of primer and two coats of finishing paint shall be applied to give a smooth finish. Alternatively, the degreased and cleaned metal work shall be powder coated in approved shade. The sheet metal parts shall be oven-baked after they are painted.
- Switchboard shall be readily extensible on either side, have modular vertical sections compartmentalized and arranged in multi-tier to accommodate components such as air circuit breaker, MCCB, switch–fuse and out-going feeders of various ratings along with their protection, control, measurement, indication & annunciation components as required.
  - Front access shall be available to all components in each cubicle which require adjustment, maintenance or replacement.

- The door sheet shall be 'machine pressed' with punched openings for meters e.g. Indication and protection meters (Protection relays, KWH meters, etc.) and indicating lamps may be mounted on front door.
- All relays, meters & switches shall be flush mounted.

o Switchboard shall be provided with anti-condensation space heaters, thermostat controlled & back-up protection (MCB) in each bay; rated for 240 Volts, single phase, 50 Hz. A. C. Power supply. The space heater shall be of 100 W rating (each). Cubicles shall be provided with LED lamps with control switches and suitable sockets.

o Switchboard shall have arrangement to carry out cable terminations:

- On the rear side of the panel in case of adequate back space; otherwise
- In the side cable alley of min. 250 mm. width to be provided for the purpose.
- Suitable arrangement for cable support shall be made inside the cable alley with removable gland plate of min 3mm thickness at a height of minimum 250 mm. from the finished floor.

o Single line power / control diagrams shall be placed in a pocket provided at the back of door in the panels with complete details as required

➢ **COMPARTMENTALIZATION**

o For compartmentalized switchboards, separate; totally enclosed compartments; shall be provided for horizontal bus-bars, vertical bus-bars, ACBs, MCCBs and cable alleys.

o The main board shall be with Form 4b Construction.

o Earthed metal or insulated shutters shall be provided between draw-out and fixed portion of the switchgear such that no live parts are accessible with equipment drawn out. Degree of protection within compartments shall be at least IP-2X / IP-54 as per design.

o Sheet steel hinged lockable doors for each separate compartment shall be provided and duly interlocked with the breaker in "ON" and "OFF" position.

o For all Circuit Breakers, separate and adequately sized compartments shall be provided for accommodating instruments, indicating lamps, control contactors and control MCB etc.

- These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, bus-bars and connections.
- Adequate space shall be provided for termination of Cables/Bus ducts for In-comer and Out-going sides of the ACB

➢ **BUSBARS:**

o Panel shall have a main bus bar chamber at the top/bottom as specified and the Earth Bus at the bottom. The space for the bus chamber and cable compartment shall be provided liberally for ease of termination and heat dissipation.

- Bus-bars shall be insulated with heat-shrink PVC sleeve and colour coded for ready identification of phases and Neutral. All the bus-bars shall be of same dimension & cross section throughout their lengths.
- The Bus-bar sizes shall be determined considering the continuous rating without exceeding the final temperature as permitted by IEC 61439; when carrying rated current and must be suitable for a fault level of xxx kA (1 sec).
- Each vertical section of the panel shall be fed through a set of vertical bus-bars; fed from the main horizontal bus and shall be of same metal as horizontal bus.
- The bus-bars connections and bus taps to individual feeders shall be by means of electrolytic Copper / Aluminium bus-bars of suitable size.

- Auxiliary bus-bars, each of minimum 25sq mm electrolytic tough pitch copper, shall be provided for following applications. (Exact number of bus-bars shall depend on various controls, metering and auxiliary power distribution requirements).
  - Panel / Motor space heater supply: 230V AC (2 wires).
  - AC / DC control supply for breaker tripping closing and indication circuits.
  - Control supply for breaker spring charging motors, closing coil & indication.
  - Control supply for motor starter control circuits.
- A continuous earth bar of size at least 50x6mm Copper, suitable for 30kA for 1 sec., shall be provided. The earth bar shall be electrically continuous and shall run the full extent of each board.
  - This earth bar shall be on the same side as the cable entry.
  - The two ends of the earth bus shall be provided with arrangement to terminate 'Body Earth' strips on each side of switchboard.
  - Each vertical unit of the Panel shall be constructed to ensure satisfactory electrical continuity between all metal parts; not intended to be alive and earth terminals of the unit.
  - The earth bar shall be accessible in each cable entering compartment either directly or through a branch extension; to earth the cable armour and shields.
- The bus-bars shall be supported at regular intervals using FRP, SMC or DMC insulators. It should have high Comparative Tracking Index (CTI > 600 as per IS: 2824 – Type test certificate to be submitted as required).
  - Only passivated high tensile strength steel bolts, nuts & washers etc. shall be used for all bus-bar joints & supports.
  - Minimum clearance between phases shall be 20mm and between phases / live parts / neutral to ground shall be 19mm except on the equipment terminals.

5.3.2. CONFIGURATION

- The Switchboard shall be configured with Air Circuit Breakers, MCCBs, MCBs and other equipment as called for in the schedule of quantities and Single line Diagrams.
  - The Air Circuit Breakers shall be arranged in Single or Double tier formation only; depending on the size; to facilitate operation and maintenance.
  - The MCCBs shall be arranged in multi-tier formation.
  - The Panel shall have modular compartments of standard width & heights to house all the electrical components of a feeder in one compartment as per the single line diagram.
  - Each module shall be labelled with permanent stickers.
  - All auxiliary equipment / components shall also be labelled and easily accessible on opening the compartment door.
- Equipment shall be mounted to ensure their vibration-free operation. Cable termination arrangement shall be provided for each feeder. Designation, as per the respective drawings, shall be provided for each equipment mounted in a module.
- The door of each feeder compartment shall be so interlocked with the handle of the equipment that the door can be opened only if the equipment is in `OFF' position. 'Defeat interlock' arrangement shall be provided for inspection.
- The Switch-boards shall be of adequate size with a provision of spare space to accommodate possible future additional switch gear

5.3.3. DIMENSIONS

- The height of the LT Panel shall not be more than 2400mm and other dimensions (W & D) not more than those given on the layout drawings.
  - Panels arranged side by side and in the same room; shall have the same height and shall be of same make.
  - The standard width of single panel with ACB shall preferably be 800mm and that incorporating MCCB / FSU / SFU shall be 400 mm (min).
  - The maximum and minimum height of the operating handles from finished floor level shall be 1800 / 250mm respectively.

5.3.4. INSTRUMENT ACCOMMODATION

- All voltmeter, ammeter and other instruments shall be flush-mounted type of size 96sq mm conforming to class 1.5 to IS: 1248 for accuracy. All voltmeters shall be protected with MCBs.
- Instruments and indicating lamps shall not be mounted on the Circuit Breaker compartment door. A separate and adequate compartment shall be provided for them. The instrumentation shall be accessible for testing and maintenance without danger of accidental contact with live parts of the switchboard.
- For MCCBs & Dis-connectors etc., instruments and indicating lamps shall be provided on the compartment doors.
- The current transformers for metering and protection shall be mounted on the solid bus-bars with proper supports.
- On all the incomers of Panel; ON/OFF indicator lamps suitable for operation on 230V AC supply, shall be provided. All lamps shall be LED based & protected by MCBs, suitably sized.
- For Incomer feeders; comprehensive power meters shall be provided to display:
  - A, V, PF, Hz, KW, KVA, KVAr, KWH, KVArh, MDI indication (average & maximum demand values),
  - THD (up to 31st order) on current and Voltage.
  - Meters shall be with LCD display with accuracy class 0.5 as per IEC 62053-22, Ethernet port and one RS 485 port, programmable contacts, analogue output etc. to link to BMS/SCADA/EMS system; as required.
- For <u>outgoing feeders</u>; comprehensive power meters shall be provided (as per IEC 61557-12) to display:
  - A, V, Pf, Hz, KW, KVA, KVAr, KWh, KVArh,
  - THD on current and Voltages (up to 31st order).
  - Meters shall display minimum and maximum values of basic parameters. Accuracy class of meter shall be 0.5. Meters shall be with Ethernet port & one RS 485 port, programmable contacts, analogue output etc. to link to BMS/SCADA/EMS system, as required.
  -

5.3.5. WIRING

- Inter-connection between the Vertical bus and the out-goings:
  - Of 100A & above rating shall be done by insulated Copper strips of suitable size.
  - Equipment below 100A rating shall be wired with insulated copper conductor with crimped lugs of suitable rating.

- The power wiring shall be connected to the vertical bus using pressure clamps, special washers, etc. The wiring shall be terminated by using crimping lugs and laid out neatly in bunches; firmly supported by the steel members of the panel.
- All wiring for relays and meters shall be with PVC insulated copper conductors. The wiring shall be coded and labelled with approved ferrules for identification. The minimum size of copper conductor for:
  - Control wires shall be 1.5sq. mm,
  - CTs shall be 2.5sq mm.
  - Power circuits shall be 2.5sq. mm.
- Runs of wires shall be neatly bunched and suitably supported and clamped. Means shall be provided for easy identification of wires. Identification ferrules shall be used at both end of wires. All control wires meant for external connections are to be brought out on a terminal board. The cables and control wires shall be suitable for withstanding 1050C.
- The 'potential circuits' shall be protected by MCB of suitable current capacity mounted near the tap-off point from the main bus. The wiring for instrumentation protection and control equipment shall be carried out with insulated flexible copper conductors.

5.3.6. TERMINALS

- All the control, instrumentation & protection wiring shall be provided with printed PVC ferrules of interlocking type at both ends.
- Suitable terminal blocks shall be provided to terminate control cables to the equipment in the panel and the terminals numbered for easy identification in accordance with IS: 11353.
- All wiring for external connections shall be brought out to the individual terminals on accessible terminal blocks. Clamp or screw type control terminal blocks shall be used.
- Minimum 10% spare terminals shall be provided for future use. Control terminal block shall be separated from power terminal blocks by means of an insulating barrier.

5.3.7. CABLE TERMINATION:

- All hardware (Bolts, Nuts & Washers) shall be galvanized / passivated.
- Lugs shall be provided with bi-metallic washers / plate; where required.
- ALL Feeders shall have Identification Plates (feeder No, 'I/C From' & 'Supply To').

5.3.8. SPACE HEATERS & ILLUMINATION

- Anti-condensation heaters shall be fitted in each cubicle controlled by a thermostat; together with an ON/OFF isolating MCB for circuit protection, suitable for electrical operation at 230 volts A.C, 50 Hz, single phase of sufficient capacity to raise the internal ambient temperature by 5O C. The electrical apparatus, so protected, shall be designed so that the maximum permitted rise in temperature is not exceeded if the heaters are energized while the switchboard is in operation. As a general rule, the heaters shall be placed at the bottom of the cubicle.
- Each cubicle shall be provided with adequate sized LED lamp with its control switch. The electrical power shall be tapped from the anti-condensation heaters circuit.

5.3.9. VENTILATION FANS

The Switchboard shall be provided with panel mounting type ventilation fans in each panel with switchgear rated for 4500 amp and above. The fan shall be interlocked with switchgear operation. The degree of enclosure protection to be maintained even with Fans.

5.3.10. EARTHING

Continuous earth bus sized for prospective fault current to be provided with arrangement for connecting to station earth at two points. Hinged doors / frames shall be connected to the earth-bus through adequately sized flexible braids.

5.3.11. SHEET STEEL TREATMENT & PAINTING

Sheet steel used in the fabrication of switchboards; shall undergo a rigorous cleaning and surface treatment; seven tank process comprising of alkaline-degreasing, descaling in dilute sulphuric acid and a recognized phosphate process after which a coat of primer paint with the final paint shall be applied over the treated surface. Final paint coat of oven baked powder coating, of minimum 50micron thickness of shade approved by Engineer-in-Charge, shall then be provided.

5.3.12. NAME PLATE

- The panel as well as the feeder compartment doors shall be provided with name plate giving the switchboard / feeder description as indicated on the drawings. Labels giving following details shall be affixed on each feeder panel:
  - Feeder No - As per feeder list
  - Equipment tag Number and Description
  - Rating (KW/KVA/AMP)
- The ‘name plate’ / labels shall be made of anodized aluminium with white engraving on black background.
  - All components whether mounted inside the switchboard or on the door; shall be permanently and clearly labelled with reference number and/or letter of their function.
  - Labels for feeder panel designation shall be fixed on the front side of respective panels with Special rivet made of nylon. These labels shall be of identical size to permit interchange

5.3.13. TESTING

Copies of type test carried out at ACB/MCCB manufacturers works and routine tests carried out at the switchboard fabricators shop, shall be furnished along with the delivery of the switchboards. Engineer-in-Charge reserves the right to get the switchboard inspected by their representative at fabricators works prior to dispatch to site to witness the following:

a. Physical variation and dimensional check

b. Verification of bill of material

c. Functional check

d. HV test

e. IR test

5.3.1.6 ELECTRICAL EQUIPMENT

5.3.1.7 AIR CIRCUIT BREAKERS (ACB)

GENERAL:

- The ACB shall be of the air-break type, robust and of compact design suitable for indoor mounting and shall comply with the requirement IS/IEC 60947-2. The ACB shall:

- Operate on 500V AC, 3 phase, 50Hz power supply system and shall have rupturing capacity of 50KA (RMS) symmetrical or as stipulated in 'Schedule of Quantities'.
- Be mounted in separate cubicle and will be of the same make to maintain the uniformity.
- Be of enclosed pattern, dead front air-break type with trip free operating mechanism.
- Be suitable for operation in extremely tropical humid climate at 50°C ambient temperature at its rated current. Both; nominal rating and de-rated rating at 50°C for each ACB inside the enclosure shall be clearly indicated.
- Have low heat loss per pole. Combined sequence test certificate from CPRI/ERDA shall be submitted.
- Shall have Ics = Icu = 100%, 65KA, Icw for 1sec. for short circuit breaking capacity & over-temperature protection feature based on microprocessor control with 4 NO/4NC auxiliary contacts.
- Have all 4 Pole with 100% rating.
- Provide class II / double insulation between the front panel and internal power circuits to avoid accidental contact with the live main current carrying path with the front cover open.

o The ACB shall comply with the isolation function requirement of IEC 60 947-2 section 7.12; suitable for isolation / disconnection for safety of operating personal while in use.

o The breaker Protective devices, metering, CTs, PTs, push buttons and indicating lamps shall be provided as per schedule of quantities.

CONSTRUCTIONAL FEATURES:

- The ACB shall be flush mounted dead front air-break type with trip free operating mechanism, metal clad, horizontal draw-out pattern; three/four pole as required and fully interlocked. Each Circuit Breaker shall be housed in a separate compartment enclosed on all sides (Cassette type).

o The ACB cradle shall be designed and constructed to permit smooth withdrawal and insertion with suitable arrangement for anchoring when in fully engaged or fully drawn-out position. The movement shall be free of jerks and easy to operate. Mechanical latch to be provided to identify the 'isolated, test & service' positions of breaker to prevent over racking.

o Main current carrying parts in the breaker shall be silver plated and suitable arcing-contacts shall be provided to protect the main 'moving contacts' which shall separate from the main 'fixed contacts' and shall be easily replaceable. Arc-chutes shall be provided for each pole, shall be easily replaceable and suitable for being lifted out for inspection of the main and the arcing contacts.

o The ACB shall have indication of mechanical wear of contacts enabling visible indication of contact life. The design of the breaker shall be such that all the components are easily accessible for inspection, maintenance and replacement.

o Self-aligning cluster type isolating contacts shall be provided for the ACB, with automatically operated shutters to screen live cluster contacts when the Breaker is withdrawn from the cubicle. Sliding connections including those for the auxiliary contacts and control wiring shall also be of the self-aligning type. The fixed portion of the sliding connections shall have easy access for maintenance purposes.

o ACB shall be fully draw-out type, unless stated otherwise.

- The cubicles shall be such that draw-out of the ACB is possible without disconnection of the wires and cables.
- The power and control circuits shall have self-aligning and self-isolating contacts.
- Mechanical latches shall be integrated in ACB at service, test and isolated position to ensure that the breaker is firmly latched in respective position. It shall not be possible to move the breaker from the position unless latch is manually operated.

- OPERATING MECHANISM
  - The ACB shall be 'trip free' with independent manual spring-operated or motor wound spring operated mechanism; as specified and with mechanical ON/OFF indication.
    - The breaker shall be provided with in-built anti-pumping mechanism.
    - The operating handle and mechanical trip push button shall be at the front of and integral with the ACB mechanical indicator on the front panel for 'Ready to close' operation.
  - The ACB shall have the following four distinct and separate positions which shall be indicated on the face of the panel:
    - "Service" : Both; main and secondary isolating contacts closed.
    - "Test" : Main isolating contacts open and secondary isolating contacts closed.
    - "Isolated" : Both; main and secondary isolating contacts open.
    - "Maintenance" : Circuit Breaker fully outside the panel; ready for maintenance.
  - ACB shall be with high accuracy CT`s which shall not saturate and measure fault current as high as 400kA. Preferably CTs shall be dual core (iron and air core).

CIRCUIT BREAKER INTERLOCKING:

Sequence type strain free interlocks shall be provided to ensure the following:

- It shall not be possible for the Breaker to be:
  - Withdrawn from the cubicle when in the "ON" position. Suitable mechanism shall be provided to lock the Breaker in the tripped position before the Breaker is isolated.
  - Switched "ON" until it is either in the fully inserted position or, for testing purposes, it is in fully isolated position.
  - Plugged in unless it is in the OFF position.
  - Raked in to `testing', `isolated' or `maintenance' position and kept locked in any of these positions.
- A safety latch shall be provided to ensure that the movement of the Breaker, as it is withdrawn, is checked before it is completely out of the cubicle, thus preventing its accidental fall due to its weight.
- Mechanical and electrical anti-pumping devices shall be incorporated in the ACB.
- The ACB shall be provided with a door interlock. i. e. door shall not open when circuit breaker is closed and breaker shall not be closed when door is open.
- The ACB will have switching 'ON' and 'OFF' time of < 4 cycles and will have the following interlocks for the safe operation of the equipment:
  - Breaker to be 'ON' only when mechanically locked in any of the three horizontal isolation positions.
  - When the breaker is in plugged in position, it will be 'ON' only with the front door closed.
- External Neutral CT for Earth Fault sensing shall be provided for all 3 pole ACBs.

CIRCUIT BREAKER INDICATIONS, AUXILIARY CONTACTS & AUXILIARIES

- The breaker will have following indications distinctly notable from outside:
  - Mechanical indicator for spring fully charged.
  - Mechanical indicator for spring discharged.
  - Electrical indication of trip circuit healthy.
  - Separate trip indication for overload and short circuit trip.

- Connected / Test / Disconnected Position (DO version).
- Contact position indicator (ON / OFF),
- Stored energy status indicator,
- OK Indicator (Mechanical) on the front panel of the Circuit breaker when the trip or OFF conditions are cleared and the Circuit breaker can be closed on “ON” command (Manual or Electrical, Unrestricted).

o Mechanical operation counter shall be provided for all ACBs.

o The Circuit Breaker shall have suitable free / minimum 6 NO/NC auxiliary contacts rated at 10 amps, 415volts, 50Hz. These contacts shall be approachable from the front for connecting external wiring. They shall close before the main contacts when the Circuit Breaker is 'plugged in' and vice versa when the Circuit Breaker is 'Drawn Out' of the cubicle.

o All electrical auxiliaries, including the spring charging gear motor; shall be installable on site without requiring adjustment or any tools other than a screw driver.

The auxiliaries shall be placed in a compartment which, under normal operating conditions, shall not contain any conducting parts capable of entering into electrical contact with the circuit breaker poles. It shall be possible to connect all auxiliary wiring from the front of the circuit breaker

6. DG SETS – PROVISION OF ESSENTIAL SUPPLY/STAND-BY POWER

6.1. SCOPE

The scope of this section consists of but not necessarily limited to the following:

o The contractor shall Plan, design & supply, deliver to site, hoisting into position, install, test and commission the standby power generating set together with the necessary controls and switchboards (set mounted) as specified. Protection circuits, control wiring and interlock circuits not specified or indicated in the Drawings, but deemed necessary for the safe operation of the generating system, shall be provided without any additional cost to complete the system.

o Provide manufacturer’s factory representatives’ services including coordination, start-up and testing supervision at site.

o Testing (factory and field), start-up supervision, training and providing necessary documentation and tools for operation.

6.2. SUBMISSION

- <u>FOR BIDDING</u>

The bidder shall submit offer with the following documents in two sets:

- Schedule of deviations from technical specifications.
- List of proposed makes for the items listed in the technical specification.
- Technical datasheets indicating overall dimensions & Catalogues of major items, highlighting the offered models.
- Overall GA drawing with Day oil tank details, residential silencer etc.
- Operation logic of the Standby DG set.

- <u>FOR APPROVAL BEFORE MANUFACTURE</u>

The bidder shall submit the following documents for approval in 4 sets for all the supplies:

o General arrangement drawings with all dimensions, showing:

- Space-requirements and civil works/foundation,

- Requirements of fixing and mounting facilities, connection devices, etc.
- Weights (for transport and service conditions).

o Electrical drawings, showing:

- Power and control single line diagrams,
- Functional/control multi line diagrams, terminal blocks,
- AMF/PLC control drawings as applicable.

o Components' list with make, type, quantity, etc.

o Detailed drawing of residential silencer,

o Quality assurance plan and bar-chart showing manufacturing schedule.

The bidder shall incorporate all comments and submit revised drawings in stipulated time till all drawings are finally approved for manufacturing.

- FOR FINAL SUBMISSION

The Contractor shall submit the following documents reflecting the as-built drawings in sets and one soft copy also:

- The drawings including wiring diagrams as revised and "as built".
- Inspection and preliminary test certificates, reports and shipping documents.
- Test certificates of kWh meters from Government approved Lab or Electric Supply Company of concerned area as required.
- Guarantee certificates.
- Instruction & maintenance manuels, Catalogues etc.
- Any other certificate / report as called for by the Client / Consultant.
- Structural support drawings with busducts / cable routing to panels etc.
- Supporting structure details for pipe lines of exhaust chimney etc. as per CPCB std.
- Layout details for HSD Tank yard in complete with motors and panels etc. as required.
- Pre delivery inspection (PDI) at factory premises shall be offered by the contractor prior to dispatch.

6.3. GENERAL

The DG Set shall be:

o Silent type conforming to the latest norms of CPCB-V, Govt. of India.

o Complete with Base, Diesel engine, Alternator, Fuel tank and Control Panel-all enclosed in a weather-proof Canopy suitable for mounting out-door, acoustically treated, to allow the D G Set function without the need to de-rate it.

o Functional in all respects and shall conform to the requirements of environmental controls and following technical specification:

o D G set when housed in a Canopy:

The DG set shall be housed in a canopy complete with a base frame, engine, alternator with all controls, in built oil-tank (as per OEM), breather system, radiator, exhaust system and cooling system to make the whole set fully functional in accordance with the latest CPCB II norms.

6.4. ENVIRONMENT

The DG set shall be suitable for operation under the following environmental condition:

- Environment : Hot, humid and dusty tropical.
- Ambient temperature : (+) 1 º C to (+) 50º C.
- Humidity : 100%; non-condensing.
- Altitude : ≤ 500M above mean Sea level.

6.5. DG SET CONFIGURATION

6.6. DIESEL ENGINE

6.6.1 DESIGN PARAMETERS

- The engine shall comply with the latest edition of I S: 10002 / B S: 649/5514 / ISO: 3046.
- The diesel engine shall be of silent type, vibration (within limits) specified as per ISO 8528-9 while in operation and comply with Center / State Pollution Control Board.
- It shall have industrial diesel engine, multi-stroke, multi-cylinder, compression ignition type, operating at a speed of 1500 rpm, turbo-charged with direct injection & water/air/external heat exchanger/ radiator cooled engine as required.
- The engine shall be capable of being 'Auto started and stopped' electrically.
- The engine shall be rated for prime duty, its engine cooling system designed for 50º C enclosed-limiting ambient temperature and capable of 10% overload intermittently for 1 hour in every 12hrs. running.
- The engine shall be complete with all accessories and auxiliary systems such as:
  - Radiator type engine with cooling fan,
  - Lubrication oil (lubricating oil pump, lubrication oil pressure gauge or microprocessor built-in display),
  - Air cleaning, 'breathing and exhaust',
  - Engine starting (complete with battery and its charger - dynamo regulator),
  - Fuel injection control and pumping systems (digital electronic type governor),
  - Engine speed regulation (digital tachometer) etc. complete with integrated hours-run recorder, over-speed trip and all other necessary auxiliaries so as to make the DG set operational and easily maintainable as a standby / base load station.
- The brake horse power of the engine with all attached accessories as specified; shall not be less than that which is required by the full load rating of the alternator at site operating conditions; taking into consideration; losses.
- A 'programmable stop delay' shall be provided to facilitate the generator to run on no-load for a reset-able period to cool it down.
- The engine with all accessories; shall be suitable to be enclosed in a Canopy to make it work silently (within permissible noise level and temperature rise as per latest CPCB norms).
- It shall be 'thermostat' controlled to facilitate the generator to start and operate at the required speed on full load within admissible time of power failure as per standards.
- The five critical components of the engine (i.e. Crankshaft, Camshaft, Connecting rods, Cylinder block & Cylinder Head) shall be covered under 3yrs additional warranty above the standard 2yrs warranty over complete DG set.

6.6.2 COOLING SYSTEM

- The radiator with expansion tank; shall be tropical (suitable for 45ºC ambient temp.) with engine-driven heavy duty, thrust type blower (cooling fan).

- The radiator shall be designed to function under hot, humid and not-so-clean atmosphere with normal dust and dirt accumulation on its fins and cooling surface.
- The coolant pump shall be belt / gear driven with thermostat and integral piping.
- Readily available coolant shall be used in the cooling system.

6.6.3 AIR FILTRATION AND EXHAUST SYSTEM:

- It shall be dry type air filter with replaceable elements.
- The exhaust shall have air-cooled manifold, residential type silencer, complete with flanges, stainless compensation bellows and elongated heat insulated piping.
- Adequately sized piping and fittings shall be installed to carry the engine exhaust discharge into the atmosphere at a height as per the requirement of Center / State Pollution Control Board or Pollution Control Committee (CPCB); as the case may be; without creating a back-pressure beyond the prescribed limit for the engine. With proper design calculation support.
- M.S. epoxy painted structural support and vibration arrestors for D.G. set chimney to specify along with drawing by the vendor for statutory clearance.
- Mufflers shall be installed to reduce the engine exhaust noise at the outlet of the exhaust pipe to muffle to noise level as permitted at site as per CPCB requirements. Flexible connection shall be provided between the engine and the fixed piping.

6.6.4 LUBRICATING OIL SYSTEM:

The engine shall be complete with a positive displacement engine-driven 'Lube oil pump' providing a positive force feed to all lubricating points, strainer, lubrication oil filter with replaceable elements, oil cooler and oil dip stick.

6.6.5 ENGINE STARTING SYSTEM:

- The generator shall be started through heavy-duty electric motor; powered by a 24V D.C. (2x12V) heavy duty chargeable battery of suitable AH (or as recommended by the manufacturer) & supplied complete with its mounting rack, charger and interconnecting cables to make the system complete. The battery charger shall be capable of operation taking electrical power either from the DG Set or external source.
- The generator shall be suitable for cold start, designed without any limitation on the number and frequency of starts in any given period.
- The electric motor shall be capable of cranking the engine to achieve the rated speed in less than 10 seconds from the initiation of the starting process. The electric start battery shall be of adequate capacity for 6 successive starts. Time delay relays shall be incorporated to provide a rest period of 1-5 seconds (adjustable) before each successive start and a time lag period of 19-100 seconds (adjustable) before the system lock out due to failure of the 3rd crank up of the engine to start.
- The generator set shall be provided with a micro-processor based control system which is manufactured by the engine manufacturer only - to provide automatic starting, monitoring, and control functions for the complete generator set including both; engine & alternator. Interface to BMS system according to point schedule on drawings shall be provided through RS-485 port as required.

6.6.6 FUEL INJECTION, GOVERNOR AND SPEED CONTROL:

➢ The control system shall include:

- An engine governor control, which shall function to provide steady state as well as transient frequency regulation.
- The governor control shall include:
  - Adjustments for gain, damping and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.
  - It shall be suitable for use in paralleling applications without component changes.

➢ The engine shall be fitted with:

- A governor capable of regulating the speed of the engine within the limits approximately 10% of the rated speed and maximum voltage dip of 10% within 6 seconds (G2 class governing as per ISO 8528 performance classes) due to:
  - A sudden application of 0 to 60% of full load in first step and
  - 60 to 100% of full load in next step or
  - Removal of total full load.

  The steady load speed shall vary within the limits of approximately 1% of the rated speed.
- Mechanical governor (up to 200 KVA) / Electronic governor (more than 200 KVA) suitable for class A-1 as per ISO: 3046 / B S: 5514 (latest edition) so that the power out-put is guaranteed within + 2% of its rated capacity,
- Fuel injector, fuel control solenoid and fuel lift pump with fuel filter.
- A heavy; dynamically balanced flywheel; suitable for constant speed governor duty.

6.7. ALTERNATOR

The alternator shall:

- Comply with latest edition of B S: 5000 (pt. 99) / I S: 4722 / IEC: 60034-1,
- Be directly coupled on to the diesel engine by flexible coupling and shall have continuous rated duty for site operating conditions,
- Be suitable to develop electric power at 415V, 3phase, at 0.8 power factor with neutral solidly earthed. The frequency shall be maintained at 50Hz at all times under any load condition including transient overload due to (load-side) motor starting etc.
- Be drip-proof, self-ventilated & screen protected with IP-23 degree of protection as per I S: 2147.
- Have the rotor-mounted main alternator field poles, brushless exciter and its rectifier module having self-regulating system.
- Have the rotor dynamically balanced up to 125% of the rated speed to minimize vibration with the shaft mounted centrifugal fan.
- <u>EXCITER</u>
  - The rectifier module of the exciter shall:
    - Be impregnated with epoxy resin,
    - Be capable of withstanding (without damage or deterioration) the thermal, centrifugal and other stresses experienced during normal / short circuit conditions.
    - Have Rectifiers of silicon type.
    - Have the non-hygroscopic winding of class H insulation impregnated with thermosetting insulated varnish to withstand tropical conditions.
  - A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and

controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of motor current for ≤ 10 seconds.

- AUTOMATIC VOLTAGE REGULATOR (AVR)
  - The automatic voltage regulator shall be directly coupled with the engine excitation system with:
    - Automatic voltage regulation of ± 1%, voltage adjusting potentiometer and
    - Under/Over speed protection,
    - Necessary equipment for field suppression and surge protection.
  - The voltage build-up shall be of self-excitation type; using the residual voltage of the alternator through a solid-state voltage regulator. The voltage regulator shall be capable of maintaining the voltage regulation to ± 1% independent of power factor, heating and 5% of speed variation. The voltage output of the alternator shall also be manually adjustable to ± 5% of the rated voltage.
  - The automatic voltage regulator and the exciter shall be manufactured to withstand 50% overload at a constant terminal voltage. The rated current of the main exciter shall be at least 10% more than the alternator rated exciter current and shall have 40% overload capability for 10 seconds.
- Have all accessories suitable to be enclosed in a Canopy to make it work silently (within permissible noise level and temperature rise).

6.8. MOUNTING ARRANGEMENT AND COUPLING

- Alternator shall be coupled by means of a flexible coupling and both shall be The engine and alternator shall be mounted on a common heavy duty, rigid fabricated steel base frame; constructed from standard rolled channel section.
- Adequate number of ‘anti-vibration mounting pads’ shall be fixed on the common base frame on which the engine and the alternator shall be mounted to save the foundation from vibrations created by the DG set.
- The engine and the mounted on the same base frame to ensure perfect alignment of the engine and the alternator with rigid construction to ensure minimum vibration.
- The coupling shall be provided with a protecting guard to avoid accidental contact with the moving parts.
- The base frame shall be provided with lifting facilities and pre-drilled foundation holes for permanent installation on pre-prepared concrete foundation.

6.9. ENGINE INSTRUMENT PANEL

A microprocessor-based instrument panel mounted on the engine shall be provided comprising of the following metering & protections:

- METERING
  - Engine Coolant Temperature
  - Lubricating oil pressure gauge
  - Tachometer, positive driven
  - Hour counter with hour totalizer.
  - Starting Battery Voltage.
- PROTECTION DEVICES

  Warning indication and automatic shut-down shall be provided for the following:

- Low oil pressure shutdown and alarm
- High coolant temperature shutdown
- Fail to crank shutdown
- Over cranking shutdown
- Over speed shutdown
- Low & high DC voltage alarm
- Low battery voltage alarm
- High and Low AC voltage shutdown
- Under frequency shutdown
- Over current alarm and shutdown
- Reverse Power and Reverse VAr
- Loss of AC current sensing
- Short circuit shutdown
- Earth fault alarm or through panel
- Overload alarm
- Emergency stop

- Failure audio-visual indication and alarm for all fault conditions shall be provided on control panel for restoring the operation to normal.

  The starting circuit shall be disconnected in the event of any of the above shutdowns.

6.10. PERIPHERALS WITH THE D G SET

6.11. ACOUSTIC TREATMENT

DG sets shall be provided with its own acoustic enclosure duly tested and approved for acceptable dB levels as per applicable latest norms of central pollution control board (CPCB-II). Suitable for outdoor applications.

6.12. FUEL TANK

A fuel 'day tank' (preferably suitable for 8Hrs running capacity of the DG Set/ 990Ltrs); shall be integral with the DG set. It shall be fitted with:

- Inlet, outlet connections,
- Air vent,
- Fuel filling arrangement with filler cap,
- Drain valve plugged, 'fuel connection' etc. integrated with the base frame.

6.13. BATTERY AND BATTERY CHARGER

- The battery shall be heavy duty, chargeable lead acid type; preferably sealed maintenance free (SMF) suitable for at-least 3 cold starts in quick succession; complete with all leads, terminations and stand.
- The battery charger shall be 'Float cum Boost' type Thyristor controlled; complete with:
  - Transformer of suitable rating (415V ± 10%, 3Phase, 50Hz ± 5%. / 230V, 1Ph, 50Hz)
  - Rectifier circuit,
  - Charge rate selector switch for 'trickle'/'boost' charge,

- DC ammeter & voltmeter, annunciation panel for battery charge indication: loading / failure etc.

- The battery charger shall:
  - Be suitable for DC load variation of 0-100%.
  - Have selector switch for Auto Float-Boost / Manual Float / Manual Boost Mode of operation. During Auto Float-Boost Mode, Automatic Changeover shall take place from Float-mode to Boost-mode and vice-versa - when the Batteries are fully charged; the charging shall automatically change from Boost-charge to Trickle-charge.
  - Boost-charge the battery at 2.15V per cell and float-charge at 2.75V per cell.
  - Be able to charge a fully discharged battery to a state of full-charge in 8Hrs. with 25% spare capacity.
  - Have Manual control for coarse and fine voltage variation.
  - Have the Float charging with built-in current limiting feature.
  - Have static type single phase full wave bridge rectifier with ripple limiting to 3% to get smooth D C voltage and
  - Have a voltage regulation achieved by a constant voltage regulator having fast response SCR control.
  - Be provided with Out-put Voltmeter & Ammeter.
- The battery charger shall function taking electrical power either from the DG Set or external source.

6.13.1 BATTERY CHARGER FUNCTION ON EXTERNAL SOURCE:

- Rating

AC Input	230 V + 10% AC 50 Hz single phase.
DC Output	To float / boost charge 180 AH batteries and also supply a continuous load.
Current Rating	30. Amps
Float Mode	27. V nominal (Adjustable) between 24-28.0 V.
Boost Mode	29. V nominal (Adjustable) between 24-32.0 V.
Voltage Regulation	% for AC input variation of 230V + 10%. Frequency Variation of 50Hz + 5% and DC load variation 0-100%.

- The battery charger shall perform the functions as mentioned above (Para 5.3).
- Housing

  The battery charger shall be housed in sheet steel cubicle of Angle Iron frame work with sheet steel panels of 1.6 mm thickness. Louvers shall be provided in the cabinet for the ventilation. The cubicle shall be painted in Siemens Grey shade RAL7032 of IS-5 or as specified. Four wheels shall be provided at the base for easy mobility.
- Components

  The battery charger shall essentially comprise of the following:

- 1 No. double pole ON/OFF MCB at AC input.
- 1 No. pilot lamp to indicate charger ON.
- 1 No. Main Transformer: Double wound, naturally air cooled, having copper winding.
- 1 set single phase full wave bridge rectifier consisting of 2 Nos. diodes and 2 Nos. SCRs; liberally rated; mounted on heat sinks and surge suppression device.
- 1 No. rotary switch to select auto-float / manual-float / manual-boost. During auto-float mode; automatic switch-over shall take place between float-mode and boost-mode.
- 1 set solid state 'constant potential controller' to stabilize the DC output voltage of the float cum boost charger at + 2% of time set value for AC input voltage variation of 230V + 10%, frequency variation of + 5% from 50Hz and simultaneous load variation of 0-100% complete with Current Limiting Circuit to drop the Float Charger output voltage upon overloads to enable the battery to take over.
- 1 No. electronic controller to automatically changeover battery charging from boost to float and vice versa.
- 1 No. DC ammeter and toggle switch to read charger output current and battery charge / discharge current.
- 1 No. moving coil DC voltmeter to read the DC output voltage.
- 2 sets of potentiometers to adjust the output voltage during manual/auto-float and boost-modes.
- 2 Nos. DP MCB at DC output, 1 No. for charger output and 1 No for load.
- 2 set DC output terminals; 1 set for the load and 1 set for the battery.
- Alarm annunciation: Visual and audible alarm with manual accept reset facility shall be provided for the following:
  - AC mains failed.
  - Charger failed.
  - Load / Output Over-voltage.

6.14. EXHAUST PIPE

- A suitable flexible connection shall be provided from the engine exhaust to the Silencer unit to reduce the engine exhaust noise at the outlet of muffler to a level as permitted at site as per CPCB requirements.
- The engine exhaust shall be taken above the near-by building(s) as per the latest norms of CPCB (or Pollution Control Committee as applicable) by using MS pipe of suitable diameter to avoid exhaust back-pressure and cladding the pipe with thermal Insulation; 75 mm thick Mineral Wool of density 64kg/m³ complete with wire mesh and 24gauge aluminium sheet cladding.
- The extended exhaust pipe shall be suitably supported taking support from the near-by building or by erecting suitable steel structure; epoxy painted as required at site for statutory clearance.
- Makes:
  - Al cladding LRB Insulation material : Lloyd Insulation/Sri Ram insulation/rook wool insulation.
  - Aluminum sheet make : Hindalco/Balco.

6.15. TERMINAL BOX

It shall be suitable for Busduct or A2XFY cables with generous spacing suitable for the size of the D G Set (as per design).

6.16. TOOL KIT

Complete Tool Kit for maintenance of the D G Set shall be provided.

6.17. INTERFACE WITH BUILDING MANAGEMENT SYSTEM

- All necessary hardware / software to integrate the Generator microprocessor panel to BMS system shall be provided by generator manufacturer / supplier.
- For the integration of Microprocessor panel of the generator with the Building Management System, an Interface Control Document shall be developed. It shall be responsibility of Generator Contractor to provide following (minimum) to BMS Contractor for preparing the interface.
  - Hardware Protocol of Microprocessor panel.
  - Software Protocol of Microprocessor panel.
  - Communication structure relating to collection of message / event information.
  - Description of the formatted packets / blocks of data which construct controller commands / responses.
  - Written permission to BMS contractor to develop the interface without any financial implication.

6.18. DOCUMENTS

The D G Set shall be supplied with

- D G Set test certificates.
- Engine Operation & maintenance Manual.
- Engine Parts Catalogue.
- Alternator Operation, maintenance & Spare parts Manual.
- Alternator test certificate.
- Set of drawings including wiring & circuit diagrams.

6.18.1 OPTIONAL ITEMS

Spares for 3 years' operation & maintenance.

6.19. ERECTION, TESTING AND COMMISSIONING

- <u>ERECTION:</u>
  - The RCC/PCC civil foundation shall be checked for its smooth finish and proper horizontal level. The foundation shall be 200mm above GL to avoid water ingress.
  - The DG set, complete with its weather-proof housing, shall be placed on the prepared foundation and check that the base sits squarely on the foundation without any gap due to undulations of civil foundation surface.
  - The engine exhaust shall be taken above the near-by building(s) as per the latest norms of CPCB (or Pollution Control Committee as applicable) by using MS pipe of suitable diameter to avoid exhaust back-pressure and cladding the pipe with thermal Insulation; 75 mm thick Mineral Wool of density 64kg/m³ with wire mesh and 24-gauge aluminium sheet cladding.
  - The extended exhaust pipe shall be suitably supported taking support from the near-by building or by erecting suitable steel structure; epoxy painted; as required at site for statutory clearance.
  - The earth pits, conforming to IS: 3043, latest edition, shall be prepared, preferably using copper earth plate / copper clad iron bar of 17mm dia. (UL listed) & 3m minimum length, surrounded by

chemical compound or using structural earth system as per NBC-2016 for sustained low earth resistance. The earth-connection shall be made for:

- Neutral point earth connection shall be connected to the Neutral terminal of the DG set using 2x40x4mm Cu strips.
- Body earth shall be connected to the two earth terminals of the DG set using 50x6mm GI strip (separate strip for each terminal).
- All the earth pits shall be inter-connected at (-) 1000mm from GL using 50x6mm GI strip / 40x4mm Cu strip.
- The earth resistance of the Neutral and for Body shall be as per the IS: 3043 and as acceptable to the inspecting agency.

o The Alternator shall be connected to the project electrical system (ACB /MCCB) using suitably sized XLPE cable(s) laid in a trench/pipe/directly buried/Bus-duct as required at site.

o The battery sets of the DG set shall be connected using a 2Cx4sq. mm YWY cable to an external battery charger fed from a separate source. This cable can be laid along with the DG power cable.

o The same procedure shall be repeated for additional DG sets. However, additional multi-core control cable may be used for control of the DG sets depending on the control scheme as required.

- <u>TESTING AND COMMISSIONING:</u>

o On completion of the installation,

- The site shall be cleaned of all unnecessary material.
- All hardware in the installation shall be checked for tightness. All electrical connections shall be checked for tightness.
- All lubrication, cooling agents and fuel shall be checked for their required quantities.
- Megger tests for all electrical items; alternator, cables, earthing etc. shall be checked.
- DG set shall be put on 'NO Load' and started.
- Any vibration or undue sound shall be checked.
- Built-up voltages, sequence and frequency of the power supply generated by each DG set shall be measured for correctness and adjusted as required.
- The DG set shall be run for a couple of hours and any abnormality observed before putting load on the set.

o All the necessary comprehensive tests shall be performed to the approval and satisfaction of the Project Manager at the completion of installation.

- The installation shall be complete and all of the preliminary testing and adjustment of the equipment to its proper running order shall have completed.
- The Contractor shall provide at his own cost; all materials including temporary electric power, instrument test set, HSD tanks fuel, lubricants and other consumable, adjustments of the equipment for carrying out the site tests and any re-tests that may be necessitated by failure of the installation or by any other causes within his control.
- During the testing period the Contractor shall appoint a qualified person to carry out the checking and testing including accurately calibrated test-equipment for checking the accuracy of gauges and instruments forming part of the installation.
- Prior to commencement of testing; a detailed list of the equipment shall be submitted to the Project Manager for his approval and no item on the list shall be removed from the site without his consent until the completion of testing.

- Sufficient notice of readiness to carry out site tests shall be given to the Project Manager.
- Prior to such notice; a detailed schedule of the tests to be carried out; shall be submitted to the Project Manager for his approval and alterations and additions to the schedule as required shall be made.
- Up on completion of all above tests, four (4) sets of the test results shall be submitted for the approval of Project Manager.
- No acceptance tests shall be carried out except in the presence of the Project Manager or their authorized representatives appointed for the purpose.

7. UPS FOR EMERGENCY LIGHTING

7.1. GENERAL

- This specification covers the design requirements of Uninterrupted Power Supply System for efficient and trouble-free operation in accordance with the latest revision of relevant standards.
- The UPS as a power solution, shall consist of the following features:
  - Three phase input and output.
  - High efficiency ≥ 96% from 30% load to 100% load.
  - Parallel Redundant configuration.
  - Fully rated Static Switch (STS).
  - Maintenance Bypass.
  - Battery units in a separate rack.
  - K13 Copper wounded in-built / external Isolation Transformer for galvanic isolation at complete output of the UPS system.

7.2. FEATURES

- The UPS shall be modular, ON-LINE, double conversion with Filter, stabilized and reliable voltage that is free from all mains interference (Over voltage, frequency variations, voltage drops). The UPS shall have IGBT rectifier and Inverter with Built-in Isolation transformer, LED-based remote-control panel & Communication software; ‘professional’ version with 30mins backup time or as specified. With N+1 configuration in parallel mode.
- For Advanced communication there shall be software system which displays the information such as the input and output Voltage, the load applied, the remaining back-up time, etc. It shall be able to provide information even in the event of a failure, to support the fault diagnostics.
- It should also contain the following hardware interfaces:
  - RS232 serial port.
  - Dry contacts.
  - EPO (Emergency Power Off).
- The UPS shall have Expandable feature. It shall be:
  - Connected in parallel up to 8 units to increase power availability or redundancy.
  - Expanded at any time. For the expandability, there shall be "Hot System Expansion" feature, the additional unit shall be connected in parallel while the other units are on-line and supplying regular power to the load.
  - On-line and will receive the updated information automatically.
- The battery cabinets used in the UPS shall be for longer run-time. The UPS shall have an in-built automatic battery test facility able to periodically check the efficiency of the batteries.

- UPS room shall be 'temperature controlled' for good efficiency of the equipment. The room shall be fitted with an 'Over temperature alarm' that can be adjusted between 26 and 42 degree C. This alarm shall be connected to the 'Control Room'.

7.3. CLIMATIC CONDITIONS

The UPS shall work under following climatic conditions:

- Ambient temperature : 0 to 50 degree C,
- Humidity : Max 95% at 25° C; Non-condensing.
- Cooling method : forced air with integral fans.

7.4. APPLICABLE STANDARDS

a) Safety : EN50091-1-1 / IEC 62040-1-1
: IS: 2147/IEC 60529 : Enclosure Protection
: IEC 60146 : Protection against AC-source over voltages.
: IEC 10004-5 level 4 : AC Surge Susceptibility

b) Emissions : EN/IEC 62040-2

c) Performance: EN/IEC 62040-3 : Uninterrupted Power Supply Unit- Method of the specifying performance and test requirements.
: ISO 9001 : Design procedures & quality controls.
: IEC 61000-4-2 : Electro-static Discharge Level 3, performance criteria B
: IEC 61000-4-3 level 2 : Continuous Electromagnetic Susceptibility, performance criteria A
: IEC 62000-4-4 level 2 : Electro-fast Transient Compatibility performance criteria

d) Certification for UPS : CE / UL Marked. :

7.5. OPERATIONAL PRINCIPLE / PHILOSOPHY

- Operational Requirements:
- The proposed Configuration are 5x100KVA UPS operating in Stand-alone/Parallel/Hot stand-by configuration with minimum 30 minutes backup time using sealed maintenance free battery as per design requirement.
- UPS shall be based on true ON-LINE, Double Conversion, VFI technology with advanced Insulated Gate Bipolar Transistors (IGBT) / Pulse Width Modulation (PWM) technology and Digital Microprocessor controls in all aspects.
- UPS shall be manufactured using IGBT or Intelligent Power Module (IPM) Transistors with high frequency (25 K. Hz) technology.
- The UPS shall have high speed switching, provide intelligent features like the drive circuitry, over-current protection, over temperature protection, control power failure protection and short circuit protection.
- Service by-pass shall be provided to permit easy maintenance.
- The main elements of UPS shall consist of:
  - Bi-directional UPS / Active Filter design Battery Charger (No SCR based charger)
  - Static bypass (via a static switch) for each unit;
  - Manual maintenance bypass for each unit
  - User and communications interface;

- D C input switch, Fault Indication devices & alarm system,
- A feedback protection device to prevent any voltage back feed in the upstream distribution board, thus ensuring the safety of the maintenance personal.
- The Power Factor Correction (PFC), standard on all modules, so that the input power factor level to 0.95 for any load percentages.
- There shall be built-in Active Filter designed to reduce the level of THDi to less than 4'%. With the effect of Active Filter; the UPS can also be connected to the low loads. These active filters shall be fitted inside the UPS so that no additional footprint is required.
- Any and all other devices required for safe operation and maintenance, including circuit breakers, switches, etc.

- The UPS system shall ensure continuity of electric power to the load within the specified tolerances, without interruption; upon failure or deterioration of the normal AC source (utility power) for a maximum protection time determined by the capacity of the backup batteries installed.
- On-line double conversion UPS system with galvanic isolation between the Utility Supply and the UPS output shall be provided.
- All UPS shall be capable to work in Hot Standby or Parallel Redundant configuration having:
  - Facility for individual or common battery bank as required.
  - There shall be redundant communication & control (Redundant signal cable between individual units).
  - The system shall allow hot insertion and hot disconnection of UPS modules without affecting loads.
- Upon restoration of mains AC power after a mains AC power outage and complete battery discharge, the UPS shall automatically restart and resume supplying power to the critical load and recharge the battery bank simultaneously.

7.6. OPERATING PARAMETERS

7.6.1UPS: INVERTER & CONVERTER

- UPS Output rating : 415V + 10% - 15%, 3 Phase, 50 Hz. ± 5%. Or 230V.
- <u>Input</u>
  - o Nominal Input Voltage : 415V + 10% - 15%, 3 Phase, 50 Hz. ± 5%.
  - o Wide Voltage window : 320-600 V. The system could able to operate at 600V for at least 1 minute.
  - o Input frequency : 50 Hz ± 10%
  - o Input power factor : The PFC rectifier shall correct power factor to 0.99 (@ loads > 40%) to unity and avoid reflected harmonics from disturbing loads sharing the utility power.
    : The rectifier output shall be filtered with a ripple current ≤ 1% rms over the continuous input voltage range.
  - o Input harmonic suppression : 12% (Max) harmonic distortion with nominal input and rated load on the UPS.
    : Third < 3% for 100% linear load
    : Third < 5% for 100% non-linear load
- <u>Output</u> :
  - o Output voltage : 415V, 3 Phase, 50Hz or 230Volts ± 1% (adjustable 220–240V), 1 Phase (Refer BOQ).

- o Output frequency : 50Hz ± 0.3 Hz
- o Voltage regulation : 1% at 100% load (steady state, ± 8% transient).
- o Overall Efficiency : > 90%
- o Over load withstand : 110% for 60 minutes,
  : 125% for 10 minutes with a
  : Maximum of 150% for 1 minute.
- o Max. voltage transient recovery time:
  - a. 20% load step change : +3%
  - b. 50% load step change : +3%
  - c. 100% load step change : +5%
- o Wave form : Pure sine wave
- o Crest factor : 3:1
- o Power Factor : 0.99 to 1.
- o Output harmonic distortion : < 5% in the 'Out-put Voltage'.
  : Single harmonic < 3%
- o Acoustic noise level : < 60 dba at a distance of 1 meter.

- Galvanic Isolation Transformer : To be provided at inverter output, inbuilt of UPS cabinet.
- Grounding : UPS A.C. Output Bus shall be electrically isolated from the UPS chassis and 'Utility system neutral'.
  : The UPS 'out-put' neutral shall be connected to a separate 'earth grid'.
  : The Neutral conductor size 1.5 times phase conductor.
- Cable Connections : Cu Cables.

7.6.2STATIC SWITCH (Integral bypass switch)

Static switch shall be equipped with an RC filter for protection against switching over-voltages and lightning strikes. In the event of over-load, over-temperature or inverter failure, the integral bypass switch rated for 100 percent continuous duty without mechanical contactor device in parallel, shall automatically transfer the critical load from the inverter to the bypass power supply with zero transfer time.

- Un-interrupted transfer :
  - Configuration : Fully rated, bi-directional type
  - Tracking range : ± 4%
  - Transfer time : < 4ms
- <u>Interrupted transfer</u> :

  If the bypass source is beyond the conditions stated below, the UPS shall make an interrupted transfer (not less than 100 milliseconds in duration in ECO mode):

  - Bypass voltage greater than ± 10 percent from the UPS rated output voltage.
  - Bypass frequency tolerance is user selectable to ± 0.1Hz, ± 3Hz and ±10Hz.
- <u>Manual transfer</u> :

Required, manual static transfer shall be initiated from the UPS control panel by turning the UPS inverter off.

- Maintenance : Make before break manual bypass switch

7.6.3 CONTROLS

The following controls shall be made available on the UPS:

- Set the alpha-numeric display language to English or the alternate language.
- Display time and date.
- Static bypass operation switch.
- Transfer to or from forced battery operation.
- Program the unit for 'economy operation'.
- Adjust the set point for different alarms.
- Calibrate metered parameters.
- Program the remote shutdown contact (enable/disable remote shutdown, polarity display).
- Set the delay for the common fault contract.
- Program the battery charger.
- Test battery condition on demand.
- Program the unit to periodically test battery condition.
- Program the Unit for soft start for use with a generator.

7.6.4 COMMUNICATION INTERFACE

- RS232 serial ports.
- COM-PORT with the following normally open or normally closed potential free contracts:
  - UPS on.
  - Static bypass operation.
  - Battery operation.
  - Battery low.

7.7. PROTECTION, ALARM, ANNOUNCIATION, & METERING

7.7.1. PROTECTIONS

- Back-feed protection (to be provided as standard feature).
- Output fully isolated from input.
- Output overload / Short circuit.
- Output under voltage / over voltage.
- Over-load & short circuit protection at input.
- Over temperature.
  - Battery Overcharge / Battery over voltage.
  - Battery low (dangerously drained) / Battery under voltage.
  - Electro-magnetic suppression to obviate distortion in computer operation.
- Surge protection (In-built) against under / over voltage, over current, lightening.

7.7.2. ALARM & ANNUNCIATION

Alarm annunciation shall be provided using either LED indicators or LCD display for depiction of fault conditions in the UPS system along with audible alarm. The system shall have 'accept', 'reset' and 'test' facility over separate push buttons. The annunciation system shall cover the faults described earlier for the entire UPS system including in the following:

- Overload
- DC over voltage
- Emergency shutdown
- Rectifier fault
- Battery low condition
- Mains failure
- Cooling fan failure (where provided)
- Fuse failure
- Static by-pass ready/fault
- Static by-pass inhibited
- Inverter fault
- Output voltage error
- Ups fail
- Short Circuit
- Battery Charging

7.7.3. METERING

- A C input voltage
- A C input Current
- A C out-put voltage
- A C out-put Current
- Battery Current (Zero center)
- D C Voltage
- Output Frequency

7.7.4. SOFTWARE CAPABILITY

The UPS shall be capable of:

- Communication with network operating system and
- Safe shutdown of critical load by means of auto shutdown software.

7.8. ENCLOSURE

- Free standing, dead front sheet steel enclosure with welded frame work to achieve an enclosure protection of I P 42 as per I S: 2147, cleaned of rust, dust etc. and painted with enamel / epoxy paint /powder coated - shade 631 of I S: 5.
- All instruments, status indications and controls shall be accessed from front.
- Forced air ventilation shall be provided to ensure proper design environment to all components.

- Ventilation openings shall be provided with suitable wire mesh to achieve required IP-42 protection.

7.9. SPECIFIC REQUIREMENTS:

7.9.1. RECTIFIER

- Each UPS shall include an active power factor corrected, Insulated Gated Bipolar Transistor (IGBT) rectifier.
- Input harmonic current suppression:

  The PFC rectifier shall produce a sinusoidal input AC current on each phase with:

  - Low harmonic content,
  - Limiting THD on the UPS input to below 3 percent @ 100% load.
- Battery charger current limiting:

  The UPS shall be equipped with a system designed to limit the battery recharge current:

  - 40% charger up to 80% load.
  - 20% charger 80% - 100% load.
  - Typical batteries re-charge time as per IEEE 485.
- Wide input voltage window:
  - 320-600 V.
  - The system can operate at 600 V for 1 minute.
- DC bus voltage shall be as per manufacturer's standard.
  - The DC bus voltage shall be compensated against temperature variations (Battery Temperature Compensation) to always maintain optimal battery float charging voltage for temperature excursions above or below 25°C.
  - DC ripple voltage shall be less than ± 1% of nominal with no battery connected.
- Pulse Width Modulation (PWM):
  - PWM Current control shall be used.
  - Digital Signal Processors (DSP) shall be used for all monitoring and control tasks.
  - Analog control shall not be acceptable.

7.10. INVERTER

- The inverter shall:
  - Consist of fast switching IGBT.
  - Be PWM controlled using DSP logic. Analog control shall not be acceptable.
  - Be fully rated.
  - Be with nominal output voltage of 415 V, 3-phase, 50Hz, 4-wire plus ground.
  - Be with Efficiency at full load: Not less than 96% from 30% load to 100% load
  - Be with Crest Factor: 1:3
  - Be provided with Remote Emergency Power off (EPO).
- <u>Transient Recovery:</u>

  The output voltage shall return to within ± 1% of the steady state value within 50ms.
- <u>Fault Clearing:</u>

- The inverter shall electronically be turned off to protect against excessive overload conditions which exceed the parameters defined.
- UPS systems shall sense an overload condition and automatically transfer to the bypass input source which shall be used to provide the necessary fault clearing current required.

o Inverter DC Protection:

The inverter shall be protected by the following features that shall be independently adjustable for maximum system flexibility:

- DC Over-voltage Trip.
- DC Under-voltage Shutdown.
- DC Under-voltage Disconnect annunciated by an internal visual alarm and relay contact closure.

o Output Protection:

- The inverter shall be electronically turned off to protect against overloads and abnormal load conditions which exceed the units rating.
- UPS systems shall sense an overload condition and automatically transfer to the bypass input source which shall be used to provide the necessary current required.

o Over-current Protection:

- The inverter shall be protected from excessive overloads, including reverse currents, by fast acting fuses to prevent damage to power semiconductors.
- All fuses shall have 'blown fuse indicator' with alarm indication on the control panel.

7.11. BATTERY & BATTERY CHARGER

The Battery room, if separately provided, shall be:

- Provided with ACID PROOF Epoxy floor covering.
- Extractor fans.
- Steel frame stands to support the batteries. The batteries shall be placed on Acid-proof painted wooden / PVC base, which in turn, shall be supported on steel structure. The steel structure shall be painted with epoxy based acid proof paint.

7.11.1. BATTERIES

The batteries shall be automotive / industrial tubular / Sealed maintenance free, lead acid type conforming to IS: 8320, 1982 (latest edition) and shall provide a back-up for the specified time for the declared output capacity of the UPS. (Refer BOQ):

o Battery Voltage : As per manufacturer recommendation.

o Minimum Battery Capacity : xx AH (refer BOQ)

o Battery Type : Maintenance free Lead Acid (refer BOQ)

o Backup Time : 1/2 Hr. (minimum)

o Battery bank inter-connectivity : When 2 or more UPS systems are working in parallel redundant mode, Battery banks shall be interconnected so that each battery bank can continue to serve for over-all battery backup time; if UPS system immediately connected to it; fails & rest of UPS system is working.

7.11.2. BATTERY CHARGER

Battery Charger shall be automatic, float-cum-boost charging type suitable for Current limiting, max voltage 2.33 volts per cell & as follows:

- Rated Input Voltage (AC) : 415 V (refer BOQ)

- Rated Frequency : 50 Hz
- Float Voltage : 2.2 V / cell
- Boost Voltage : 2.33 Volts / cell
- Setting Range of Output Voltage : ±10%
- With Battery in Parallel:
  - Output Voltage Variation (for 0 to 100% output current and 240 V ± 10 input voltage variation) : ± 1%
  - ±15% input voltage variation : 3 %
- Charging Current : 10% of AH of battery
- Ripple Current : 2mv max.

7.12. TESTS

- The manufacturer shall commence manufacturing only after the Drawings and QAP are approved by the Client.
- The system shall be tested as per the QAP at the manufacturer's works and at site. Battery back-up test on full load shall be shown at the factory and site as well.

7.13. DRAWINGS & DOCUMENTS

The following drawings and documents shall be furnished:

- o General arrangement drawing showing
- o Overall dimensions
  - Total Weight
  - Sectional View
  - Bill of Materials
  - Manufacturing Schedule & Test Schedule
- Calculation for Selection of Batteries for Back-up

7.14. SUBMITTALS

- o The following documents shall be submitted within 15 days from issue of letter of commencement of work.
  - Product catalogue sheets or equipment brochures.
  - System single-line operation diagram.
  - Tentative Bar Chart clearly indicating the various activities
  - Battery selection calculation.
- o The following documents shall be submitted on completion of the work:
  - Installation manual, which includes instructions for storage, handling and start-up of all systems.
  - User manual, which includes operating instructions.
  - As built equipment drawings.

8. INTERNAL ELECTRICAL WORK

8.1. SCOPE

- The scope shall include laying of concealed/surface mounted metallic/non-metallic conduit and its accessories, all type of wiring, provision of distribution boards, sub-mains/mains and fixtures of electrical and low current: telephone, TV and local area network (LAN) systems.
- Responsibility of the installer shall be to follow the NBC 2016 in terms of fire safety specially the clauses as mentioned here-under:

- Clause **3.4.7** : **F**or electrical installations "the shaft shall be sealed at every floor with fire stop materials having the same fire resistance as that of the floor…"
- Clause **3.4.6.5** : **F**or vertical opening, "every vertical opening between the floors of a building shall be suitably enclosed or protected."
- Clause **3.4.5.4** : Service ducts and shafts, "the space between the cables/conduits and the walls/slabs shall be filled in by a fire stop material having fire resistance rating of not less than 120 min…."

8.2. STANDARDS

- The electrical Installation shall be carried out as per latest edition of:
  - IS: 732-1989 & IS: 2274-1963 : Code of Practice for electrical wiring,
  - IS: 14772, 2000 : Specifications for Accessories for household and similar fixed electrical Installations.
  - IS: 3043: 1987 : Code of practice for earthing.
  - IS: 1646: 1997 : Code of practice for fire safety of buildings (general): Electrical installations.
  - National Electrical Code (NEC), India, 2011.
  - Indian Electricity rules & regulations, 1956.
  - Requirements of the Local Electricity Supply Authority and Fire Insurance regulations.
- Individual items shall conform to the latest edition of:
  - I S: 9537 Pt. II, 1981 : M S/G I ERW rigid steel Conduit pipes.
  - I S: 14768, pt.-II, 2003 : Steel conduit fittings & accessories.
  - I S: 9537 pt. III, 1983 : Rigid PVC Conduit pipes.
  - I S: 3419, 1988 : Rigid PVC Conduit accessories.
  - I S: 5133, pt.1, 1969 : Metal box for electrical accessories.
  - I S: 3854, 1966 : Switches for domestic and similar purposes.
  - I S: 1293, 1967 : Plugs and socket-outlets of rated voltages up to and including 250V and rated current up to and including 16A.
  - I S 694, 1977 : Wires for lighting.
  - I S: 8130 : Conductor for insulated electrical cable & wires.
  - I S: 2036-1994 : Phenol laminated sheet to grade P-I (approved shade).
  - I S: 732 : Circuit wiring for points.
  - IEC 61534-22. : Floor power socket system for adaptable power, data, audio & video distribution in screed floors.

- AISI 304 : Specification for Stainless steel material.
- EN 60 670 / EN 50 085-2-2 : Under-floor & On-floor ducting systems.
- DIN VDE 0634, Pt-1 & 2 : Tests for Under-floor electrical systems.

8.3. CONDUIT WIRING SYSTEM

8.3.1. INSTALATION OF CONDUITS AND ACCESSORIES

8.3.1.1. RECESSED / CONCEALED CONDUITS:

➢ **TYPES OF CONDUITS**

a) RIGID PVC CONDUITS

Recessed mounted conduit shall generally be made of rigid PVC though steel conduit can also be used for this purpose.

- They shall conform to I S: 9537, pt. III, 1983 (latest edition).
- The wall thickness shall be minimum 1.6mm for 20mm and 2mm for 25mm & above conduits.
  - Conduits, complete with their accessories of corresponding size, shall be supplied and laid as per NEC 2023 (latest edition).
  - Minimum size of PVC conduit shall be 20mm diameter.

b) STEEL CONDUITS

Recessed mounted conduit shall generally be made of rigid PVC though steel conduit can also be used for this purpose.

- They shall conform to IS: 9537 Pt. II, 1981 (latest edition).
- The wall thickness shall be minimum 1.6mm for 20mm up to 50mm conduits.
  - Conduits, complete with their accessories of corresponding size, shall be supplied and laid as per NEC 2023 (latest edition).
  - Minimum size of steel conduit shall be 20mm diameter.

➢ **ERECTION OF CONDUITS**

- Installation of conduits:
  - o Entire work of chase cutting in the wall, fixing the conduit and accessory in chases and filling the chase with cement mortar before plastering, shall form part of wiring work.
  - o Conduits shall normally be run in the wall (brick wall) with chase properly cut, ceiling and above the false ceiling.
  - o Conduits and accessories laid on walls, shall run either horizontally or vertically while those on ceiling / Floor shall be parallel or perpendicular to the meeting lines of the walls and ceiling / Floor.
  - o Open surface of the accessories shall be mounted flush with the wall. Suitable ventilating holes shall be provided in the inspection box covers.
  - o Wherever the length of conduit run is more than 10 meters, circular draw box shall be provided to facilitate wire drawing.
  - o Fixing of standard long bends and elbows shall be used for steel conduits and all curves maintained by bending the PVC conduit itself with the long radius to permit easy drawing-in of conductors.
  - o The chase of ample dimensions shall be neatly made in the wall to permit the conduit and its matching accessories to be totally embedded in the wall. The chase shall be filled with cement mortar (1:3 ratio), properly cured and surface finished as desired, with plaster. The open surface of the switch box shall be flushed with the plastered surface.

- In the case of building under construction, conduit and accessories shall be buried in the wall before plastering and finished neatly with only the open surface of the switch box flushed with the plastered surface. In case of exposed brick / rubble masonry work, the conduit and accessories shall be fixed in position along with the building work.
- When laid in a slab / ceiling before casting, the conduit and its accessories of corresponding size shall be put in the upper / lower portion of the slab depending on the direction in which it comes out of the slab (above / below the slab). The conduits and accessories shall be laid as per approved plan such that it is totally embedded in concrete. Only the opening of the accessories shall be flush with the concrete slab surface.
- It shall be ensured that the cement mortar does not enter the conduit & accessories at all.
- Under no circumstances the reinforcement bars shall be cut while cutting a chase.
- The conduit system of each circuit or section shall be completed, ensured that it has no blockade and thoroughly cleaned before insulated conductors are drawn in.
- The entire system of conduit; after erection, shall be tested for mechanical and electrical continuity (in case of metallic conduit system) throughout and permanently connected to the earthing system by means of special earth-clamps (approved type) effectively fastened to metal conduit pipe / metal boxes in a workman-like manner.
- Gas / water pipe shall not be used as earth conductor.
- The maximum number of PVC insulated 650/1100volts grade copper wires that can be drawn in a conduit (of various sizes), shall be as per IS Code/NEC.
- The size of the conduit and matching accessories shall be selected according to the number of wires that are required to be drawn in a conduit. Should more than permitted number of wires are required to be carried from one point to the other, parallel conduits of required sizes shall be laid.
- The size of conduit shall be such that the wires provided inside shall not occupy more than 50% of the cross-sectional area.
- The maximum number of wires, which can be drawn inside conduit, shall be as per the table given below as per CPWD specification for internal works -2013.

8.3.1.2. SURFACE MOUNTED CONDUITS

The surface mounted conduits shall be made of mild steel; black painted or hot dipped galvanized. Generally, the PVC conduits are not used when surface mounted.

➢ **Erection**

- Conduits and its accessories shall normally be run on the surface of the wall/column/steel structure and clamped using proper sized clamp and hard-ware as required at site. The clamps may need to be welded on the steel structure or secured otherwise as required at site.
- Conduits and accessories laid on walls, shall run either horizontally or vertically while those on ceiling shall be parallel or perpendicular to the meeting lines of the walls and ceiling.
- Wherever the length of conduit run is more than 10 meters, circular draw box shall be provided to facilitate wire drawing.
- Fixing of standard couplers, long bends & elbows and junction boxes etc. shall be done by making proper threads at the ends of the steel conduits to permit easy drawing-in of conductors. The length of the threaded portion shall conform to I S: 9537, pt.-II. The conduit shall be secured with suitable check nuts and lock-nuts when entering the junction box.
- The sharp edges and burrs in the joints of the conduits and accessories shall be totally avoided to prevent any damage to the insulation of the copper wires while drawing in to the conduit system.

- In the case of building under construction with exposed brick / rubble masonry work, the conduit and accessories shall be fixed in position along with the building work.
- The conduits and accessories shall be laid as per approved plan.
- It shall be ensured that the cement mortar does not enter the conduit & accessories at all.
- Under no circumstances the reinforcement bars shall be cut/damaged while fixing the saddles for the conduits.
- The conduit system of each circuit or section shall be completed, ensured that it has no blockade and thoroughly cleaned before insulated conductors are drawn in.
- The entire system of conduit; after erection, shall be tested for mechanical and electrical continuity (in case of metallic conduit system) throughout and permanently connected to the earthing system by means of special earth-clamps (approved type) effectively fastened to metal conduit pipe / metal boxes in a workman-like manner.
- Gas / water pipe shall not be used as earth conductor.
- The maximum number of PVC insulated 650/1100volts grade copper wires that can be drawn in conduit (of various sizes), shall be as per IS code/NEC. The size of the conduit and accessories shall be selected accordingly.

8.4. TRUNKING

8.4.1. SURFACE MOUNTED

- Pre-fabricated metallic trunking made of (minimum) 1.6mm thick G.I. Steel Sheet of minimum size 75x50mm, shall be used. The size of the trunking shall be as per the electrical drawing. Trunking shall be complete with its cover & fixing arrangement.
- Pre-fabricated PVC trunking made of PVC of minimum size 40x40mm; shall be used. The size of the trunking shall be as per the electrical drawing.
- Trunking shall be complete with its cover, partitions, Tees, angle covers, end pieces & fixing arrangement as required.
- Separate trunking systems shall be used for electrical and telecommunication circuits.
- Normally trunking shall be surface mounted above the false ceiling (when provided). Wires for any point wiring on the wall shall be run in surface / concealed conduits connecting the trunking to the outlet point.

8.4.2. FLOOR - DUCTS / CONCEALED TRUNKING (Screed covered)

- Pre-fabricated floor ducts made out of (minimum) 2.5mm thick sheet steel in one / multi-compartments (as required), complete with Junction Boxes and Service Boxes made of 3mm. thick M. S. sheet and screed covered, shall be used to carry the electrical / communication insulated wires in the floor.
- The sheet steel shall be properly cleaned, degreased and painted with 2 coats of primer followed by 2 coats of synthetic enamel / epoxy paint of acceptable quality. Alternatively, powder coated sheet may be used.
- Pre-fabricated floor ducts made out of PVC, complete with duct connectors, vertical connection box, fastening clamps, vertical & horizontal bends as required under the screed cover shall be used to carry the electrical / communication insulated wires in the floor.
- The floor duct of required size shall be embedded in the concrete / mortar in the floor.
  - Wires shall be taken out of the floor through Junction / Service boxes.
  - The cover plate of two sections of floor duct shall be butt jointed & shall not be over lapped.
  - Wherever there are 90^0 Bends, T Joints and Cross Joints; bends/joints of standard size shall be used (avoid sharp bends) so that wires can be drawn comfortably.

- The joint section shall be covered to protect the cables and wires from ingress of dust, vermin etc.
- The duct shall be supplied in standard lengths of (say) 2,500mm with suitable coupler and end plates as required to make the duct way complete.

8.5. OUT-LET BOXES & COVERS

- The outlet boxes shall conform to I S: 5133, Pt. 1, 1969.
- The switch box shall be made of metal sheet covered on all sides except on the front. Mild steel box shall be hot dip galvanized/passivated. M.S. box up-to 200x300mm size shall have wall thickness of 18 SWG and above 200x300mm size, 16 SWG.
- The non-galvanized metal boxes shall be painted with anti-corrosive paint after surface treatment to remove rust and dust, before erection.
- Clear depth of the box shall not be less than 50mm.
- Outlet box shall be provided with earth terminal. All fitting shall be installed in flush pattern.
- In case of modular configuration, switch/socket shall have their own grid & top plate. In such a case, the outlet box shall be sized accordingly.

8.6. MODULAR SWITCHES & SOCKETS

- Switches shall conform to I S: 3854, 1966 (latest edition). They shall be piano key type suitable for 240volts A.C. Minimum rating of the switch shall be 5Amps.
- The switches/sockets shall be modular unless specified otherwise, in which case the switch plates shall also be modular.
- Domestic type sockets shall conform to I S: 1293, 1967 (latest edition).
- 5Amp socket shall be 3/5 pin type whereas 15Amp socket shall be 3/6 pin type. For heavy duty, industrial type plug-sockets may be used.
- Switches, Sockets, Telephone out-lets, TV outlets etc. shall be flush type in off-white finish unless specified otherwise.
- The switches controlling the lights/fans/socket outlets; shall be connected to the phase wire of the circuit, never to the neutral.
- For HPMV/HPSV lamps the minimum size of switch shall be 10Amps.
- Modular switch-sockets and other out-lets shall have their own grid plates. The grid plates (shall be metallic) and mounting boxes shall be selected suitably. Unused space in the grid-plate shall be filled up with blanks; specifically made for the purpose.

8.7. WIRING

8.7.1. CODES AND STANSARDS [Latest edition]

- I S: 694, 1990. : PVC insulated solid / stranded copper conductor unsheathed wires of 650/1100Volts grade.
- I S: 1554 pt. I, 1988: Single/multi core Al. Conductor sheathed power cables of 1100Volts grade.
- I S: 8130, 1984 : Conductor of annealed, stranded Cu / Al of high conductivity.
- I S: 5831, 1984 : PVC insulation compound: type-A; Sheath PVC compound: type ST-1.

8.7.2. WIRE SIZE

- All internal wiring shall be carried out with (all I S to be of latest edition):
  - 1100V grade PVC insulated unsheathed single core wire:

- With high conductivity plain annealed electrolytic grade solid / stranded copper conductor (*class-2 as per I S: 8130*). *Stranded copper conductor as per class-5, I S: 8130 shall not be accepted*.
- Insulated wire as per I S: 694 (latest edition).
- The current rating shall be as per I S: 3961 (pt.-V),
- PVC insulation: type A as per I S: 5831, 1984.

o Wiring shall be carried out with following sizes of PVC insulated stranded single core copper conductor wire:

- Light/Fan/5 A plug point – sub main wiring	:	2.5Sq mm
- Light Point wiring	:	1.5Sq mm
- Plug Point (5A Switch/Socket. outlet)	:	2.5Sq mm
- General Power Point (15A Sw/socket)	:	4.0Sq mm
- Power Point for A. C/geyser above 1.0 kw	:	4.0Sq mm.
- Any other service	:	As indicated

o Cable conductor size and material shall be as specified in design.

o When the electrical load calls for more than 10Sq.mm. wire size, suitable size of cable (XLPE insulated) shall be used. The voltage drop and the derating factor shall be taken in to account while considering the cable size. Depending on the site requirement, these cables shall be armored or unarmored, and run on cable tray/saddled on civil structure/directly buried in ground, etc.

o Maximum number of PVC insulated 650/1100V grade copper conductors through a given size of the conduit, shall be as per NEC 2023.

8.7.3. CIRCUIT and POINT WIRING

o The circuit wiring for points shall be carried out in loop-in system and tested as per IS: 732, also conforming to the NEC 2023 (India).

o No joint shall be allowed in the length of the conductors.

o Circuit wiring shall be laid in separate conduit originating from distribution board to switch board for light/fan/5A switch-socket.

o A light / fan switch board may have more than one circuit but shall have to be of same phase. Looping circuit wiring shall be drawn in same conduit as point wiring.

o Each circuit shall have a separate neutral wire. Neutral looping shall be carried out from point to point or in light/fan switch board.

o A separate earth wire shall be provided along with circuit wiring for each circuit.

o Circuit wiring shall be carried out with PVC insulated wire:

- Red, yellow or blue color	:	for R, Y, B phase respectively
- Black color	:	for the neutral.
- Green or green-yellow	:	as earth continuity conductor

o Earth continuity conductor shall be drawn along with other wires for each circuit.

o No wire shall be drawn into any conduit until all work of any nature, that may cause injury to wire, is completed. Care shall be taken in pulling the wires so that no damage occurs to the insulation of the wire.

- Before the wires are drawn into the conduit & its accessories, they shall be thoroughly cleaned of moisture, dust and dirt.
- All joints shall be made at terminals of switches, distribution board, socket and switch boxes only. No joint shall be made in conduits and junction / draw boxes. Conductors shall be continuous from outlet to outlet.
- Single phase sub-main shall have single earth wire whereas three phase circuit shall be provided with two earth wires.
- When drawn out-side the conduit, the earth wire of proper rating shall be fixed to metallic conduits by means of suitable M. S. clips at not more than 1000 mm distance and to the earth terminal of outlet boxes.

8.7.4. INSTALLATION NOTES

- Point wiring (lighting) shall commence from out-let of MCB in Light distribution board (including sub-switchboards) up to the light/fan/exhaust fan point. It shall include all conduits with accessories, metallic switch box of suitable size, switch, 5A switch socket, light point outlet box, wire connector (ceiling rose), all wires (P + N + E) as required duly installed and connected.
- Point wiring (Power) shall commence from the MCB outlet in Light distribution board (including sub-switchboards) up to the power switch socket. It shall include all conduits with accessories, SW & socket outlet boxes, all wires (P + N + E) and the 15Amps Switch socket as required duly installed and connected.
- Light, fans & 5 amps switch-sockets may be connected to a common circuit with a total load not exceeding 800 Watts or 12 points - whichever is less. Circuit wire shall be 2.5sq mm Cu & point wiring of 1.5sq mm (Cu).
- Each lighting circuit shall be controlled by a 6/10Amps SP MCB and each point shall be controlled by its own switch unless otherwise specified.
- Each of the 15Amp. Switch socket shall be controlled by ‘16Amps SP MCB’. In case an additional 15Amps switch-socket is used only to facilitate alternative use of gadget but does not substantially add to the load, use of such additional switch-socket is permitted. 2x15Amps switch-sockets shall be controlled by 1x20Amps S P MCB in the D. B.
- In case of 5Amps switch-sockets connected to the UPS system, one 10Amps SP MCB may control up to 4nos. switch sockets.
- Each ‘ceiling fan point’ shall have provision to mount the ceiling fan with ‘S hook’ and fan regulator in the switch-board which shall be effectively connected to earth. The ‘solid state regulator with steps’ shall be used for fan.

8.7.5. TELEPHONE WIRE / CABLES

- Separate conduits shall be provided for internal wiring of telephone system commencing from IP EPABX to switch to telephone out-let.
- Each telephone outlet shall be wired with CAT 6A telephone cable from the switches.
- Telephone wires shall be of 0.61mm diameter (minimum) annealed, tinned high conductivity single strand copper conductor, hard grade;
- Internal Telephone wiring in conduits shall be carried out in 25mm diameter conduit or DLP trunking of suitable sizes.
- Multi-pair PVC insulated cables laid in conduit, shall be provided for connecting various tag blocks.
- Telephone cables used for external connections shall be armored when laid directly in ground or unarmored when laid in pipe etc. as called for in the Drawings / BOQ.

8.8. INSTALLATION NOTES

- All electrical installation shall be done as per latest editions of I S: 732, 1963 and National Electrical Code (NEC) 2023.
- Earth-pit shall be made as per I S: 3043, 1966 (latest edition).
- Main Distribution Board (MDB) shall be installed surface mounted on the wall. Top of the MDB shall be 2000 mm above finished floor (FFL) unless specified otherwise.
- The Fire Doors for all the rooms facilitated for electrical panels, MDBs, AHUs, Server Data center, BMS etc. shall be fire resistant for min 4.0 Hrs. for other rooms shall be for 2.0 Hrs as per NFPA guidelines.
- Light Distribution Board (LDB) and Air conditioner Distribution Board (A/C BD) shall be installed recessed or surface mounted on wall as specified. Top of the LDB & A/C BD shall be 2000mm above FFL.
- Light switches shall be installed 1200mm above FFL (top of rocker).
- 16/5amps Switch-sockets shall be installed above the floor Skirting (Bottom of SW plate) / 230mm from FFL. However, SW-socket in the kitchen and Toilets shall be installed 1200mm above the FFL (top of switch plate). 150mm above counters or benches as per requirement unless otherwise specified.
- 5Amps Switch-sockets shall be installed above the floor Skirting (Bottom of SW plate) / 300mm above FFL (top of switch plate) unless specified otherwise.
- Each power circuit in building can feed following outlets:

  Not more than 2 No. 16A outlets.

  Not more than 4 No. 6A outlets.

  Not more than 1 No. 16A and 2 No. 6A outlets.

  Not more than 1 No. 25A outlet. (Geyser/AC)
- Wall mounted luminaires shall be installed 2250mm above FFL unless specified otherwise.
- Conduit runs shall be either horizontal or vertical in the walls (surface mounted). When run concealed in ceiling / floor, conduit shall be embedded in the concrete such that there is a cover of approx. 10mm of concrete over the conduit. The joints in these conduits shall be threaded to avoid opening under mechanical pressure. Concealed/ inside slab conduiting shall be avoided. Apart from Staircase, equipment rooms.
- Size of Sub Distribution Board (SDB / UPS-DB) and enclosure of sheet steel with double doors shall be as specified with number of poles with Neutral in-coming MCB / RCCB of specified sensitivity. SDB shall be of reputed make as approved.
- All internal electrical works shall be carried out with MS conduit. All switches, sockets, AC Starter, IP Phone socket, Data sockets, stepped type (2 module) fan regulators, bell push and accessories along with matching mounting boxes shall be of modular type. Power point for computer outlet shall have 3 sockets and 2 switches in one box.
- All mounting boxes for plate type accessories shall be of metallic construction and of the same make as that of the plate type switches and accessories.
- The fireproof cable penetration (FPCP) sealing system shall be used, conform to the requirement of latest edition of NBC including amendments of BS:476 Part-20 Fire tests on Building materials and structures.
- All lighting fixtures (internal, street, pathways etc. should be LED type having efficacy more than 120 Lumen/ Watt, except for any outdoor landscape or façade lights for which efficacy shall be more than 100 lumen/watt and CRI >80, THD <5%, LM 79 & LM 80 test report, from NABL or EN/ UL accredited lab should be submitted by the agency. Colour temperature may be

3000/4000/6000K as per site requirement. The External light shall be of IK 8~10 & IP 66 rating fitting & driver. And any waterbody lights shall be of IP68 with IP68 driver also.

- Lighting Design should be carried out as per National Lighting Code 2010/NBC/ECBC guidelines. Wherever range of illumination for space is mentioned, higher side of Lux level must be taken for design purpose.
- Ceiling fans will also be provided everywhere except stairs/ toilets/ Bath rooms/Air-conditioned areas. Only BLDC type ceiling fans of size 1400/ 1200 mm shall be used. Optimum size and number of ceiling fans for rooms of different size shall be as per provision laid down in NBC 2016.
- Wiring with Cat 6A for Intercom / Telephone shall be terminated in suitable size of G.I. Junction box and RJ-45 socket. All the other end of wiring shall be terminated in Patch panel including rack of each floor and in the EPBAX room. The wiring shall be suitably tagged/marked mentioning the location of each point. The fiber optic (OFC) cable shall be used for inter connection of floor networking switches, server room etc. The patch panels patch chords and layer 2 and layer 3 switches, Core switches etc. are in complete scope of work.
- Wiring for CCTV/ Access Control in MS conduit with Cat6A also shall be provided as per the design and is to be terminated in G.I. Junction box.
- Lights shall be controlled by passive infrared occupancy sensors in basement Parking areas, common lobbies, passages, Toilets, Staircases etc. but not for the emergency circuits.
- UPS DBs shall be separate. The size of DBs at one location shall be same, irrespective of number of circuits connected from the DBs.
- The wiring and conduit route plan/shop drawings shall be submitted by the contractor and shall be got approved from the Engineer-in-charge.
- To facilitate drawing of wires, 14 SWG, 2.0mm GI fish wire shall be provided in recessed conduit. Conduits laid for other services, like fire alarm, PA system, ELV works etc., where wiring is not done along IEI works, fish wire shall be invariably drawn.
- The connection between incoming switch / isolator and bus bar shall be made with suitable size of thimble and cable.
- Power supply to DBs located in lift machine room or at any suitable location, shall be done using suitable XLPE insulated armored cable. Supply of cable shall be in the scope of work.
- Size of distribution board shall be as per number of lights / power circuits. All distribution boards shall be double door type. RCBO of suitable rating shall be provided as main incomer in all DBs.
- Load Balancing of circuits in three- & single-phase installation shall be planned and shall be checked by the Contractor before the commencement of wiring and shall be strictly adhered to.
- Color code shall be maintained as indicated as per Code requirement for the entire wiring installations. Red, yellow, blue shall be for three phases, black for neutral and green shall be for earthing. Ferruling shall also be done properly.
- LT panel shall be cubicle type with IP 42 protection class and fabricated from approved fabricator as per accepted list attached and shall be equipped with digital type measuring instruments like ammeter, voltmeter, frequency meter, watt meter, multi- function, dual source energy meter etc. as per drawing approved by Engineer – in – charge.
- Each floor Panel shall be fabricated from 2 mm thick M.S. sheet powder coated with 7 tank process and shall be equipped with 4 pole MCCBs, MCBs, Bus bar, digital multifunction meter, LED indicating lamp extended rotary handle and all accessories as required.
- MCCB, if used as incomer then it should have earth fault protection and time delay. Earth leakage modules are not acceptable.
- Inside the lift shaft there shall be arrangement of one light point at each floor level and one light point at overhead top, & one light point in lift pit. All light points shall be in group controlled and

wired with 2.5 sq mm FRLS copper wires. 15-amp power plug and 5-amp power plug shall be provided at each floor level. Wiring of these power plugs shall be done with 4.0 sq mm FRLS copper wires. LED Bulk head fittings of suitable rating to provide inside shaft. Average 100 lux shall be planned with each light point of lift shaft.

- The breaking capacity of MCCB for all types of panel boards except DBs shall be as per fault level of that location. The rated service breaking capacity should be equal to rated ultimate breaking capacities (Ics=Icu=100%). Where Ics is service breaking capacity and Icu is ultimate breaking capacity and they should be of approved make. MCCBs above 200A of 35 /36 KA breaking capacity rating shall be provided with microprocessor relay with suitable fault level with adjustable O/L, S/C, protection and upto 200A with Thermal Magnetic release of suitable fault level having adjustable settings for O/L and S/C.
- Rising mains: Upward transmission of power inside the buildings shall be done with the sandwich compact type rising mains with busbar i/c all accessories i.e adapter box, cable end box, tap-off box with MCCB. Rising mains shall be provided separately for Generic & UPS loads. Both rising mains shall be planned with 50% loading only. 100% capacity shall be kept for future flexibility or in case of any emergency. Rating of rising mains shall be decided as per maximum load of the building and future expansion and as approved by Engineer – in – Charge. Rising mains shall be conforming to IEC 61439 as amendment up to date. Design of rising main shall be as per ECBC 2017.
- Surge suppressors of suitable rating shall be provided with all the LT panels, MDBs & each UPS distribution board as required in a structured manner.
- Aviation lights (LED Type) shall also be provided as per Std. norms for high rise building.
- RCBO of 300 ma sensitivity of suitable rating shall be provided as Incomer of each Distribution board.
- For accommodating various size of cables incoming to the building, medium class G.I. & HDPE pipe of suitable size shall be provided.
- LED mirror light (Cove or inbuilt in mirror) above each wash basin shall be planned & considered while designing.
- In other areas which are not covered in above paras following minimum provision shall be provided in the building: -
- In common,passage, corridor, waiting, lobby etc. area for each 25 sq. mtr area 1 no. 15 amp power plug and, 1 nos 5 amp light plug outlet with switches shall be planned.
- Near each computer outlet/ work station, 1 no. 15 amp switch and 3 nos 5 amps sockets along with 2 nos RJ 45 socket shall be provided, one for LAN and one for Telephone. Entire wiring for networking along with all necessary components like OFC, Cat-6A wire, Patch panel, Patch cords, Rack etc. are in the scope of work. The system schematic/ SLD shall be got approved by the consultant/ Engineer-in-charge.
- Heavy duty Metallic exhaust fan with louvers as per the requirement of ventilation shall be provided in each Electrical/ HVAC/ PHE/ UPS/ Panel/ machine/ equipment room.
- External / Landscape / Façade lighting: For compound lighting minimum 6.0 mtrs decorative pole with LED post top lantern shall be provided around the building & along the roads inside the campus. For service yard street lights shall be planned. Illumination to be maintained as per NBC and shall be automatic controlled by timer switch panel. Landscape features like big trees and small plants etc. shall be illuminated with concrete embedded inground/ spike lights etc. as required. Building façade lighting also shall be planned, designed with approval from consultant/ engineer in charge with appropriate IP65~68 rated façade lights.
- The LED light luminaries/electrical light fixtures provided under the contract shall be guaranteed for a period of 5 years from the date of completion/ handing over whichever is earlier. In this regard contractor shall furnish an undertaking and bond for Guarantee/Warrantee of 5 years.

8.8.1. MINIMUM SIZE OF ELECTRICAL CONDUITS & ACCESSORIES

- Conduit : 20mm diameter.
- Lighting wire : 1.5sq. mm. stranded copper conductor (max. 7 strands)
- Power wire : 2.5sq. mm. stranded copper conductor(max. 7 strands)
- Telephone cable : CAT 6A; or 2 pair, 0.61mm diameter copper conductor PVC / PVC insulated (single conductor) if applicable.
- Earth wire : 1.0mm or 1/18 gauge copper conductor (single conductor), PVC insulated, green colored.
- Neutral wire : shall have same size & specification as phase wire.
- Color
  - Neutral wire : Black,
  - Phase wire : Red, Blue & Yellow (for different phases)
  - Earth wire : Green/green-yellow.

8.8.2. MINIMUM SIZE OF MAIN EARTH CONDUCTOR (OR AS PER DESIGN)

- Between earth pits : 50 x 6mm G I strip
- From earth pit, up to the Transformer : 40 x 4mm GI Strip
- From earth pit, up to the D G set : 40 x 4mm GI Strip
- From earth pit, up to the MDB : 8 SWG G.I. wire or 25 x 3mm GI strip.
- From MDB to LDB : 25 x 3mm GI strip.

Each lighting switchboard shall have 1 No. 5Amps switch & 3/5 pin socket outlet unless specified otherwise.

8.8.3. SIZE OF MCB SHALL BE AS FOLLOWS

- For light / fan circuit : 10A SP (9KA)
- For 15Amps power points : 16A SP (9KA)
- For window type air conditioners of :
  - Up to 2 Tons (1 Ph) : 25A SP (9KA)
  - 3 Tons (1Ph) : 32A SP (9KA)
  - 4 Tons (1Ph) : 40A SP (9KA)

8.9. COMPLETION TESTS

The completion tests shall be carried out as per latest edition of National Electrical Code.

9. EARTHING SYSTEMS

9.1. GENERAL

- Electrical Earthing & Lightning protection system shall conform to latest editions of:
  - IS: 3043, 1987 : Code of practice for Earthing.
  - IEC 60364, pt. 4-41 : Low-voltage electrical installations: Protection for safety.
  - IS/IEC 62305 : Protection against lightning.
  - IEC 62561 : Lightning Protection-Earth enhancing compound.
  - National Electrical Code (NEC), 2011.
  - National Building Code (NBC), 2016.
  - Indian Electricity Rules, 1956 and
  - The regulations of the local Electricity Supply Authority.
- Two independent earth-pits for earthing of non-current carrying metallic parts of the electrical equipment shall be provided at a distance of minimum 1.5M from the building line using suitably sized GI/Cu strips / GI wires as required.
- Each earth station, as per IS: 3043, shall comprise of:
  - An earth pit connected to the earth strip of GI or Copper metal.
  - An earth electrode; either of any, a GI / Copper Plate, a GI pipe or Copper-clad MS rod (conforming to UL certification).
  - Artificial treatment of the soil immediately surrounding the earth electrode, if required.
  - Arrangement to add water to the earth electrode in the Earth pit.
  - Structural bonding system as per IS/IEC 62305.
- All the earth electrodes shall be interconnected underground at (-) 1000 mm from G L.
- Earthing for safety, voltage reference, shielding and lightning current dissipation shall confirm to the requirement as per the above standards and as follows:
  - TT system of Earth with double earthing for transformer / DG set (separate earthing for body & Neutral point), electrical panels and major equipment satisfying IS: 3043, IS: 732, IEC 60364 shall confirm to the regulations.
  - To ensure safety during fault conditions, PE conductor shall be earthed at the installation satisfying double earthing requirement and shall reduce power frequency voltages within the allowed limits as per IS: 732.
- The requirement of PE conductor & supplementary PE earthing shall be satisfied as per the above standards such that earthing shall have:
  - (Earth) resistance < 10Ω / 1Ω / 0.2Ω depending on the application including direct earthing (connected to the earth pit) for Lightning Protection.
  - Protective provisions for Star / Mesh / Ring or other defined earthing typologies for IT enabled areas / buildings.
- The earthing system shall ensure that:
  - Equipment Protection is achieved in the prescribed time specified in IS: 732.
  - After completion of the electrical installation, earth resistance needs to be measured for each panel / equipment and the fault clearance time checked to ensure their safety.

- Earthing and structural bonding system shall confirm to the requirements of IS/IEC 62305 (all parts) as well as NBC 2016.

9.2. EARTH PIT

The complete earth system including the earth pit shall consist of the following components:

9.2.1. EARTH ELECTRODES

The earth electrode shall be one of the following types:

9.2.1.1. PLATE ELECTRODE:

Earth shall be provided with plate electrode of either GI or copper of following minimum dimensions:

- G I Plate Electrode : 600 x 600 x 6.3mm thick.
- Copper Plate Electrode : 600 x 600 x 3.15mm thick.

The electrode shall be buried in ground with its faces vertical and top horizontal edge at a depth as specified but ≥ 1.5m below ground level.

9.2.1.2 PIPE ELECTRODE:

Pipe electrode shall be 38mm diameter GI perforated pipe of specified length but ≥ 2.5m. The top edge of the pipe shall be ≥ 1.25m below the ground level.

9.2.1.3 COPPER CLAD MS ROD:

Cu-clad MS rod shall be UL listed (conforming to its requirements). The Cu-clad rod shall be of specified length but ≥ 2.5m. The top edge of the rod shall be ≥ 1.25m below the ground level. The rod shall be covered with the specified chemical material to improve the earth resistivity.

9.2.2. EARTH STRIP

- GI Strip:
  - GI strip shall be fabricated with MS grade E-250 (FE-410).
  - The galvanization of the strip shall be done in accordance with IS: 2629 with galvanized coating thickness ≥ 85micron.
  - The weight of zinc coating shall be ≥ 610gms/m².
  - The Zinc used for galvanization shall conform to Zn-90, IS: 209.
- Cu Strip:
  - Cu strip shall be fabricated with Bus bar grade 99.9% pure copper.

<u>CONNECTION WITH EARTH ELECTRODE</u>

- 20 mm diameter medium class GI pipe shall be provided and attached to the electrode-from the ground level to the top edge of the ground electrode. A funnel with GI wire mesh; shall be provided on the top of this pipe for moisturizing the earth around the earth-electrode.
- The watering funnel attachment shall be housed in a masonry chamber of not less than 300x300x300mm size, flushed with the ground level. MS frame with hinged cover having locking arrangement; shall be provided at top face of this chamber. The top cover shall be able to sustain the motor vehicle axle load.
- The MS frame shall be provided with at least two coats of red oxide paint and finally painted in gray shade to be approved by the owner / client. The inside of cover shall carry the earth station number in the following manner.

EARTH PIT NO. 5

- Earth electrode shall be situated ≥ 1.5m away from the building line. Care shall be taken that the excavation for earth electrode shall not affect the column footing or foundation of the building. In such case, electrode may be pushed further away from the building.
- Earth electrodes shall be situated away from the effective area of the nearest electrode; preferably ≥ 3m away from each other.
- GI strip of minimum 32x6mm size (preferably 50x6mm) shall be connected to the earth electrode (GI plate or GI Pipe) by welding and taken under the funnel chamber. This earth strip shall run under ground at a depth of ≥ 800mm (preferably 1000mm).

ARTIFICIAL TREATMENT OF SOIL

The soil immediately surrounding the earth electrode; shall be treated by addition of sodium chloride / calcium chloride / sodium carbonate / copper- sulphate salt, soft coke (wood charcoal) and wood saw-dust in alternate layers of 300mm to reduce the earth resistance. Alternatively, Bentonite compound may be used to reduce the earth resistance.

RESISTANCE TO EARTH

- The over-all resistance of earth system shall be ≤ 1Ω (One Ohm).
- If the earth resistance is too high, multiple earth electrodes shall be provided.
- All the earth electrodes shall be connected to each other in a ring formation with GI / Cu earth strip of specified size laid at a depth of 1000mm from G.L. The over-all resistance of this earth grid system shall be ≤ 1Ω.
- The soil resistivity immediately surrounding the earth electrodes shall be reduced by soil treatment as mentioned above to reduce the grid earth resistance to < 1Ω.

9.3. EARTH CONNECTION

- All the non-current-carrying metal parts of electrical installation shall be properly connected to earth through equi-potential bus bar following the stipulations of the relevant standards mentioned above.
- All earth bus shall be solidly connected to the earth pits at two points with properly sized GI/Cu Strips/conductors as laid down in the relevant specifications.
- Body of all switch-gear, distribution boards, switch boxes, outlet boxes, metal conduits / trunking and all other non-current carrying metal parts shall be bonded together and connected by means of two nos. specified earth conductors to the earth system.

9.4. STRUCTURAL EARTHING & BONDING SYSTEM

- Structural bonding system to create a maintenance-free permanent earth as per IS/IEC 62305; consists of:
- A continuous steel conductor of round steel bar of required diameter installed inside the RCC plinth beams and columns along with structural steel at the plinth level and the columns.
- The grid thus formed; shall be used for the interconnection of PE conductor with the structure and shall reduce over voltages due to fault inside the building.
- The conductor shall be of continuous length from plinth to the roof-top of the building with exothermic welding for additional length.

- o This conductor at the plinth in the form of a ring and risers in the columns as required, shall support the electrical installation and act as supplementary PE conductor.
- o Sizing of the conductor shall be as per the loop resistance/fault current requirement of the installation confirming the standards.
- o The conductor shall have minimum joints and all joints shall be exothermically welded for application in soil and under foundation.
- o Clamp joints are permitted only inside concrete / exposed in air.
- Use of galvanized steel material is not allowed inside concrete as the zinc coating in steel damages concrete in most atmospheres (ref IS/IEC 62305-3 E.4.3.).
- Exothermic weld shall confirm to the requirements of IEEE 837, 2014.
- o Every component used shall be able to withstand the fault current with minimum temperature raise.
- o Fault duration shall be calculated as per electrical system design and approximate heat generation shall be evaluated by the structural engineer.
- The earth studs shall be 100% corrosion resistant and shall confirm the requirements of IEC 62561.

9.4.1. EARTH CONDUCTOR & EARTH STUD

➢ <u>EARTH CONDUCTOR</u>

- 10mm round or other sizes specified; based on transformer short circuit level.
- Copper coated steel tested to IEC 62561 shall be used as dedicated earth conductor in concrete as well as ring earth in case if the foundation has water proof plastic membrane.

➢ <u>EARTH STUDS</u>

- Earth studs are for the purpose of bringing the electrical connection between structural steel with other steel installations in the building.
- Both earth conductor as well as earth stud shall be corrosion resistant and shall be tested according to IEC 62561.
- Earth stud shall be connected to earth conductor by exothermic welding.

9.4.2. EXECUTION

➢ <u>BUILDING WITH PLASTIC WATERPROOF MEMBRANE:</u>

- The installation of the earth conductor needs to be carried out before installing the waterproof membrane, preferably below PCC.
- The earth conductor shall run under waterproof membrane as a grid of 10x10m.
- The grid shall be extended up to floor level outside the plastic membrane at every 10m.
- All joints shall be exothermically welded, in addition, wrapped with corrosion protection bandage.
- Puncturing of water proof membrane is not permitted in case if this “under foundation earthing” is not carried before laying the waterproof membrane.
- Alternatively, ring earthing with vertical earth electrodes at floor level can be done with special care.

- At floor level / above water proof membrane, the conductor shall be connected to Steel in RCC columns & plinth beams.

➢ BUILDINGS WITHOUT WATER-PROOFING:

In case of raft / mat foundation which is in electrical contact with soil (without water proof plastic membrane), earth conductor running throughout the RCC as a mesh of 10X10m exothermically welded in all joints, connected to foundation steel at every 5m with a tested connector and every 1m with braid wire, need to be installed.

➢ BUILDINGS WITH FOUNDATION OTHER THAN RAFT / MAT FOUNDATION:

The earth conductor shall run throughout the interconnected plinth beam. Plinth beam at the outer wall / perimeter of the building shall have earth studs at every 10m for the purpose of ring earth interconnections.

➢ GRID SIZING:

For industrial and commercial buildings, the earth grid design shall satisfy NBC-2016 (5*5m grid) for improvement of the Earth termination system in a power source.

9.4.3. DOWN CONDUCTOR AS WELL AS BONDING CONDUCTOR

➢ RCC BUILDING:

The dedicated copper coated 10mm solid round conductor shall run inside columns on the periphery of the building and must be connected to the reinforced steel available in the columns to serve the purpose of:

- Down conductor for lightning protection as well as
- Base for Equipotential bonding in every floor of a multi-storeyed building.
- If the distance between 2 columns is lesser than 5m, alternate columns shall be selected to route the down conductors.
- If the distance is more than 10m, all the columns shall be used for down conductor routing.
- Provisions for interconnection of metal frame of wall cladding shall be made at every 5m in vertical and horizontal sections based on the architectural design.

➢ PEB BUILDING:

Steel Columns and/or metal façade interconnected to foundation conductor through earth stud/ foundation bolt; meeting the requirements of IS/IEC 62305; don't require separate down conductor.

9.5. EARTHING FOR SAFETY OF LV NETWORK

- Additional earth studs need to be installed where electrical panels & electronic equipment are installed.
- All electrical rooms as well as every floor level in electrical shaft must have a local equipotential bonding earth stud extended from the structural earthing.
- Sizing of earth stud for electrical room shall be based on the Short circuit current requirement of the electrical system considering TN-S network.
- Earth studs to test the efficiency of protection system; shall be provided in easily accessible places at top and bottom of the building at every 20m around the periphery of the building.

10. LIGHTNING PROTECTION SYSTEM

Installation of Lightning Protection System shall be strictly in accordance with IS/IEC 62305. The contractor shall prepare & submit the drawings as per design and get them approved from the client/ consultant before the start of the work. The approval of drawings however does not absolve the contractor not to supply the equipment /materials as per requirement. The drawing consists lay out drawings of the horizontal and vertical conductors including its support details, sections, connections etc. The vendor from the NIT/make list shall be considered for LPS system provide they meet all test parameter defined in the tender specification.

The detailed requirement/ scope of work, installation of lightning conductor system for protection of following structures/ building against lightning shall be worked out and executed as per IS/IEC:62305 (Part-I to IV).

The principal components of a lightning protective system are: -

a) Air terminations,

b) Down conductors,

c) Essential Joint and bonds,

d) Testing joints,

e) Earth terminations, and

f) Earth electrodes.

10.1. STANDARDS

Earthing for lightning Protection system shall confirm the following regulation and standards:

- CEA regulations for Measures relating to Safety and Electric Supply, 2010.
- NBC 2016 : National Building Code of India, 2016.
- NEC: 2011(SP30) : National Electrical Code of India, 2011.
- I S: 3043, 1987 : Code of practice for earthing.
- I S: 732. : Code of practice for electrical wiring installations.
- IEC 60364. : Low-voltage electrical installations.
- IS/IEC 62305 : Protection against lightning:
  - Part 1 : General Principles,
  - Part 2 : Risk Management,
  - Part 3 : Protection of structures,
  - Part 4 : Protection of Electrical & Electronic equipment within structure.

1	General Principles	IS/IEC 62305-1:2010
2	Risk Management	IS/IEC 62305-2:2010
3	Physical damage to structures and life hazard	IS/IEC 62305-3:2010
4	Electrical and electronic systems in structures.	IS/IEC 62305-4:2010
5	Wind velocity	IS 875 – 1987

6	Design of lightning protection system	NBC 2016
7	Material test standard	IEC / EN 62561 (Part 1 to 8)
8	Lightning current capability test for special High Voltage Insulating cable.	IEC/TS 62561-8 (ed.1.0), 81/457/CD:2013-11 Clause 5.4.7.1 –
9	Surge Protection Device for Power Supply	EN 61643-11:2012 / IEC 61643-11:2011 OR latest
10	Surge Protection Device for Data Line	IEC 61643-21:2009 and EN 61643-21: 2010 OR latest

Note:

1. All the components shall be tested as per applicable IEC 62561 and the bidder must submit the manufacturer's test report having laboratory with test facility for lightning impulse current (min 200KA, 10/350 microsec) , accredited by third party accreditation body like VDE, ILAC, Dakks, UL, NABL.

2. The bidder shall submit the accreditation copy of manufacturer's test lab from above competent accreditation body as a mandatory technical requisite. In absence of valid test certificate, the tender shall be liable for rejection considering the safety at site.

10.2. GENERAL

TNS system with PNE - Double earthing shall be followed in India.

- Earthing for safety, voltage reference, shielding and lightning current dissipation shall confirm to the requirement as per the above standards.
  - TT with double earthing for transformer, electrical panels and major equipment satisfying IS: 3043, IS: 732, IEC 60364 shall confirm to the regulations.
  - To ensure safety during fault conditions, PE conductor shall be earthed at the installation satisfying double earthing requirement and shall reduce power frequency voltages with-in the allowed limits as per IS: 732.
- Earthing shall satisfy the requirement of PE conductor. Supplementary PE earthing shall:
  - Reduce resistance less than 10Ω / 1Ω / 0.2Ω depending upon the application as per the above standards.
  - Include type B earthing for Lightning Protection.
  - Make protective provisions to provide STAR / MESH / RING / IBN or other defined earthing topologies for IT enabled areas/buildings.

o **Protection & Layout:**

The system design and layout shall be done in accordance with IS/IEC 62305 & NBC 2016). The Contractor shall design lightning protection & earthing system in level 1, as per Table no. 5 of NBC 2016. They shall submit shop drawings and shall employ the air termination network (Vertical Or Horizontal) as per the protection level.

1. For new construction, it is recommended to use down conductor through reinforcement. However, for existing building, where reinforced system is not possible, down conductors need to be installed along the wall.
2. While designing the External Lightning Protection (ELP), using isolated concept, the separation distance shall be calculated between building (electrical installations / metal parts) and down conductors. The Separation distance can be maintained by use of special cable - High Voltage Insulated cables tested by competent test laboratories like VDE, NABL, UL, as per IEC/TS 62561-8 (ed.1.0), 81/457/CD:2013-11 Clause 5.4.7.1 – for current carrying capability and equivalent separation distance based on level of protection to avoid uncontrolled flashover or arcing.
3. The system design and layout shall be done in accordance with IS-IEC: 62305 (with up-to-date amendments) and as specified in the tender documents. The design, shop drawing and bill of materials etc shall be prepared/ worked out by the bidder (OEM) as per standards for the lightning protection system and submitted to End User for approval after getting vetted from the manufacturer of LPS. In case bidder is not OEM, He shall submit the required document from OEM with their authorization. The final certificate of proper installation shall be provided by the OEM to the contractor along with 3D drawings of the whole installation.
4. All drawings to be certified by the OEM duly stamped and signed.
5. The work can be taken at site only after approval of technical submittal and shop drawing approval by Customer. The test certificate of the materials to be used as per IEC/EN 62561, attested in original by the manufacturer shall also be submitted by the bidder before being incorporated for the works to be executed.
6. All components shall meet the requirement of IEC 62305 (part I - IV) standard. The materials supplied like - air terminations, down conductors, earth termination etc. of the protective system shall be reliably resistant to corrosion or be adequately protected against corrosion. Roof conductor / Air terminal shall be Aluminium / Stainless steel/copper. Down conductor shall be of Aluminium / Stainless steel / copper. Aluminium should not be used underground / under reinforced.
7. GI material shall not be used as per instruction from NBC 2016 clause no. 11.5.5 & IS/IEC 62305-3 clause no E.4.3.4

Shapes and Minimum Sizes of Conductors for Use Above Ground

Sl. No.	Material and Shape	Minimum Size
1	St St round conductor	8mm Dia
2	Aluminium Alloy round conductor	8mm Dia
3	Copper strip	25 x 3mm

Shapes and Minimum Sizes of Conductors for Use Below Ground in reinforcement for Down Conductor

Sl. No.	Material and Shape	Minimum Size
1	St St round conductor	10mm diameter
2	Copper Strip	25 x 3mm

Shapes and Minimum Sizes of Conductors for Use Below Ground for Earthing

Sl. No.	Material and Shape	Minimum Size
1	St St round conductor Grade 316	10mm diameter
2	Copper Strip	25 x 3mm

10.3. STRUCTURAL BONDING SYSTEM

- Structural bonding system shall consist of:
  - An additional conductor installed inside an RCC column along with structural steel.
  - The grid thus formed; shall be used for the interconnection of PE conductor with the structure and shall reduce over voltages due to fault; inside the building.
  - The conductor shall be of continuous length from basement to the top of the building.
  - This conductor shall support the electrical installation and act as supplementary PE conductor.
  - Sizing of the conductor shall be as per the loop resistance/fault current requirement of the installation confirming the standards and installed as follows:
    - The conductor shall have minimum joints and all joints shall be exothermically welded for application in soil and under foundation. Alternatively,
    - Clamp joints shall be used only inside concrete / exposed in air.
    - All conductors for this purpose shall preferably be copper coated and the coating thickness of conductor shall confirm to NBC-2016 (minimum 100microns).
- Use of Aluminium and galvanised steel material is not allowed inside concrete as the zinc coating in steel damages concrete in most atmospheres (ref IS/IEC 62305-3 E.4.3).
- Exothermic weld shall confirm to the requirements of IEEE 837, 2014.
  - Every component used shall be able to withstand the fault current with minimum temperature raise.
  - Fault duration shall be calculated as per electrical system design and approximate heat generation shall be submitted for evaluation by the structural engineer.
- The earth studs shall be 100% corrosion resistant and shall confirm the requirements of IEC 62561.

JOINTS / Bonds:

- A lightning protective system should have as few joints as possible.
- Joints should be mechanically and electrically effective, for example, clamped,
- The joints / connecting clamps shall be tested with lightning Impulse current (10/350µs waveform) as per IEC/EN 62561-1, clause 6.2, Table 1.
- Use of dissimilar metals at Joints shall be avoided to ensure non corrosion. As far as possible, stainless-steel joints/clamps shall be used to avoid bimetallic effect.

10.4. EARTH CONDUCTOR & EARTH STUD

10.4.1. EARTH CONDUCTOR:

- 10mm round copper coated steel rod or other sizes specified based on transformer short circuit level.
- Copper coated steel tested to IEC 62561 shall preferably be used as dedicated earth conductor in concrete as well as ring earth in case the foundation has water proof plastic membrane.
- Generally, in new construction buildings, it is recommended to use reinforced down conductor and earthing.

As per clause E.4.3.1 of IS/IEC 62305-3:2010, it is to be ensured for continuity and maximum overall resistance of 0.2 ohm shall be achieved and can be checked by measuring the resistance between the air-termination system and a ground plate (grounding bus-bar / grounding termination) at ground level.

10.4.2. EARTH STUDS

- Earth studs shall be used for the electrical connection between structural steel with other steel installations in the building.
- Both; earth conductor as well as earth stud shall be corrosion resistant and shall be tested according to IEC 62561.
- Earth stud shall be connected to earth conductor by exothermic welding.

10.5. DOWN CONDUCTOR & BONDING CONDUCTOR

10.5.1. RCC BUILDING:

The dedicated continuous reinforced steel re-bar / copper coated 10mm solid round conductor shall run inside columns on the periphery of the building and must be connected to the reinforced steel available in the columns as well as the floor beam at the foundation level and beams at various floors. The connection of the vertical re-bar / copper coated 10mm solid round conductor to the horizontal re-bars shall be done as per NBC 2016 & shall serve the purpose of:

- Down conductor for lightning protection,
- Base for Equipotential bonding in every floor of a multi-storeyed building.
- If the distance between 2 columns is < 5M, alternate columns shall be selected to route the down conductors.
- If the distance is > 10M, all the columns shall be used for down conductor routing.
- Provisions for interconnection of metal frame of wall cladding shall be made at every 5M in vertical and horizontal sections based on the architectural design.

NOTE: Training for making this interconnection shall be provided to façade supplier / installer as required.

10.5.2. PEB BUILDING:

Steel Columns and/or metal façade interconnected to foundation conductor through earth stud/ foundation bolt; meeting the requirements of IS/IEC 62305; don't require separate down conductor.

10.5.3. EXTERNAL DOWN CONDUCTORS

- Preferably round conductor (long length to have minimum joints) shall be made of Aluminium or its alloy or GI or Copper or Stainless Steel, min dia. 8 mm, complying with EN 62561-2.
- Where it is not possible to maintain the separation distance as per IS/IEC 62305-3, to prevent dangerous flashover between the parts of the external lightning protection system and conductive parts inside the structure (electrical / electronic equipment, pipes, ventilation ducts,

etc.) resulting from a direct lightning strike, special insulated cable (like HVI) can be used to avoid separation distance.

10.6. AIR TERMINATION SYSTEM

Air termination system (Horizontal/Vertical) on the roof shall be according to Lightning Protection Level specified in NBC 2016.

- The air termination system consisting of vertical rods and/or mesh; shall be connected to the structural conductor through earth studs provided at the parapet / columns of the building.
- For this purpose, sufficient earth studs with provision of mechanically strong connection; shall be provided at the parapet / wall / column at the top of the building.
- Air termination system shall be installed after completion of the installation of all roof mounted electrical / metal works.
- The terminal shall withstand wind velocity of 145KM/hour. The length of the Air-terminal rod varies from 1mtr to 4mtr depending on design.
- Fixing Accessories: Suitable fixing accessories shall be used with Air-terminal to withstand Lightning current and suitable clamp complying to EN 62561-1 for connecting Air terminal with roof conductor.
- For building with metal roof, the air terminal shall be directly connected to the steel roofing sheet with special leak proof screws. Bonding of roof steel and structural support columns shall be ensured by installing braided wires at every 10M.

10.7. CLAMP FOR SUPPORT TO CONDUCTOR

The conductor shall be made of Stainless Steel/GI and shall be supported with the structure at every 1mtr. The clamps shall be tested for natural weathering and exposure to corrosion (i. e. Salt Mist Treatment test according to EN 60068-2-52 and Humid Sulphurous Atmosphere treatment test according to BS EN ISO 6988). In special application, if drilling is not possible, special adhesive clamp is recommended to hold roof conductor on roof / shed.

10.8. TEST CLAMPS

It shall be made of Stainless Steel/GI and shall be used for every down conductor at 1.0 meter (approx.) above the ground level (connection / disconnection purpose). while not inviting unauthorized interference, it is convenient for use when testing.

10.9. EARTHING SYSTEM

Each down conductor shall be terminated to either earth electrode or ring earth.

- Earth electrode shall be 3/4" dia, 10 feet long, UL listed, min 254-micron copper coating over mild steel.
- Each earth electrode shall be supported with RoHS certified, low resistivity (≤0.2ohm. mtr) Ground Enhancement Material (min22.6Kg), to increases the contact area with earth electrode.
- The final resistance using one rod or ring, shall be ≤ 10 Ω.

10.9.1. EQUI-POTENTIAL BOND

All metal (natural conductor) components shall be bonded together with roof/down conductor for equi-potential bonding.

10.9.2. LIGHTNING FLASH RECORDER

The Lightning system shall be installed complete with the Lightning flash recorder/counter with digital recording.

- The Lightning flash recorder, complying to EN 62561-6, shall consist of a mechanical 3 digit display which will register all Lightning discharges with a sensitivity of up to 100KA 10/350 µs Lightning impulse current.
- The Lightning flash recorder shall be housed in IP 65 rated enclosure and will operate without reliance on batteries or an external power source.
- It shall be installed on the most direct down conductor, at height of about 2 meter above ground level or as per user guideline.

10.10. EXTERNAL LIGHTNING PROTECTION SYSTEM USING STRUCTURAL STEEL

10.10.1. DESIGN

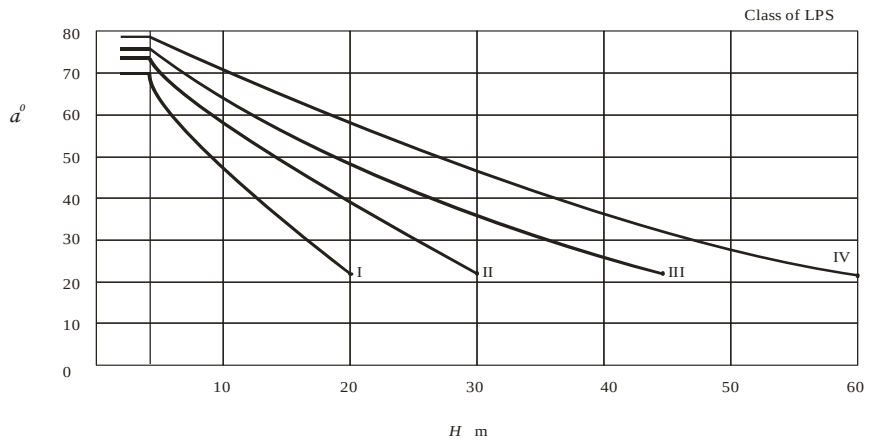
- Before designing, it is essential to determine the risk involved in the structure as per IS/IEC 62305-2 and depending on the risk involved, level of protection is determined. A Class I lightning protection system provides the maximum protection and a Class IV, the least.

Application	LPL*
Computer Data Centres, Military Applications, Nuclear Power Stations, High raise Hotels/Hospitals, airports, essential services such as telecom towers etc.	1
EX-Zones in the industry and chemical sector, Low raise Hospitals & Hotels, fuel retail outlets, gas station, compressor station etc.	2
Schools, Banks, Residential Buildings, Temples, Churches, Mosques etc.	3 to 4

- <u>LPL levels, probability and basic design consideration:</u>

Class of LPS	Lightning current MINIMUM	Lightning current MAXIMUM	Interception probability	Rolling sphere radius (m)	Mesh size (m)	Down Conductor Spacing
1	3 kA	200 kA	98%	20	5*5	10
2	5 kA	150 kA	95%	30	10*10	10
3	10 kA	100 kA	88%	45	15*15	15
4	16 kA	100 kA	81%	60	20*20	20

- Protection angle with respect to Height:



- The design shall be made according to IS/IEC 62305-3 & NBC-2016 using any or combination of three method, as per defined lightning protection level:
  - Rolling sphere method.
  - Mesh method.
  - Protective angle method
- Lightning Protection shall consist of external Protection for the building with:
  - Air termination,
  - Down Conductors,
  - Test clamps,
  - Earthing and
  - Internal protection for power lines with Surge Protective devices.
- Current parameters as per IS/IEC 62305 and the effects of lightning are as below:

Current Parameters	Symbol	Unit	Lightning Protection Level				Effect
			I	II	III	IV	
First positive Impulse							
Peak Current	I	kA	200	150	100		Mechanical
Impulse charge	Q_{SHORT}	C	100	75	50		Thermal (arc)
Specific Energy	W/R	MJ/Ω	10	5.6	2.5		Mechanical & Thermal
Average Steepness	d_i/d_t	kA/µS	20	15	10		Surges and flashover
Time Parameters	T_1/T_2	µS/µS	10/350				
First Negative Impulse							
Peak Current	I	kA	100	75	50		Mechanical

Average Steepness	d_i/d_t	kA/µS	100	75	50	Surges and flashover
Time Parameters	T_1/T_2	µS/µS	1/200			

- Damages from lightning strike are due to Peak Current (I), Charge (C), Specific Energy (W/R) & Rate of change of current (di/dt).
- Lightning protection shall be designed to take care of these effects of lightning.

10.10.2. Earth Termination Network for lightning protection system

1. An earth station comprising one or more earth electrodes as required, should be connected to each down conductor. This shall be specified.
2. The whole of the lightning protective system, including any ring earth, should have a combined resistance to earth not exceeding 10 ohms without taking account of any bonding.
3. If the value obtained for the whole of the lightning protection system exceeds 10 ohms, a reduction can be achieved by extending or adding to the electrodes, or by interconnecting the individual earth terminations of the down conductors by a conductor installed below ground, sometimes referred to as a ring conductor. Buried ring conductors laid in this manner are considered to be an integral part of the earth termination network and should be taken into account when assessing the overall value of resistance to earth of the installation.
4. A reduction of the resistance to the earth to a value below 10 ohms has the advantage of further reducing the potential gradient around the earth electrode when discharging lightning current.
5. Earth electrodes should be capable of being isolated and a reference earth point should be provided for testing purposes.
6. The earthing for lightning protection shall be graphite based Chemical earthing. Bentonite based chemical earthing is not acceptable. Low carbon steel, high tensile strength copper bonded rod with min 254 microns of copper plating, UL listed with company name marked on rod. Diameter- 17.2 mm, Length- 3 meters, Material- Copper Bonded, Coating thickness- 250 microns, min, Approvals- Tested acc. IEC / EN 62561-2, UL 467.
7. The ground enhancing material / backfill compound shall have following properties:
   - Backfill compound: Graphite based backfill compound shall be tested from NABL accredited test labs for RoHS, Thermal stability, Corrosive resistance, pH value, Moisture retention, Resistivity, Sulphur content, Low water solubility.
   - Environment friendly (RoHS certified), Thermal stability (+/- 60° C for 24 Hrs)
   - Corrosion/polarization resistive (≥ 4.0 Ohm - m²) for non-aggressive Copper plated electrode , pH value (between 6.5 - 7.5)
   - Moisture retention Test (Moisture loss of 0.2% at 50% Rh)
   - Leaching test shall be done as per IEC 62561-7 / EN 12547-2
   - The Ground enhancement compound/ backfill shall be tested for atleast 100Columbs (0.5Sec) long lightning wave and 10KA 10/350 microsec short lightning wave against formation of unwanted fulgurites.

10.11. INTERNAL LIGHTNING PROTECTION SYSTEM (SPD'S for Power, DATA Lines etc.)

Effect on internal Lightning Protection System is mainly due to:

- Coupling and the rate of change of current due to very high d_i/d_t of the first negative stroke.
- The problem is the response time of SPD and the voltage drop in the connecting wires.
- SPDs at the incoming panels shall have a response time less than 1nano sec & shall be of BUS-BAR mounted type to avoid connecting wire length.
-

A. <u>Internal Lightning Protection</u>

The Internal Surge Protection Device shall be selected as per zone of protection described in IEC 62305, 61643-11/12/21, 60364-4/5. Depending on Zone concept of provided in IEC 62305 – 1 & 4.

LPZ -O_B & LPZ 1: At Mains entry point (Main LT Panel): Type 1 + 2, i.e.

SPD Combined Arrester with Integrated Backup Fuse

LPZ1 & LPZ 2 :Sub distribution panel at each floor will be used with Type 2 SPD i.e SPD with integrated fuse - for each Sub Distribution Panel

CCTV control room Panel + Server room Panel + IT building panel will be used with Type 2 SPD for each Panel.

All data network will be protected using suitable Surge Protection Device.

A.1. Power Line Protection

Main Distribution Board shall have Type 1 SPD to discharge Lightning current surges for 415 V AC, 3 phase 4 wire (TT) configuration. UPS / Sub Distribution Board shall have Type 2 SPD to discharge switching surges for 415 V AC, 3 phase 4 wire (TT) configuration. Server and sensitive equipments shall have Type 3 SPD at their power input to discharge switching surges.

Type 1, Type 2 and Type 3 devices shall be from same manufacturer to achieve the co-ordination

Type 1 SPD (with inbuilt Fuse) - at Main LT Panel

a) The device shall be non-exhausting metal encapsulated, spark gap based technology and tested as per latest and valid IEC 61643-11:2011 or EN 61643-11:2012 standards. The use of MOV as main type 1 SPD is not permitted as perfect equipotential bonding is desired at the main panels,

b) There should not be any leakage current through the Type 1 in normal operation in the absence of any lightning or surge. MOVs are not allowed as these are prone to leakage and ageing.

c) The device shall be capable to discharge Lightning current (10/350µs) of 25kA (L-N) and 100kA(N-E).

d) The device shall have voltage protection level of device shall be ≤ 1.5 KV including inbuilt fuse for L-N.

e) The device shall have Follow current extinguishing capability [L-N]/[N-PE] : 100kArms / 100Arms

f) The device shall have built in fuse and operation of SPD shall be independent of Line current for L-N SPD. The short circuit with stand capability of the device shall be 100 KArms for L-N SPD.

g) The device shall have mechanical indication for both the states (green for 'healthy' and red for failure) on L-N and N-PE.

h) The device shall be certified by KEMA or VDE or NABL lab as per IEC 61643-11:2011 or or EN 61643-11:2012 for testing of all parameter at 10/350 µs and 8/20 µs.

Type 2 SPD - at Each Sub Distribution Panel - For CCTV Control Room Panel, Server room panel & IT room panel

a) The device shall be single shield high duty discharge capacity Zinc Oxide Varistor and spark Gap combination between L-N and single shield high discharge capacity spark gap between N-Earth.

b) The device has Zero leakage current in L-N due to galvanic isolation using Spark gap in combination with varistor.

c) Maximum continuous voltage is ≥ 275V

d) Voltage Protection level of device shall be ≤ 1.5 KV for L-N / N-E.

e) The nominal discharge current for 8/20 µs is 20KA for L-N and 80 KA N-E.

f) The device shall have mechanical indication for both the states (green for 'ok' and red for failure) on all modules (L-N and N-PE)

g) Short-circuit withstand capability (Isccr) is upto 25KArms for L-N.

h) The device shall have pluggable option to change cartridge without disconnection.

i) The device shall be tested for Vibration and Shock as per EN 60068-2

j) The device shall be certified by KEMA or VDE or NABL lab as per IEC 61643-11:2011 or or EN 61643-11:2012 for testing of all parameter at 8/20 µs.

Type 2 SPD: for CCTV Control Room Panel, Server room panel & IT room panel (for load current less than 125A)

a) The device shall be single shield high duty discharge capacity Zinc Oxide Varistor between L-N and single shield high discharge capacity spark gap between N-Earth.T

b) The device shall be suitable for 3 phase 4 wire (TT) **OR** 1 Phase 2 wire system with nominal voltage parameters of 230 Vac ±10% between L-N and 415 Vac ±10% between L-L

c) The device shall be capable to discharge 12 KA (10/350 µs, lightning current) between N-PE and 40 KA (8/20 µs switching surges)

d) Voltage Protection level of device shall be ≤ 1.5 KV

e) The device shall have mechanical indication for both the states (green for 's' and red for failure) on all modules (L-N and N-PE)

f) The device shall have pluggable option to change cartridge without disconnection.

g) The device shall be tested for Vibration and Shock as per EN 60068-2

h) The device shall be certified by KEMA as per IEC 61643-11:2011

Note: it is important to select proper Type 1 and Type 2 SPDs to ensure proper co-ordination. The scheme and background of selecting particular products with test reports shall be provided by panel manufacturers.

Data Tel Line Protection:

It shall consist of Lightning current protector directly coordinated with fine suppressor

Lightning current arrestor shall be expandable to a combined lightning current and surge arrester by means of course and fine suppressor protective plug.

The integrated disconnection block contacts allow for testing, measuring and patching with plugged-in protection. The three-pole gas discharge tubes have a fail-safe function with visual fault indication.

Fault indication:	Visual color change
Nominal voltage:	180 V DC
Max Continuous Operating Voltage:	180 V DC
Max Continuous Operating Voltage:	127 V AC
D1 total 10/350 µs (I_{imp})	5KA
D1 per line 10/350 µs (I_{imp})	2.5 KA
C2 total Nominal Discharge (In) (8/20 µs)	10 KA
Voltage protection level:	≤500 V

Shall comply IEC 61643-21 and approved by third party like EAC

CCTV:

The IP based camera shall be installed with suitable surge protection device for communication interface over POE at both the ends.

General Specification of SPD:

a) The device shall be capable to discharge lightning impulse current (at 10/350µs) of 0.5KA & 10 KA total nominal discharge current (at 8/20µs).

b) The device shall be suitable for maximum continuous DC voltage of 48V.

c) Voltage Protection level (line to line / line to ground) of device shall be ≤ 700V.

d) The device shall be enclosed within Zinc die cast material.

e) The device shall be DIN rail mounted adopter type with sockets.

f) The device shall comply to IEC 61643-21/ EN 61643-21 and shall be UL approved.

g) Cut-off frequency shall be minimum 100 MHz.

11. POWER FACTOR IMPROVEMENT SYSTEM

11.1. GENERAL

a) There must be a calculated provision of 1 or 2 steps fixed type capacitor bank for less power consumption in holidays or night time when loads are minimal. The rated voltage for Capacitor banks of APFC Panel shall be 480V.

b) The industries today use power electronics loads which are non-linear, hence when connected to a sinusoidal voltage, create non-sinusoidal currents which generate harmonics of varied frequencies. To counter these harmonics:

- Besides using passive harmonics filter solutions; active harmonic filtering solutions (active filters) are used, especially in case:
  - The required PF is minimum 0.98 or near to 1 or
  - The harmonic disturbances are changing frequently.
- This specification deals with the design, manufacturing, supplying, testing and commissioning of Active / Hybrid Power Factor Correction (APFC/HPFC) panel having insulated-gate bipolar transistors (IGBTs), microprocessor controls, capacitors, reactors and other associated accessories as required.
- The active filter shall be of Modular design. The modules shall be able to work in parallel so as to be able to increase the capacity as required at site.

- The APFC should be of OEM make only
- APFC should be designed as per IEC 61921 and type tested as per IS 16636 in a reputed laboratory. Type test certificate should be submitted along with the offer.
- All major components such as MCCBs/ACBs/Capacitors/Reactors/Contactors/Meters/APFC Relay/Indicating lamps etc in the APFC should be of single make.
- The OEM should have Inductive Load bank to demonstrate the performance of APFC ON -Load during FAT.
- THE ACTIVE FILTER:

  It is a harmonic filter system for elimination of harmonic oscillations in the current wave-form; consequently, to reduce costs. The filter monitors the current signal and compensates for the unwanted elements of the measured current, thus ensures harmonic suppression independent of the number of loads.

  Minimum Technical feature of AHF:

- The AHF should be designed to respond within 25micro Sec.
- IGBT Switching frequency should be 20kHz.
- The CT shall be provided either Load end or Source end, the AHF should be capable of working in either condition.
- Manufacturing facility should have ISO 9001/2015 & ISO14001/2015
- Manufacturing facility should have IGBC Green Factory Building Gold certificate.
- Modules of AHF Should have UL 508, ROHS, CE certification.
- AHF Must have fastest response time <25Micro second.
- AHF Module will be on the multiple of 60A,120A,200A & 300A
- AHF commissioning should be done by UNIT HMI no additional device should be used for commissioning of AHF
- The AHF should work irrespective of CT Secondary (either 1A or 5A)
- The AHF should have the below mandatory features:
- IGBT 3 level topology. With 4 IGBTs per phase total 12 IGBT inverter circuit
- Modular construction (number of unequal rated AHF can be paralleled seamlessly).
- Target setting of THDI%.
- Target setting of THDV%.
- Losses <3%.
- Ambient working upto 40Deg C/50deg C.
- AHF should display multipoint temperature including PCB board temp and unit temp
- AHF HMI screen must have start and stop option on every screen of HMI
- AHF should have capabilities as below:
- Load balancing.
- PF correction.
- AHF should be capable of splitting the unit capacity (in %age) between harmonics mitigation and power factor compensation.
- Capable of CT sensing at 415V & 11kV

- Harmonic cancellation from 2nd to 51st harmonic.
- Selectable individually from 2nd to 51st seamlessly.
- AHF should have HMI – for configuration, display with in built 3 channel Oscilloscope that can display waveforms, Bar graphs, phase angle, PF, Internal health monitoring, Fault logs etc.

  The filter shall:

  - Correct the power factor, improving the systems efficiency while reducing harmonic pollution.
  - Work on utility fed networks as well as local backup generators.
  - Provide reactive power compensation. Target power factor shall be settable up to unity. Both; capacitive and inductive modes shall be possible.
  - Measure the network currents at the supply side of the unit; allowing for closed loop control.
  - Perform with dedicated CTs of class 1 accuracy for all 3phases.
  - Have the Power inverter based on insulated-gate bipolar transistor (IGBT) technology.
  - Operate automatically for current harmonic suppression using microprocessor-based controls for fast operation.
  - Be flexible to select the filter capacity to compensate harmonic or power factor or both.
  - Be able to select specific independent harmonic based on the need at site; for better compensation of harmonic current.
  - Have the Power-loss limited to 3% of rating of the filter.
  - Have in-built MCCB and fuses for internal protection of the components.
  - Be able to function in parallel with the other active harmonic filters with equal load sharing for higher current rating.
  - Have Control logic with 'advanced 32bit DSP controller' for faster response time.

11.1.1. ENVIRONMENTAL CONDITIONS

APFC panel shall be suitable for:

- Continuous operation at 40º C and work at higher temperature up to 50º C with derating.
- Audible noise < 65dBA at full load.
- Operation at an altitude up to ≤500m. Derating may be required if this altitude is exceeded.
- Operation in relative humidity < 95%, non-condensing.

11.1.2. POWER SUPPLY SYSTEM

The APFC panel shall be suitable for following AC power supply system:

- 415V ± 10%,
- 3-phase, 4-wire &
- 50Hz ± 5%

11.1.3. STANDARDS

The APFC panel shall comply with the following standards (latest amendments):

- IEC 60747-6 : Semiconductor devices. Discrete devices: Thyristors.
- IEC 60050 : International Electro-technical vocabulary
- IEC 60068 : Environmental Testing
- IEC 61000 harmonics : Electromagnetic compatibility (EMC)-Harmonics and Inter-
- IEC 61642 : Application of Filters and Shunt Capacitors
- IEC 60068-1 : Gate Driver Card
- EN50178 : Sensor
- UL1012, UL 60950,

  TUV EN 60950,

  IS 13340, 1993,

  IS 13341, 1992. : SMPS
- IEC 60831-1 & 2 : Shunt power capacitors of the self-healing type for A.C. systems having a rated voltage up to and including 1000 V.
- IEC 60076-6 : Power transformers - Part 6: Reactors
- IEC 60085-1 : Electrical insulation – Thermal evaluation and designation.
- IEC 60664 : Insulation coordination for equipment within low-voltage systems.
- IEC 60439-1 Tested : Low-Voltage Switchgear and Control-gear Assemblies: Type and Partially Type-Tested Assemblies.
- IEC 60947-1 : Low-voltage Switchgear and Control-gear: General Rules
- IEC 60947-2 : Low-voltage Switchgear and Control-gear: Circuit-Breakers.
- IEC 60947-4-1 : Low-voltage Switchgear and Control-gear: Contactors and Motor-starters.
- IEC 62208 : Empty enclosures for low-voltage switchgear and control-gear assemblies – General requirements
- IEC 60529 : Degree of protection provided to enclosures (IP code)
- IEC 60068-2-11 : Basic environmental testing procedures: Tests –K. Salt mist
- IEC 62262 : Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
- IEC 60068-2-6 : Environmental testing: Tests Fc: Vibration (sinusoidal)
- IEC 61326-1 : Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements.
- IEC 61000-6-4 : Electromagnetic compatibility: Generic Emission standard for industrial environments
- IEC 61000-6-2 : Generic standards – Immunity for industrial environments
- IEC 61000-3-6 : Assessment of emission limits for the connection of distorting installations to MV, HV and EHV power systems.
- IEEE 519-1992 : Recommended Practices and Requirements for Harmonic Control in Electric Power Systems.
- ANSI/IEEE C62.41 : Surge withstand capability

In addition to the above listed standards, the regulations for electrical installations issued by UTILITY shall also be adhered to.

11.2. APFC PANEL

The Hybrid APFC panel shall comprise of active filters and have the components as follows:

- Enclosure.
- Power supply unit.
- Active Filter unit.
- Microprocessor based Controller unit.
- HMI Unit.

11.2.1. ENCLOSURE:

Components as mentioned above and MCCBs etc. shall be housed in this enclosure.

- The APFC panel shall be:
  - o Free-standing type, fabricated out of 14/16-gauge CRCA sheet steel, compartmentalized, floor-mounted, dust and vermin proof.
  - o Reinforced with suitable size angle iron, channel, 'T' sections and/or flats as necessary to make it sturdy to withstand mechanical shock due to electrical shorts. Pre-treatment of panel shall be carried out before epoxy powder coating with 7 tank process.
  - o Provided with:
    - Cable gland plates on top / bottom (as per client's requirements).
    - 'Lifting hooks' for all transportation sections on all four corners of the panel.
    - Two numbers of earth terminals on either side of the panel.
    - Colour coded Bus-bars mounted on insulator supports. Suitable clearances for the bus-bars and other live parts shall be as per standards.
    - Shrouds for all live parts of the system.
    - Terminal strip, number ferruling and other labelling.
    - Stickers marked with "DANGER" as per standards.
    - Cooling/ventilation fans for heat removal from the IGBT & other devices.
- The APFC panel shall have:
  - A minimum of IK 10 certification (external mechanical impacts) as per IEC 62262.
  - A degree of protection > IP31 in accordance with IEC 60529.
  - A certification for steady-state sinusoidal vibration as per IEC 60068-2-6.
  - The panel-door interlocked with the incomer MCCB / switch-disconnector. Doors shall not be provided on the sides of the capacitor bank.
- The enclosure shall be manufactured and tested as per the requirements of the following IEC Publications:
  - IEC 62208 : Empty enclosures for low-voltage switchgear and control-gear assemblies – General requirements.
  - IEC 60529 : Degree of protection provided enclosures (IP code).
  - IEC 60068-2-11 : Basic environmental testing procedures: Test K- Salt mist.
  - IEC 62262 : Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code).

11.2.2. POWER SUPPLY UNIT

The power supply to the panel shall be received at the incomer of the Circuit breaker/MCCB from where it shall be distributed to the active filters. However, there shall be a common controller for the active filters.

- Power supply Incomer: (refer BOQ)
  - o A suitably sized three-pole circuit breaker (ACB/MCCB).
  - o The 3Pole MCCB shall:
    - Have a front door mounted rotary operating handle, interlocked with the door to ensure that the filter bank is de-energized when door is open.
    - Be rated for an insulation voltage of 660V & designed for ambient temperature of 50º C.
    - The current rating shall be 1.5 times the full load current of the filter bank and shall have a mechanical endurance > 1000 operations.
    - Have microprocessor-based overload & short circuit protection.
    - The overload protection shall be adjusted to trip if the RMS current exceeds the overload setting.
    - 36kA breaking capacity (Ics) or as required with Icu = Ics.
- The MCCB shall be manufactured and tested in compliance with IEC 60947-1, 2 & 3:
  - IEC 60947-1 : Low-voltage switchgear and control-gear - Part 1: General rules
  - IEC 60947-2 : Low-voltage switchgear and control-gear - Part 2: Circuit-breakers.
  - IEC 60947-3 : Low-voltage switchgear and control-gear - Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units.
- Metering and Indication:
  - o A digital display meter showing V, I, Hz, PF, THD, kW, kVA, and other related parameters.
  - o Required number of CTs of suitable rating.
  - o Required number of three phase digital ammeters showing current of APFC panel.
- Power supply to Active Filters

  Active filter units of suitable rating & number to provide the reactive power in a step-less mode to meet:
  - The required power factor correction,
  - Harmonic compensation and
  - Load balancing.

  Each Active filter unit shall have the components as required (refer BOQ).
  - o Incomer: A suitably sized three-pole circuit breaker (MCCB) having:
    - Metering and Indication as above.
    - On/Off selector switch for the Active filter.

11.2.3. ACTIVE FILTER UNIT

- The active filter unit shall have following components:
  - A three phase Inverter Stack for full rating of active filter (comprising of IGBTs, DC Capacitors and IGBT driver circuits) + sufficient margins for overloading the filter. Alternatively,

- Equivalent number of single-phase inverter stacks; depending on the rating of the active filter.
- Three number single phase inductor chokes with overload margin of 150% for 1 minute.
- Heavy duty PWM filter comprising capacitors, resistances and/or inductors to filter out the switching ripples from the filter output.

- The inverter stack shall comprise suitable number and rating (with margin for overload) of IGBTs, DC Capacitors and IGBT driver-circuits to meet the full power output of the inverter stack.
- Resistors, capacitors and other passive components of suitable rating (with sufficient margin) and quantity to continuously carry the full load of the filter.

11.2.4. PROTECTIONS

- Following protections shall be provided:
  - Over voltage (AC) protection.
  - Over voltage (DC) protection.
  - Phase sequence protection.
  - Over current protection.
  - One phase disconnection (single phasing) detection/protection.
  - Over temperature protection.
  - Temperature sensor abnormality detection.
  - Protection circuits for the IGBT stack and its components.
  - All components and wiring used shall adhere to the relevant ISI and IEC standards.
- Temperature based de-rating the system to protect and for longer operational life:
  - De-rate its capacity by sensing the control card temperature.
  - Sense abnormally high stack temperature and trip itself to protect the converter with suitable error indication.
  - Sense abnormality with stack temperature sensing circuit and generate error indication.

11.2.5. POWER FACTOR CONTROLLER:

Control and switching of each Active & Passive filter to meet the following requirement:

- Advance DSP microprocessor controller to monitor the voltage and current in the three phases (Red, Yellow and Blue) to compute the exact power requirement in the three phases and implement the following features:
  - Step-less compensation of leading and lagging power factor,
  - Harmonics compensation and
  - Load balancing.
- Suitable number and rating of voltage and current sensing circuits.
- Necessary control and firing cards with proper wiring and connecting lugs.
- Suitable number and rating of any other items, e.g. relays, SMPS etc.
- A control MCB of rating FP 10A, 10kA, C Curve is to be used to provide power supply to the controller.

11.2.6. CONTROL UNIT- HMI

The HMI (human machine interface) installed in the APFC Panel shall have the following features.

- Have a 7-inch, coloured touchscreen LCD interface.
- Have at-least one of each; Ethernet port, USB port and SD card port.
- Support MODBUS TCP communication protocol.
- Show Start, stop and trip status (with trip code) on the home screen.
- Support Internal CAN communication with the DSP controller.
- Have provision for Ethernet communication.
- Display the following (minimum) numerical parameters:
  - Arms : All 3 phase currents + Neutral
  - A1rms (Fundamental Current) : All 3 phase fundamental currents
  - iTHD (%) : All 3 phase current harmonic distortion
  - Aunb (%) : All 3 phase current unbalance
  - Vrms : All 3 phase voltages
  - Urms : All 3 line voltages
  - V1rms (Fundamental Voltage) : All 3 phase fundamental voltages
  - V THD (%) : All 3 phases voltage harmonic distortion
  - Vunb (%) : All 3 phase voltage unbalance
  - Grid Frequency : 50Hz ± 3%.
  - Active Power (kW) : All 3 phases + Total
  - Reactive Power (kVAr) : -- do --
  - Apparent Power (kVA) : -- do --
  - Power Factor (PF) : -- do --
  - Displacement P. Factor (dPF) : -- do --
  - Apk : Peak Current of 3 phases of power stack
  - Utilization (%) : Utilization percentage of 3 phases of power stack
  - Vdc : DC bus voltage of power stack
  - Stack Temperature : Temperature of 3 phase IGBTs of power stack
  - Control Card Temperature : --º C.
  - System Running hours : --hrs.
  - Fan Running hours : --hrs.
- Have advanced logging capabilities as follows:
  - The HMI shall save a minimum of 50,000 time stamped event logs.
  - The log's viewing shall be password protected.
  - The logs shall capture system events like System On/Off.
  - System trip event shall be logged with associated trip code and time stamp.
  - User entry into settings shall get logged.
  - Any failed user login attempt (wrong password) shall be logged.

- Changes in user settings shall be logged.
- Logs shall be accessible day-wise for ease of navigation.
- Logs shall be arranged in First In - Last Out fashion to display the latest events on top.
- User shall be able to export the logs to an external USB storage device.
- The HMI shall provide graphical information for the following (minimum) data:
  - : Individual harmonic bar chart of 3 phase currents – up to 51st order.
  - : Individual harmonic bar chart of 3 phase voltages – up to 51st order.
  - : Simultaneous graphical display of 3 phase currents and voltages on single window with user select-able options.

11.2.7. ACTIVE APFC PANEL – ADDITIONAL FEATURES

3.1 THE APFC PANEL SHALL HAVE THE FOLLOWING ADDITIONAL FEATURES:

- o Panel shall:
  - Be suitable for operation within
    an ambient temperature : Between 0º C & 50º C.
  - Have an audible noise level : < 70db.
  - Have a filtering efficiency : ≥ 98%.
  - Have a reaction time of : < 200micro-seconds.
  - Have provision for selection of individual harmonic order for compensation in the 'harmonic compensation-mode' through HMI.
  - Compensate the load balancing requirement arising from distributed loading in the three phases or due to two phase loads.
- o Priority selection between the three features of the filter shall be programmable using the HMI:
  - PF compensation,
  - Harmonics compensation and
  - Load balancing.
- o In the default mode, 3 priorities shall be settable:
  - 1st priority : Harmonics compensation,
  - 2nd priority : PF compensation,
  - 3rd priority : Load balancing.
- o Any unbalanced current in the neutral shall not be compensated.
  (4P/4W APFC Panel shall be required for such cases).
- o Auto fold-back of the APFC Panel if total current requirement exceeds the rated capacity of the filter.
- o Detailed drawings and manuals shall be provided wherever required.

11.2.8. ACTIVE FILTER – SETTINGS:

- o The APFC Panel shall have the following setting options for the active filters:
  - Define priority between Harmonic, Reactive and Unbalance compensations: user can choose only one of the three or a combination of all three priorities. Filter shall utilize its full capacity as per defined priority.
  - Individual harmonic selection for compensation.

o The APFC Panel shall also have provision for advanced modes for the active filters, like:

- MODE 1 : Fixed reactive power-compensation mode with lead with/without CT feedback
- MODE 2 : Fixed reactive power-compensation mode with lag with/without CT feedback.
- MODE 3 : Fixed reactive power-compensation mode with user defined rating with/without CT feedback.
- MODE 4 : Power factor correction based on CT feedback.
- MODE 5 : Harmonic compensation.
- MODE 6 : Load unbalance compensation.
- MODE 7 : Harmonic compensation with reactive power compensation for available power rating in lead.
- MODE 8 : Harmonic compensation with reactive power compensation for available power rating in lag 10. Mode selection shall be done by HMI with password protection.

11.2.9. DOCUMENTS FOR SUBMISSION

11.2.9.1. TEMPERATURE RISE CERTIFICATION:

The capacitor banks shall be of type tested design and temperature rise test report of the capacitor bank performed at an independent laboratory shall be submitted along with the offer.

11.2.9.2. TDD / THD CALCULATIONS:

The manufacturer / supplier shall prove through submission of software simulations:

- The Total Demand Distortion (TDD) is within the limits as specified in IEEE 519-2014: Recommended practices and requirements for Harmonic Control in Electric Power System.
- If the TDD / THD limits are exceeded; suitably rated Active Harmonic Filters shall be proposed.
- The simulation software shall take into consideration the performance of the detuned capacitor bank. The capacitor bank shall not amplify the existing system harmonics.

TECHNICAL PARAMETERS:

- Connectivity : 3-wire: 3 phase, 4-wire: 3 phase + neutral lead
- Rate of harmonic reduction : > 98% (Vendor to confirm)
- Phase compensation current : (Vendor to specify)
- Neutral lead compensation current : (Vendor to specify)
- Input voltage : 3-wire : 200 V to 480 V ± 10% (Vendor to confirm)
  : 4-wire : 200 V to 400 V ± 10% (Vendor to confirm)
- Frequency : 50/60 Hz ±3 Hz
- Reaction time : (Vendor to specify) (immediate load change reaction)
- Steady state response time : (Vendor to specify) (steady state response time to full steady state compensation)
- Switching frequency : 24 kHz (Vendor to confirm)
- Control frequency : 48 kHz (Vendor to confirm)

-	Harmonic compensation	:	Up to 50th harmonic, 50 active harmonic orders simultaneous selectable (Vendor to confirm).
-	Power factor correction from 0 to 100% (Vendor to confirm) compensation	:	Fully inductive and capacitive current
-	Weight single unit	:	(Vendor to specify)
-	Dimensions single unit	:	(Vendor to specify) (w x d x h) mm.
-	Current transformer Source or load Side specify)	:	Selectable, primary current range (Vendor to
-	secondary current	:	1 A
-	Overload current	:	(Vendor to specify) A
-	Maximum power losses (W)	:	(Vendor to specify)
-	Cabinet mounting	:	Wall / Floor
-	Weight including cabinet	:	(Vendor to specify) kg
-	Dimensions including cabinet	:	(Vendor to specify)
-	Air flow rate	:	(Vendor to specify) cfm
-	Interface	:	Ether-cat 100 Mbit/s, USB, Active sensor bus, display bus (Vendor to confirm)
-	Ambient temperature	:	-10 / +40°C full performance, up to +55°C derating 2%/K
-	Humidity	:	95% non-condensing
-	Self-protection	:	Yes
-	Overheating protection	:	Yes
-	Over & under-voltage protection	:	Yes
-	Noise level	:	< 56 dB (Vendor to confirm)
-	Altitude Max.	:	4000 m (Vendor to confirm)
-	Design/Standards	:	IEC 61000-4-2, 4-3, 4-4, 4-5, 4-6, 4-8, 4-11, IEC 60146, EN 55011 Class A, EN 50091-1, EN 50178 (Vendor to confirm)
-	Compliance with standards	:	IEE 519, IEC 61000-3-6-ER G5 (Vendor to confirm).

12. CABLES, CABLE TRAYS & CONDUITS

12.1. H. T. CABLE

12.1.1. GENERAL

- The high tension (3.3KV & above) cable shall have Aluminium or Copper stranded & circular conductors, extruded Semi-conducting Shield for the conductor, Cross Linked Polyethylene (XLPE) insulated, extruded Semi-conducting core shielded, Cu tape screened, Core identification taped, Filler, Over-all Tape wrapped, armoured and over all PVC sheathed construction.
- The process of cross-linking shall be as per the applicable standards.

- Responsibility of the installer shall be to follow the NBC 2016 in terms of fire safety specially as mentioned here-under:
  - Clause **3.4.7** for electrical installations "the shaft shall be sealed at every floor with fire stop materials having the same fire resistance as that of the floor…"
  - Clause **3.4.6.5**for vertical opening, "every vertical opening between the floors of a building shall be suitably enclosed or protected."
  - Clause **3.4.5.4** Service ducts and shafts, "the space between the cables/conduits and the walls/slabs shall be filled in by a fire stop material having fire resistance rating of not less than 120 min…."

12.1.2. RATING

The cables shall be rated for 33/11KVolts, earthed or un-earthed, 3 phase, 50Hz. System or as specified. (Refer BOQ).

12.1.3. STANDARDS

The H T cables shall conform to the requirements of the following I S Standards (latest editions):

- I S: 7098, pt-2, 2011 : XLPE thermoplastic sheathed Cable specification for working voltage from 3.3kV up to & including 33kV.
- I S: 8130, 1984 : Conductors for insulated electric cables.
- I S: 5831, 1984 : PVC insulation and sheath of electric cables.
- IS: 1255, 1982 : Code of Practice for Installation and Maintenance of Power cables up to and including 33kV rating.

12.1.4. CORE IDENTIFICATION

Cores shall be identified by numbers '1, 2 & 3' printed on their insulation.

12.1.5. CURRENT RATING

The current rating shall be based on the following conditions:

- Max conductor temperature (normal) : 90° C
- During short circuit : 250° C
- Ambient Air temperature : 46° C
- Ground temperature : 38° C
- Depth of laying : 1000mm.
- Thermal resistivity of soil : 150° C cm / W

12.1.6. SHORT CIRCUIT RATINGS

Short circuit rating for the cables shall be as per I S: 7098, pt-2 (Latest Edition). However, the rating shall be based on the following:

- Max conductor temperature (full load) : 90° C
- Max conductor temperature (short circuit) : 150° C

12.1.7. CONSTRUCTION

Salient Construction features as per I S: 7098, Pt.-II, 1985 shall be as under:

- CONDUCTOR : The conductors made from EC grade aluminium wires, are stranded and compacted together. All sizes of conductors of

single or three core cables are circular in shape. Conductor construction and testing comply with I S: 8130, 1984 (as amended up to date).

- CONDUCTOR SCREENING: Conductor shall be provided with extruded semi-conducting compound for cables rated above 3.3KV.
- INSULATION : High quality XLPE; unfilled insulating compound of natural color; shall be applied on the conductor by extrusion process and chemically cross linked by continuous vulcanization process.
- SEMI CONDUCTOR SHIELD: The conductor XLPE insulation shall be provided with extruded semi-conducting compound for cables rated above 3.3KV.

  : Inner conductor shield, XLPE insulation and outer core shielding shall be extruded in one operation to ensure perfect bonding.

  : The conductor shield bond prevents the formation of cavities at the surface of the conductor when the cable is subjected to bends.

  : The void formation at the interface of the semi conducting layer and conductor insulation too is eliminated during heating and cooling cycles in the operation.
- INSULATION SCREENING: Metallic tape (Cu) shall be provided over the semi-conducting shield on the core insulation.
- CORE IDENTIFICATION: The core identification shall comply with the requirements of IS: 7098, pt-2 as follows:
  - By Numerals: 1, 2, 3 printed on cores.
  - By coloured strips applied on the cores.
- INNER SHEATH (common covering): For multi-core cable, cores covered with identification tapes shall be stranded together and to cover the gaps with non-hygroscopic fillers; and provided with common covering of plastic tape. As an alternative to the tape, PVC extruded inner sheath may be provided.
- ARMOUR : For multi-core cable; armouring shall be applied over the inner sheath comprising of galvanized Steel Wire or galvanized Steel Strips.

  : Single core armoured cables shall be provided-with non-magnetic armour consisting of hard drawn flat or round aluminium wires.
- OUTER SHEATH: A tough outer sheath of heat resisting PVC compound (Type ST2 as per I S: 5831) shall be extruded over the armour with embossing of the name of manufacturer, size of cable, Voltage grade etc. as per the requirements of IS specification.
- CROSS-LINKING: The XLPE compound is cross-linked by steam curing for cables up to 11KV grade, however, curing by an inert gas such as 'Nitrogen' is preferred for all HT cables covered by IS: 7098-pt-2.

12.1.8. TESTS (at manufacturer's works)

The cables shall be tested as per IS: 7098 (Pt. II) for 'Type test' (as required) and 'Routine tests' for the following:

- Conductor Resistance Test.
- Partial Discharge Test.

- High Voltage Test.

  The following test voltage is applied between conductor and screen / armour:

VOLTAGE RATING		TEST VOLTAGES
- 1.9/3.3 or 3.3/3.3KV	:	10 KV (rms.) for 5 Minutes
- 3.8/6.6 KV (E)	:	12 KV (rms.) for 5 Minutes
- 6.35/11 KV (E)	:	17 KV (rms.) for 5 Minutes
- 11/11 KV (UE)	:	28 KV (rms.) for 5 Minutes
- 12.7/22 KV (E)	:	32 KV (rms.) for 5 Minutes
- 19/33 KV (E)	:	48 KV (rms.) for 5 Minutes

12.1.9. STORING, LAYING and JOINTING

HT Cables shall be laid in trenches or ducts unless otherwise specified. Generally, laying, jointing and commissioning shall be as per the regulations of ISS and local authorities.

12.1.9.1. STORING

On receipt of H T Cable at site, it shall be inspected to detect any apparent damage. The ends of cable shall be in sealed condition. After inspection, cable shall be stored in a ventilated place on flanges. The cable drums shall not be stored `on flat' with flanges horizontal.

12.1.9.2. LAYING

Cables shall be laid as per the IS: 1255, 1982: Code of Practice for Installation and Maintenance of Power cables up to and including 33kV rating.

- CABLE LAYING IN TRENCH (Directly buried):
  - HT cables shall be laid in outdoor trench at a depth of not less than 1000 mm from upper surface of the ground unless otherwise specified. Where more than one multi-core cables are laid in the same trench, a horizontal internal spacing of 0.15meters (or as specified) shall be maintained to reduce mutual heating and to ensure the fault occurring on one cable shall not damage the adjacent cable.
  - Cable shall be laid in PVC pipes encased in concrete or Hume pipes at all road crossings.
  - Cable shall be laid in trench over rollers placed inside the trench. After the cable has been properly laid and straightened, it shall be covered with 80 mm thick layer of sand. Cable shall then be lifted and placed over this sand cushion. Again, the cable shall be covered with a sand layer of 80 mm thickness. Over this sand layer a course of cable protection tiles with an overlap of 50 mm on either side of cable; shall be provided. Trench shall then be back-filled with earth and consolidated. Suitable cable markers made of aluminium or cast iron; indicating the voltage grade and direction of run of the cables shall be installed at regular intervals.
  - In case precast concrete slab in two halves is used, the base of the cable trench shall be dressed horizontally, compacted using hand compactor and then one half of the precast concrete slab shall be laid on the compacted base. Next half of the precast concrete slab shall be laid adjacent to the first slab in length such that the grooves in the slab are in-line with the first slab. This process of laying the bottom half slabs shall be repeated to get a continuous grooved channel in the whole length of the cable trench. Then the cable shall be laid in the groove as described above and covered with top half slab; encasing the cable in the groove.
  - After the cable has been laid and covered throughout its length, the trench shall be back-filled with earth and consolidated. Suitable cable markers made of aluminium or cast iron; indicating the voltage grade and direction of run of the cables, shall be installed at regular intervals.

- CABLES LAID ON TRAYS:
  - The cables shall be laid on pre erected & treated Steel trays in 'pukka trench' following the procedure mentioned above for cable laying (not sand/earth filling).
  - The cables shall be dressed and clamped to the cable tray using G I sheet steel formed clamps of suitable thickness or nylon ties of suitable size at an interval of 1M when laid vertically and 1.5M when laid horizontally.

12.1.9.3. CABLE JOINTING / TERMINATION

- Cable jointing / termination shall be made as per the instructions of the cable jointing / termination kit manufacturer by qualified and competent cable jointer.
- Cable jointing / termination standard kits shall be heat shrinkable / cold shrinkable type, suitable for in-door / out-door cable termination.
- Cable shall be jointed as per coding; colour or numbering of the cores.
- The cable end-seal shall not be removed until all preparations for jointing / termination are completed.
- Good electrical contact shall be ensured between the glands and armour clamp with cable armour and 'Earth' of the body of the switchgear. The cable end-box and gland shall be bonded to the main earth bus using suitable size of copper tape.

12.1.9.4. TESTS AFTER CABLE JOINTING

- Insulation resistance of both sections of the cables to be jointed; shall be checked by a 1000V megger.
- H. T. cables shall be tested to withstand a voltage as per I S Specifications and local standards after the jointing is completed. Before carrying out the DC high voltage test, the cable shall be laid in its final position with all the end terminations kept unfinished so that substation equipment are not subjected to the test pressure.

12.1.9.5. H.T CABLE TERMINATION

- ALL H.T cables shall have Heat shrink cable termination with cable lugs & accessories) on both side (in-door or out-door as per requirement). Termination Bolts, nuts & Washers shall all be galvanized.
- Each cable shall have Nominal identification plates on both sides showing ('supply from' & 'supply to').

12.2. L T CABLES (PVC & XLPE)

12.2.1. GENERAL

- The LT (1.1KV) XLPE cable shall have Aluminium stranded conductors, Cross Linked Polyethylene (XLPE) insulated, each core having different colour sheath for identification, extruded/taped inner sheath, armoured and over all PVC sheathed construction.
- The LT (1.1KV) PVC cable shall have Copper/Aluminium stranded conductors, PVC insulated, each core having different colour insulation for identification, extruded/taped inner sheath, armoured and over all PVC sheathed construction.
- FRLS cable shall have the over-all outer PVC sheath with the characteristic of flame-retardant low smoke generation.
- Responsibility of the installer shall be to follow the NBC 2016 in terms of fire safety specially as mentioned here-under:
  - Clause **3.4.7** for electrical installations "the shaft shall be sealed at every floor with fire stop materials having the same fire resistance as that of the floor…"
  - Clause **3.4.6.5**for vertical opening, "every vertical opening between the floors of a building shall be suitably enclosed or protected .."

- Clause **3.4.5.4** Service ducts and shafts, "the space between the cables/conduits and the walls/slabs shall be filled in by a fire stop material having fire resistance rating of not less than 120 min…."

12.2.2. STANDARDS

o The LT cables shall conform to the following I S Standards (latest editions):

- I S: 7098, pt-1, 1985 : XLPE insulated PVC sheathed Cable specification for working voltage up to 1100V.
- I S: 1554, Pt-1, 1988 : PVC insulated Cables up to 1100 V
- I S: 8130, 1984 : Conductors for insulated electric cables.
- I S: 5831, 1984 : PVC insulation and sheath of electric cables.

o Tests for flame retardant low smoke (FRLS) cables shall be as per following standards:

-	ASTM-D-2863/77	: Oxygen Index Test	:	29 % (min)
-	ASTM-D-2863/77	: Temperature Index	:	250º C (min)
-	ASTM-D-2843/77	: Smoke Density	:	Light Transmission
-	I S: 10810-1988	: Smoke Density	:	40% (min)
-	I S: 10810-1988	: Gas generation		
-	IEC – 754 – 1	: Halogen Acid	:	20% (max)
-	SS-424-14-75	: Flame Retardant Test	:	300mm (min)
	(Class F–3)	: Swedish Chimney Test		

12.2.3. SELECTION CRITERIA

Cable shall be selected based on following factors:

- Short circuit current and its duration,
- Continuous current carrying capacity,
- Installation conditions,
- Voltage drop under starting and normal running conditions.
- Limit cable sizes to standard manufactured sizes.

12.2.4. TECHNICAL SPECIFICATION

12.2.4.1. LT CABLE – PVC INSULATED

PVC cable shall be extruded PVC sheathed Aluminium or Copper stranded conductor. All other items shall be same as for XLPE cable.

12.2.4.2. LT CABLE (1.1KV) XLPE INSULATED

The LT (1.1KV) XLPE cable shall have Aluminium stranded conductors with Cross Linked Polyethylene (XLPE) insulation as per I S: 7098, pt-1 with the following requirements:

o CORE IDENTIFICATION: The core identification for multi-core cables shall be provided with colour coding / numbering.

o CONDUCTORS: The conductors of power cables are made from electrical purity aluminium, and those of control cables are of annealed high conductivity copper. However, copper conductor power cables can also be made as required. All conductors conform to I S: 8130, 1984.

o INSULATION : High quality cross-linked Polyethylene (XLPE) unfilled insulating compound (with steam curing) is used for XLPE Cables of 1.1KV grade.

- LAYING UP : In multicore cables, cores shall be laid up as per the colour scheme and interstices filled up wherever necessary; to make the laid up cable circular in cross-section.
- INNER SHEATH: For all multi-core cables; inner sheath shall be either extruded GP PVC as per I S: 5831 or thermoplastic or proofed tape (refer BOQ).
- ARMOURING : For multi-core cables, armouring shall be applied over the inner sheath.
  - : In case of cables where the fictitious diameter over the inner sheath does not exceed 13mm, the armour shall consist of galvanised round steel wires;
  - : Above this size, normally the armour shall be of galvanised formed steel strips.
  - : For single-core cables, armour shall be Aluminium round wires.
- OVER ALL PVC SHEATH: For multi-core cable, the over-all PVC sheath insulation shall be of type ST-2 as per I S: 5831.
- In case of unarmoured single-core cables, the over-all PVC sheath insulation shall be extruded over the insulation.

12.2.4.3. FRLS PVC CABLE

- Flame Retardant Low Smoke generating (FRLS) PVC cable shall be PVC insulated Aluminium conductor, FRLS PVC extruded / taped inner sheath, armoured, over-all FRLS PVC sheathed cable conforming to I S: 1554 (Part-I) 1972 (Latest edition).
- Both; inner & outer sheaths of the Cable may or may not be FRLS depending on the specification. However, the outer sheath of the Cable shall be FRLS PVC
- The inner and outer sheaths shall be GP / HR PVC as specified in BOQ.
- The armour shall be G I strip or round wire as per the IS specification.

12.2.5. CABLE INSTALLATION

12.2.5.1. GENERAL

- LT cables shall be supplied, inspected, laid, tested and commissioned in accordance with drawings, specifications, latest edition of relevant Indian Standard Specifications, National Electrical Code (latest edition), cable manufacturer's instructions and as instructed by the engineer-in-charge.
- The cable shall be delivered at site in original drums with manufacturer's name clearly written on the drum.
- The recommendation of the cable manufacturer with regard to joining and sealing shall be strictly followed.
- Beyond 10sq.mm Cu wire size, Cables shall be considered.

12.2.5.2. CABLE LAYING

- Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize scratching and twisting of cables.
- While shifting for a small distance the cable drum shall be rolled such that the cable does not unwind, then it shall be placed on jacks before unwinding the cable to avoid formation of kinks. The drum shall be unrolled and cable run over wooden rollers in a trench placed at intervals not exceeding 2 meters.
- Cables shall be laid in trenches or on cable trays as per indicated route. While laying cables in trench, at least 10 cm of fine sand cushion shall be put under them.

- Cable ties shall be used to keep the cables in position at every 1.5 meters when laid horizontally and 1 meter when laid vertically on tray.
- At change of direction in horizontal and vertical planes, the cable shall be bent smoothly with a radius of bend not less than 12 times the diameter of the cable.
- Minimum 3 meters long loop shall be provided at both sides of every straight joint and at each end of the cable.
- Identification marks indicating cable number as per cable schedule shall be put on cable tags tied on the cable at intervals for identification.
- Insulation tapes of appropriate voltage in red, yellow and blue color shall be wrapped just below the sockets for phase identification. The insulation tape for neutral wire shall be black and for earth it shall be green.

12.2.5.3. LABELS ON CABLES

Labels shall be of anodized aluminium strip of minimum thickness of 1.6mm with white engraving on black background. They shall be properly secured to the cable with fasteners.

12.2.5.4. JOINTS IN CABLES

- The cables received at site; shall be apportioned to various locations in such a manner as to ensure maximum utilization avoiding joints. This apportioning shall be approved by the client before the cables are cut to required lengths.
- Normally no jointing shall be permitted between feeder lengths unless the required length is more than the cable drum length. The cable jointing shall be done as per the recommendations of the manufacturer.

12.2.5.5. CABLE TERMINATION

- Cable entries and terminations shall be provided in the Distribution board to suit the number, type and sizes of power and control cables specified for in-coming and out-going feeders.
- Provision shall be made for top and/or bottom entry of cables in the Distribution board as required with the position of cable gland and terminals such that cables can be conveniently and safely terminated without any forces on the termination points.
- Barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of other live circuit.
- Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

12.2.5.6. CONTROL WIRING

- Control wiring shall be carried out with 1100 / 660V grade single core PVC insulated Cu wire conforming to I S: 694 having stranded copper conductor of minimum 1.5sq mm for potential circuits and 2.5sq mm for current circuits.
- Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance.
- Control wiring shall be identified by interlocking type numbering ferrules at both ends.
- All control fuses shall be mounted in front of the panel and shall be easily accessible.

12.2.5.7. TERMINAL BLOCKS

- Terminal blocks shall be 500Volts grade of the stud type ELMAX make or equivalent.
- Insulating barriers shall be provided between adjacent terminals.
- Terminal blocks shall have a minimum current rating of 10amps and shall be shrouded.
- Provision shall be made for label inscriptions.

12.2.6. CABLE IDENTIFICATION

Cable identification shall be provided as per the requirements of I S by embossing on the outer sheath the following:

- Manufacturer's name / trade mark,
- Voltage grade,
- Year of manufacture,
- Type of insulation,
- Nominal area of cross-section of the conductors & No. of cores.

Cable shall be jointed / terminated using standard cable jointing / termination kits - heat shrinkable / cold shrinkable type, suitable for in-door / out-door cable termination.

12.2.7. PACKING

Cables shall be supplied in non-returnable drums made of wood / steel. The drums shall be of heavy construction as per I S requirements.

12.2.8. TESTS

12.2.8.1. TESTS AT MANUFACTURER'S WORKS

Type tests as agreed; shall be carried out at the manufacturer's works as per I S: 7098 (Pt-1) (latest edition).

All routine tests specified in I S: 7098, Pt-1 (latest edition) shall be carried out and test certificates submitted to the Engineer-in-charge.

12.2.8.2. TESTS BEFORE LAYING

Insulation test shall be done between phases and between phase & earth for each length of cable before laying the cable.

12.2.8.3. TESTS AFTER LAYING

- On completion of cable laying work, the following test shall be conducted in the presence of the Owner's representative:
  - Insulation resistance Test. (Sectional & overall)
  - Continuity Resistance Test.
  - Sheathing continuity Test.
  - Earth Test.
- All tests shall be carried out:
  - In accordance with relevant Indian Standard Code of Practice and Indian Electricity Rules.
  - The Contractor shall provide necessary instruments, equipment and labour for conducting the above test and shall bear all expenses in connection with such tests.
  - All tests shall be carried out in the presence of the clients' Representative.

12.2.9. DOCUMENTATION

- Manufacturer's Catalogue giving cable construction details, current ratings under different laid conditions, guaranteed technical particulars etc.
- Type test reports.

12.3. CABLE TRAYS

12.3.1. GENERAL

- Cable tray shall be of following types:
  - Perforated Sheet cable tray,
  - Ladder type cable tray.
  - Wire mesh cable tray.
- The MS cable trays shall undergo rigorous rust proofing process comprising of degreasing, de-scaling and a recognized phosphating process using '7 tank method'. The steel work shall; then be given two coats of oxide primer before two coats of final painting.
- Cable trays shall be either painted (Stove enameled) or hot dip galvanized as called for in the schedule of quantities.
- When the cable tray needs to be hot dipped galvanized:
  - The galvanization shall be done in accordance with ISO 1461-1999 or
  - Zinc to be used shall conform to minimum Zn 98 grade as per requirement of I S: 209, 1992. Minimum weight of zinc coating for mild steel flats with thickness up to 6 mm; shall be as per I S: 6745, 1972; shall be 400 g/sq m.
  - The weight of coating expressed in grams per square meter shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.
  - The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches, black spots, pimples, lumpiness, runs, rust stains, bulky white deposits, blisters etc.
- Cable trays shall be complete with bends, joints, coupler plates, accessories and hard-wares as may be required for joining the cable trays.
- Separate cable trays shall be used for the following group of cables:
  - H T Power cables,
  - L T Power cables,
  - Control, measuring and metering cables,
  - D C Cables,
  - Light current cables.
- Responsibility of the installer shall be to follow the NBC 2016 in terms of fire safety specially as mentioned here-under:
  - Clause **3.4.7** for electrical installations “the shaft shall be sealed at every floor with fire stop materials having the same fire resistance as that of the floor…”
  - Clause **3.4.6.5**for vertical opening, “every vertical opening between the floors of a building shall be suitably enclosed or protected ..”
  - Clause **3.4.5.4** Service ducts and shafts, “the space between the cables/conduits and the walls/slabs shall be filled in by a fire stop material having fire resistance rating of not less than 120 min….”

12.3.2. STANDARDS

Cable tray shall be made to the following Standards:

- IEC: 61537 : Cable management – Cable tray & cable ladder systems.

- ISO 1461-1999 articles. : Hot dipped galvanized coatings on fabricated iron & steel
- I S: 6745, 1972 : zinc coating for mild steel galvanization.
- I S: 209, 1992. : Zinc grade (minimum Zn 98) to be used for galvanization.

12.3.3. DESIGN AND FABRICATION OF CABLE TRAYS / LADDERS

The cable trays shall be fabricated according to the design specified by IEC: 61537 and shall be tested for Safe Working Load (SWL).

- The relevant details of SWL and the load chart with respect to SWL, supporting distance and the deflection shall be according to the following chart as per IEC 61537:

Safe Working Load (SWL) with a span length up to 3 meters						
Description	Side Height (in mm)	Width (in mm)	Span length (in meters)			
			1.5m	2m	2.5m	3m
			Permitted Load (in kg/meter)			
Perforated Cable Tray	35	50 - 300	125	90	50	-
	60	50 - 600	150	100	50	-
	85	100 - 600	175	110	50	-
	110	100 - 550	185	130	75	60
Cable Ladder	45	200 - 600	180	140	100	55
	60	200 - 600	-	225	150	100
	110	200 - 600	-	310	200	140

Safe Working Load (SWL) with a span length up to 10 meters									
Description	Side Height (mm)	Width (in mm)	Span length (in meters)						
			4m	5m	6m	7m	8m	9m	10m
			Permitted Load (in kg/meter)						
Perforated Cable Tray (long span distance)	110	200 - 300	160	110	75	-	20	-	-
		400 - 600	200	150	100	-	40	-	-
	160	200 - 300	230	180	140	100	70	-	-
		400 - 600	250	200	160	130	100	-	-

Cable Ladder (long span distance)	110	200 - 300	160	110	80	40	-	-	-
		400 - 600	210	150	100	70	-	-	-
	160	200 - 300	230	180	140	100	70	-	-
		400 - 600	250	200	160	130	100	-	-
	200	200 - 600	-	-	300	250	200	140	100

- Fabrication of Tray / Ladder and accessories at site and welding is not permitted.
- In unavoidable circumstances if any cut or holes are made in the trays / Ladder / accessories, zinc spray need to be applied over the surface.
- Cables shall run in cable tray / ladder mounted horizontally or vertically on cable tray support system supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures using mounting accessories.
- The cable tray and all accessories shall be fabricated from sheet steel and shall have a Base Perforation Class B according to IEC: 61537.
- The cable tray and all accessories be hot dip galvanized against corrosion confirming to ISO: 1461-1999 for installations in both; indoor and out-door applications.
- The cable trays shall be supplied in standard lengths of 3M and the width of the tray shall be: 50, 100, 150, 200, 300, 400, 500, 600 & 750mm.
- All the cable tray accessories like Bends, TEEs, Crossovers etc. shall be designed in accordance with IEC: 61537 and shall be fabricated in the same factory as the cable tray for compatibility.
- The accessories shall be of the same material as the tray and of modular design.
- The accessories shall be connected with the trays by using fasteners as recommended by the manufacturer (of the cable tray).
- For Cable trays designed, tested and confirming to IEC 61537:
  - Sheet thickness of cable tray shall be according to the manufacturer's catalogue.
  - For locally fabricated and non-tested tray, thickness shall be minimum 2mm up to span length of 3meter and 2.5 to 4mm for span length between 4M and above.
- Standard technical details of ladder type cable trays shall be as follows:

S. No.	SIZE OF TRAY	SIZE OF MAIN CHANNEL	SIZE OF RUNG & SPACING	CABLE TRAY SUPPORT (Horizontal)
1.	900 to 1500 mm	25x100x25x2.5 mm	20x50x20x 2mm @ 250 C/C	50x50x 5mm angle @ 1000mm spacing.
2.	450 to 750 mm	25x75x25x2.0 mm	20x50x20x2mm @ 250 C/C	40x40x5mm angle @ 1250mm spacing.
3.	150 to 300 mm	25x75x25x2.0 mm	15x30x15x2mm @ 250 C/C	40x40x3mm angle @ 1500mm spacing.

12.3.4. COVER FOR CABLE TRAYS / LADDERS

The Cover for trays / ladders to protect the cable insulation from falling objects, water droplets, (harmful) effects of ultraviolet rays and accumulation of dust shall:

- Be made either of hot dip galvanized sheet steel or superior quality double-dip galvanized sheets. For outdoor application, double-dip galvanized material shall be used.
- Be fitted properly to the Ladder / Tray by using pre fixed and tested locks which ensure that covers are fitted rigidly to the Tray / Ladder.
- Have additional cross over beadings for outdoor application in high wind areas for fixing the cover on tray / ladder of width > 500mm.

12.3.5. MOUNTING ACCESSORIES (SUPPORTS AND BRACKETS)

- The mounting accessories (supports and brackets) for installation in both; indoor and outdoor shall be:
  - Fabricated from sheet steel and shall be modular in design.
  - Factory made, hot dip galvanized (confirming to ISO 1461-1999) after completing welding, cutting, drilling, other machining operations and tested according to IEC: 61537.
  - Designed to allow easy assembly at site by using bolts and nuts. The main support and brackets shall be fixed at site using necessary brackets, clamps, fittings and other hard ware etc. as required.
- Welding of the components at the site shall not be allowed.
- Hangers shall be minimum 10mm diameter GI Round bar, threaded at both ends.

12.3.6. ERECTION OF CABLE TRAYS AND LADDERS

The cable tray and ladder:

- Shall be run horizontally and/or vertically as required at site.
- When run horizontally, shall be either supported from the ceiling or supported on wall/structure as per site requirement.
- When supported from ceiling:
  - Hangers/suspenders of minimum 10mm diameter round bar shall be used to hang the tray. The suspenders, threaded at both ends, shall be passivated/galvanized as required.
  - The hangers/suspenders shall be supported using ‘Hilti’ type metal fasteners of suitable size at an interval of maximum 1.5M horizontally.
  - Adequate size of angle iron or flat, properly treated for preventing it from rusting, shall be used to support the tray by hangers.
- When run vertically, shall be supported on the column / wall as required at site in plum at an interval of maximum 2M / (horizontally 1.5M) on 25x40mm GI channel section or factory-made support accessories so that a clear gap of 40mm remains between the tray and the supporting wall / column, required to strap the cables on the tray.
- Shall be bonded to the earth terminal of the distribution boards at both ends. The length-wise joints shall be bonded by strips / flexible wires of suitable size unless the earth strip runs throughout the length of the cable tray.
- Length shall be measured along the center line of the cable tray, including bends, reducers, tees, cross joints, etc.

12.3.7. INFORMATION BY MANUFACTURER

The manufacturer shall provide in his literature; all information necessary for the proper and safe installation and use of the cable tray and cable ladder system including the SWL. The SWL and impact resistance shall be valid for the whole temperature classification declared. The information shall include:

- Instructions for the assembly and installation of system components and for the precautions required to avoid excessive transverse deflection, which could cause damage to the cables.
- Thermal Expansion properties and precautions to be taken, if necessary.
- Material, surface treatment and Salt Spray Test certificate.
- Relative humidity if it affects the material and surface treatment.
- Information on holes/devices provided for equipotential bonding or to run Earth Bonding Bar.
- Precautions for transport/storage outside the temperature classification zone, as applicable.
- Product dimensions.
- Torque setting in Nm for screwed connections and internal fixing devices. These devices should not damage the cable when correctly fixed. Sudden/jerky motions shall be avoided to tighten reusable screw connections.
- End-span distance.
- Position and type of coupling along the span.
- SWL in kg/m for the fittings when not directly supported.
- Fixing method for installing cable tray or cable ladder to the supports.
- SWL in kg/m for the cable tray / ladder lengths including joints for various spans in the form of a diagram, table etc. Compliance shall be checked by inspection.
- SWL in kg for cantilever brackets.
- SWL for pendants as a bending moment in kg and /or as a force in N.
- The appropriate material specification and environmental conditions, chemical environments or aggressive agents for which the product is suitable.

12.3.8. TESTING AND CERTIFICATION

Cable tray / ladder, bend, T Bend, cross, and all supports shall be tested for 'Safe Working Load' (SWL), deflections, Impact resistance & electrical continuity test according to IEC: 61537.

- The cable tray/ladder shall not deflect more than 1/100th of the span length at SWL in mid-span and the transverse deflection of all mounting accessories at SWL shall not exceed 1/20th of the length.
- The cable tray / cable ladder shall be tested up to 1.7 times SWL at minimum and maximum room temperatures.
- The temperature classification of cable tray system shall be - 5 to + 150°C.

12.3.9. SPECIFICATION FOR WIRE MESH CABLE TRAY

12.3.9.1. GENERAL

- Wire mesh cable tray system shall support and accommodate power, Instrumentation & communication (data network, voice, video and other low-voltage) cables.
- Cables shall run in cable tray mounted horizontally or vertically on cable tray support system which in turn; shall be supported from floor, ceiling, overhead structures, trestles or other building structures using mounting accessories.
- Installer shall comply with manufacturer's installation procedures. Support and cable loading shall be done in accordance with manufacturer's load diagram.

12.3.9.2. STANDARDS

Cable tray shall be made to the following Standards:

- IEC: 61537 : Cable management – Cable tray & cable ladder systems.
- ISO 1461-1999 : Hot dipped galvanized coatings on fabricated iron & steel articles.
- I S: 6745, 1972 : zinc coating for mild steel galvanization.
- I S: 209, 1992. : Zinc grade (minimum Zn 98) to be used for galvanization.
- DIN: E-12329 : Electro galvanization of steel wire.

12.3.9.3. DESIGN AND FABRICATION OF MESH CABLE TRAYS

The wire mesh cable tray system shall be designed, constructed and tested according to IEC: 61537 (tested for Safe Working Load) (SWL).

- The relevant details of SWL and the load chart, supporting distance and the deflection as per the requirements of IEC: 61537 are as follows:

Safe Working Load (SWL) with a span length up to 2 meters					
Description	Side Height (in mm)	Width (in mm)	Span length (in meters)		
			1 m	1.5 m	2 m
			Permitted Load (Kg/meter.)		
Mesh cable tray	35	50 - 150	25	11	10
		200	30	14	10
		300	75	22	15
	55	50 - 150	25	12	8
		200 - 400	60	28	25
		500 - 600	75	38	25
	105	100 – 200	80	55	37
		300 – 400	110	75	53
		500 – 600	125	85	60

- Each section of mesh tray shall have a standard length of 3meter of continuous, rigid, welded steel wire mesh.

- Consecutive straight lengths of mesh trays shall be connected without couplers or connecting tools.
- Screwed connections and internal fixing devices for the mesh tray shall not damage the cable. Sudden or jerky motions shall not be used to tighten reusable screw connections.

12.3.9.4. SURFACE TREATMENT

The surface treatment of the wire mesh cable tray and accessories shall be done according to area of application as follows:

- Electro galvanized wire mesh confirming to DIN: E-12329 with minimum 10 microns zinc coating for indoor closed and dry atmospheric application.
- Hot dipped galvanized wire-mesh confirming to ISO: 1461, 1999 with minimum 60 microns zinc coating for outdoor or open area applications.
- Stainless steel 304 wire-mesh for food/beverage/pharmaceutical and clean room application.
- Stainless steel 316 wire-mesh for highly corrosive atmospheric areas like chemical plant & Off-shore platforms.

12.3.9.5. CONSTRUCTION

- The Tray shall be constructed using 50mmx100mm grid except for 50mm wide tray to ensure maximum ventilation of cables and dissipation of heat.
- For 50mm wide tray, the grid size shall be 20mmx100mm.
- All exposed fabricated edges shall be tapered to ensure safe handling and installation of the product. One end of each straight section of formed wire mesh cable tray shall be of integrated interlocking ends.
- The diameter of the steel wire shall be minimum 3.5mm for trays up to 150mm width and 4.5 mm for trays up to 600mm width.
- Screw less straight connection of mesh cable tray shall be made without couplers and special tools for straight consecutive lengths.
- All tray fittings (for change in direction) shall be constructed at site by using bolt cutters and fastened using joint connectors, clamps & corner connectors with M6x20 bolt and combination nut.
- The connectors and clamps shall be same or higher corrosion resistance class of the tray.

12.3.9.6. MOUNTING ACCESSORIES (SUPPORTS AND BRACKETS)

- The mounting accessories shall be fabricated from steel and shall be hot dip galvanized against corrosion confirming to ISO 1461-1999 for installations in both indoor and outdoor applications and shall be of completely modular type.
- All supports and Brackets shall be factory made, hot dip galvanized after completing welding, cutting, drilling, other machining operations and tested according to IEC: 61537.
- The system shall be designed so as to allow easy assembly at site by using bolts and nuts.
- The main support and brackets shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc to form various arrangements required to support the mesh trays.
- Welding of the components shall not be allowed.

12.3.9.7. TESTING AND CERTIFICATION

- Mesh tray and all mounting supports shall be tested for Safe Working Load (SWL), deflections, Impact resistance, Salt Spray & Electrical continuity test according to IEC 61537.
- The cable tray shall not deflect more than 1/100th of the span length at SWL in Mid span for mesh trays and the transverse deflection of all mounting accessories at SWL shall not exceed 1/20th of the length.
- The mesh tray shall be tested up to 1.7 times SWL at minimum and maximum Temperature. The temperature classification of mesh tray system shall be - 5 to + 150°C.
- CORROSION PROTECTION TEST: Sample tray / accessories / mounting accessories and supports shall be salt spray tested according to ISO: 9227 as follows:

#	Corrosion resistance class	Material Surface Treatment	Salt spray test duration
1	1	Electro Galvanized	24 Hours
2	6	Hot Dip Galvanized	550 hours
3	6	Double Dip Galvanized	550 Hours
4	9 A to 9 D	Stainless Steel	Not applicable

12.3.9.8. MARKING, DOCUMENTATION, COMPLIANCE AND INSPECTION

The manufacturer/vendor shall provide in his literature all information necessary for the proper and safe installation and use of the mesh tray system. The SWL and impact resistance shall be valid for the whole temperature classification declared. The information shall include:

- Instructions for assembly & installation of wire-mesh tray assembly components and precautions to avoid excessive transverse deflection causing damage to the cables.
- Thermal expansion properties and precautions to be taken, if necessary.
- Material, surface treatment and Salt Spray Test certificate.
- Relative humidity if it affects the material and surface treatment.
- Information on devices provided for equi-potential bonding or to run Earth Bonding Bar.
- Product dimensions.
- Torque setting in Nm for screwed connections and internal fixing devices. These devices shall not create any damage to the cable when correctly fixed. Sudden or jerky motions shall not be used to tighten reusable screw connections.
- End span distance.
- Position and type of coupling along the span.
- SWL in Kg/m (in the form of a diagram, table) for:
  - The fittings when not directly supported.
  - Mesh tray lengths / lengths including joints for various span distances.
  - Cantilever brackets.
  - Pendants as a bending moment in Kg and /or as a force in N.
- Fixing method for installing mesh tray on to the supports.

- The appropriate material specification and environmental conditions, chemical environments or aggressive agents for which the product is suitable.
- Each system component shall be durably and legibly marked with:
  - Manufacturer's / vendor's name or trade mark or identification mark;
  - Product identification mark which may be a catalogue number, a symbol, or the like.
  - When system components are supplied in a package, the product identification mark may be marked on the smallest package unit.
  - Marking shall be applied by molding, pressing, engraving, printing, adhesive labels, or water slide transfers.
  - If a system component is stored and transported at a temperature outside the declared minimum and maximum temperatures, the manufacturer or responsible vendor shall declare the precautions and the alternative temperature limits.

13. SOLAR POWER PLANT

13.1. SCOPE

This specification covers complete planning, design, manufacture, testing at the manufacturer's works, packing & forwarding and delivery at the site including its installation, testing & commissioning of Stand-alone Roof-top or on building facade Solar PV Power Plant as required on a turnkey basis; complete with all accessories, fittings and auxiliary equipments as required for efficient and trouble-free operation.

13.2. QUALIFICATION REQUIREMENTS

The Solar PV Power Plant bidder shall have:

- An entity duly incorporated in India under relevant law and engaged in the business of solar power. Incorporation certificate to be provided.
- The company or its affiliates or its parent company shall be manufacturer of PV modules with IEC: 61215: 2005, IEC: 61730 pts 1 & 2, 2007 in conjunction with factory inspection. Relevant proof to be submitted.
- The PV module manufacturing plant shall be certified under ISO: 9001: 2008 & ISO: 14001 – proof to be submitted.
- MNRE approved channel partner certification and tested their products as per IEC standards.
- A minimum experience of 5 years in this field,
- Planned, designed and executed roof top & building façade solar PV power plants (i.e. supply, installation, commissioning and O & M) in India on turnkey basis in the last five years, & having a capacity of 200kwp plant in one location, minimum 100kWp plant installed at two location; operating for more than 3 years. Purchase orders and final Commissioning & handover certificates shall be provided.

13.3. SITE CONDITIONS

The power plant shall comply and perform satisfactorily at the following general climatic conditions, prevailing at project site:

a) Ambient temperature : 45ºC

b) Relative humidity : 95% (at 55ºC)

The power plant shall be suitable for continuous operation at rated load for the above ambient temperature and relative humidity, the maximum temperature and humidity, however, not occurring simultaneously.

13.4. STANDARD

The complete planning, design, manufacture and performance of equipment shall fully comply with all currently applicable statues, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be construed to relieve the CONTRACTOR of his responsibility. The equipment shall comply with the latest edition of the following standards:

1. IEC: 61215/IS14286 : Requirements for photovoltaic modules
2. IEC: 61730-I : Requirements for construction for photovoltaic modules
3. IEC: 61730-II : Requirements for testing for photovoltaic modules
4. IEC: 61683, 1999 : Requirements for efficiency of photovoltaic modules
5. IEC: 60068-2-1,(2-2, 14, 30) : Requirements for Environment capacity for photovoltaic modules
6. IEC: 60529:1989+A1:1999 : Requirements for IP-65 protection of photovoltaic modules
7. IEC: 62109 : Requirements for Safety of photovoltaic modules
8. IEC: 61727 : Requirements for Grid connectivity of photovoltaic modules
9. IEC: 60227/IS 694/IEC: 60502/ IS: 1554 (Pt.-1 & II) : PVC insulated Al /Cu conductor, armored/un-armored . Cable.

   IEC: 60947 part I, II, III/IS: 60947 Part-I, II, III/

   EN: 50521 : L V Switchgear & Control gear.

13.5. SYTEM CONFIGARATION (Utilization Voltage & Variations)

a) Main Power circuits : 415V ±10% AC

b) Lighting Power circuits : 230V ±10% AC

c) Emergency Power Supply : 415V AC from DG Source

d) Control Power : 230V ±10% AC

e) Frequency : 50 Hz ±5

13.6. QUALITY AND WORKMANSHIP

Solar PV modules are designed for a life-cycle of 25 years or more. It is, therefore, essential that all system components and parts including the mounting structures, cables, junction boxes, distribution boxes and other parts also have a life-cycle of 25 years. All works; therefore; shall be undertaken with the highest level of quality and workmanship.

13.7. TECHNICAL SPECIFICATION

13.7.1. SOLAR PV MODULE:

- The photo-voltaic modules shall be Mono/Poly Crystalline with at least 540 *Wp* power class or higher.
- The photo-voltaic modules shall meet the requirements of:
  - IEC: 61215 / IS: 14286 standards,
  - IEC: 61730-I for construction &
  - IEC: 61730 part - 2 for testing and safety qualification.
- The photo-voltaic modules shall:
  - Have high efficiency and very good low light performance.
  - Be tested and approved from any of the NABL / BIS / IEC / MNRE accredited Testing Calibration Laboratories.
- The supplier shall provide performance guarantee for the PV modules used in the power plant which shall be warranted for their output peak watt capacity:
  - Not less than 90% at the end of 10 years and
  - 80% at the end of 25 years.
  - Product Warranty: 5 years.
- Necessary TDS of the SPV modules shall be furnished from OEMs.

Detailed specifications of the solar PV modules shall be as follows:

1	Make of Panel	Refer make list
2	Wattage and qty of the Panels	As per latest design standard by OEM
3	Type of Panel	Monocrystalline
4	Panel Glass Thickness	3.2mm
5	Module Framing	Potential Induced degradation (PID)
6	Panel Certification	BIS
7	Yearly Degradation for 25 years	maximum 1%
8	Module efficiency	minimum 18%
9	Power guard Insurance	To be provide by Vendor
10	Make of DC Cable	LAPP / Leoni copper

11	Make of Connector of DC Cable	Multi , Mc4 model
12	Conduit	UV Protected FRLS Color - Black
13	DC Cable joint	By Hydraulic Crimping
14	Alignment	by Laser before & after Installation
15	Make of Inverter	SMA/delta (Designed at 55°C Ambient) IP 67
16	Capacity of inverters and Qty	To be provide by Vendor as per design
17	Remote Monitoring through internet	In the scope of Vendors (Internet connection in the scope of client)
18	String Monitoring SCADA System	Upto String Level
19	Make of Lighting Arrestor	ESE type Level 2
20	DG & Panel Synchronization	in the scope of Solar Vendors
21	Main Electrical Panel Synchronization	in the scope of Solar Vendors
22	Junction Box	IP67
23	Mounting Structure for Module	Aluminum with SS fasteners
24	Walkway PEB Structure	Hot dipped GI 600mm with hand rail
25	Earthing & LPS	in the scope of Vendors/ Contractor, warranty 10 years, dual earthing of each component, Vendor to Specify type and qty.
26	Net Meter installation, liasioning with Govt. / SEB and safety approvals	in the scope of Vendors/ Contractor
27	Liasioning & Approval from Pollution control board if any	in the scope of Vendors/ Contractor
28	Structural design and validation with certification	in the scope of Vendors/ Contractor
29	REC certificates and IEX registration	in the scope of Vendors/ Contractor
30	System individual warranty	Warranty - Solar Panels- 10 years, inverter 7 Years & rest components (Earthing - 10 years), rest structure , cable, panel etc for 5 years
31	AC Cable, Wires XPLE	Make - Havells, Polycab , KEI, Ralison, Universal

13.7.2. INVERTERS:

13.7.2.1. ON-GRID INVERTER:

String inverter / PCU of capacity 100 KW, 3 ph, 400V grid / as required; shall convert DC Power in to AC Power.

The Inverter shall:

- Be 'String Inverter' with efficiency of ≥ 98% and extensive DC and AC side protections.
- Be rated for continuous operation at full load.
- Have Programmable battery management parameters.
- Have 'Temperature compensated' battery charging system.
- Have 'automatic re-start' after over-load triggered shutdown.
- Have 'Continuous battery life' and 'state-of-health' monitoring. It shall have Integrated data and fault logging.
- Have industrial-type data communication with SCADA network / PC.
- Have facilities like Remote diagnostics, monitoring and reporting via Internet and GSM.
- Have 'Product Warranty' for 5 years, extendable to 10 years.

13.7.2.2. SOLAR GRID INVERTER:

The solar grid inverter; used to convert the DC power of the solar PV modules to grid-compatible AC power; shall have the detailed specifications as follows:

Enclosure	Free standing / Wall mounted, IP-66, Epoxy powder coated.
Cooling	Temperature controlled fan forced/Natural Air Cooling.
Total output power (AC)	To match solar PV plant capacity while achieving optimum system efficiency.
Input DC voltage range	As required for the solar grid inverter DC input.
Dielectric strength	1.1 KV between input / output and ground with EMI protections removed
Maximum power point (MPPT) tracking	Yes
Number of independent MPPT Inputs	1 or more
Output AC voltage	Three phase: 415V (+ 12.5%, - 20%)
Operating Frequency range	47.5 – 52.5 Hz
Nominal frequency	50 Hz
Power factor of the inverter	> 0.98 at nominal power
Surge Rating @ 40°C	105% > 60 sec, 150% > 30 sec, 200% > 5 sec
Total harmonic distortion	< 3%
Built-in Protection	AC high / low voltage; AC high /low Frequency

Anti-islanding protection	As per VDE: 0126-1-1 / IEC: 60255.5 / IEC: 62116 / equivalent standards. (Proof to be submitted).
No load consumption	< 500W
Operating ambient temperature range	0°C to +60°C
Humidity	0 - 95% Rh, Non-condensing
Inverter efficiency Weighted efficiency	: ≥ 95% : 94%
Protection degree	: IP 65 for outdoor mounting,
Communication interface	RS 485 / RS 232 and RJ45
Cooling Convection Display type	LCD for data display, LCD / LED for status display
Display parameters to include	: Output power (W), cumulative energy (Wh), : DC voltage (V), DC current (A), : AC voltage (V), AC frequency (Hz), AC current (A).

Inverter IEC Certificates: Shall be provided along with the offer complying the following:

1. IEC: 61683: 1999 : (Efficiency)
2. IEC: 60068-2-1, (2-2, 14 & 30) : (Environment)
3. IEC: 60529: 1989+A1: 1999 : (IP 65 or higher)
4. IEC: 62109 : (Safety)
5. IEC: 61727 : (Grid Connectivity)

13.7.2.3. CONNECTION TO BUILDING ELECTRICAL SYSTEM:

- The AC output of the solar grid inverter shall be connected to the building's electrical system:
  - The solar grid inverter output shall be connected to a dedicated module in the Main Distribution Board (MDB or LT panel) of the building.
  - It shall not be connected to a nearby load or socket point of the building.
- The grid connection shall be done after connecting the 'Dual energy meter' unless there is no chance of feeding the energy to the grid in which case the 'Dual energy meter' is not required.
- 'Solar power' needs to be run in parallel with the diesel generator, a paralleling controller shall be used for the purpose.

13.7.3. CABLES & CABLE RACKS:

- All cables shall conform to IEC: 60227 / IS: 694 & IEC: 60502 / IS: 1554. Voltage rating: 1100V AC, 1500V DC.
  - For the DC cabling: XLPE insulated and PVC sheathed, UV stabilized single core flexible copper cables shall be used. Multi-core cables shall not be used.

- For the AC cabling: PVC or XLPE insulated and PVC sheathed single or multi-core flexible copper cables shall be used. Outdoor AC cables shall have a UV- stabilized outer sheath.
- Total voltage drop: On the cable segments from the solar PV modules to the solar grid inverter shall not exceed 2.0%.
- Total voltage drop: On the cable segments from the solar grid inverter to the building distribution board shall not exceed 2.0%

➢ The DC cables from the SPV module array shall run through a UV stabilized PVC conduit pipe of adequate diameter with a minimum wall thickness of 1.5mm.

➢ Cables and wires used for the interconnection of solar PV modules shall be provided with solar PV connectors and couplers.

- All cables and conduit pipes shall be clamped to the rooftop, walls and ceilings as required with thermo-plastic clamps at intervals not exceeding 50 cm.
- The minimum cable size shall be: (or shall be as per actual design)
  - DC cable size : 4.0 mm² copper.
  - AC cable size : 4.0 mm² copper / Aluminum.
  - In three phase system, the size of the neutral wire shall be equal to the size of the phase wires.
- The following color coding shall be used for cable wires:
  - DC positive line : Red (the outer PVC sheath can be black with a red marking)
  - DC negative : Black.
  - AC single phase : Phase: red; neutral: black.
  - AC three phase : Red, yellow, blue.
  - Neutral : Black.
  - Earth wires : Green.
- Cables and conduits that have to pass through walls or ceilings, shall be taken through a PVC pipe sleeve.

➢ Cable conductors shall be terminated with tinned copper end-ferrules to prevent fraying & breaking of individual wire strands.

- The termination of the DC and AC cables at the Solar Grid Inverter shall be as per instructions of the manufacturer; using special connectors.
- Cable trays made of hot dip galvanized steel sheet / angle iron & flats; depending on the site conditions; shall be used in the installation.

13.7.4. SWITCHES / CIRCUIT BREAKERS / CONNECTORS:

All switches / circuit breakers / Connectors shall be as per IEC: 60947 part I, II, III / I S: 60947 Part I, II, III / EN: 50521.

13.7.5. JUNCTION BOXES:

13.7.5.1. SOLAR ARREY JUNCTION BOXES / ENCLOSURE FOR INVERTERS / CHARGE CONTROLLERS & LUMINARIES:

- The cables from the array strings to the solar grid inverters shall be provided with:
  - An array Junction box with DC fuse protection.
  - DC Fuses shall have a voltage rating of 1000 V DC, current rating as required.
  - DIN rail mountable fuse holders.
  - DC Fuses shall be housed in thermoplastic enclosures with transparent covers having IP 65 protection for outdoor / IP 21 protection for indoor as per IEC: 60529
- Array Junction Box shall be mounted close to the solar grid inverter and shall comprise the following components and cable terminations:
  - Incoming for each string; both - Positive and negative DC.
  - DC surge protection device (SPD), class 2 as per IEC: 60364-5-53.
  - Outgoing (Positive and negative DC) to the solar grid inverter.
  - Cable terminations shall be taken through thermo-plastic cable glands.
  - Cable ferrules shall be fitted at the cable termination points for identification.
- All Junction Boxes / Enclosures for Inverters / Charge Controllers / Luminaries shall be IP-65 (for outdoor) / IP-21 (for indoor) as per IEC: 6 0 529.

13.7.6. AC DISTRIBUTION BOX:

An AC distribution box shall be mounted close to the solar grid inverter. The AC distribution box shall be of the thermoplastic enclosure with IP-65 protection, DIN rail mounting arrangement and shall comprise the following components and cable terminations:

- Incoming 3 core / 5 core cable from the solar grid inverter.
- AC circuit breaker, 2 pole / 4 pole.
- AC surge protection device (SPD), class 2 as per IEC: 60364-5-53.
- Outgoing cable to the building electrical distribution board.

13.7.7. ENERGY METER:

Energy Meter to measure the power generation of the PV system; shall be provided. The Energy meter shall be got approved by the local power distribution organization.

13.7.8. PROTECTION:

The system shall be provided with all necessary protections like SPDs, earthing, lightning protection and grid islanding as follows:

13.7.8.1. LIGHTNING PROTECTION:

- The SPV power plant shall be provided with lightning & over-voltage protections to reduce the over-voltage to a tolerable value before it reaches the PV & other sub system components.

  (The source of over voltage can be lightning, atmosphere disturbances etc.)

- The entire space occupying the SPV array shall be suitably protected against Lightning by deploying required number of Lightning Arrestors as per IEC: 62305 / NBC standards.

- The protection against induced high-voltages shall be provided by the use of metal oxide varistors (MOVs) and suitable earthing such that induced transients find an alternate route to earth.

13.7.8.2. SURGE PROTECTION

Internal surge protection shall consist of three MOV type surge-arrestors connected from +ve and –ve terminals to earth (via Y arrangement).

13.7.8.3. EARTH PROTECTION

- Each array structure of the PV yard shall be grounded / earthed properly as per NBC/ I S: 3043-1987. In addition, the lightning arrester / masts shall be earthed inside the array field. Earth resistance shall be tested in presence of the representative of client.

- PCU, AC-DB and DC-DB shall also be earthed properly.

- Earth resistance shall not be more than 5Ω. It shall be ensured that all the earth points are bonded together to make them at the same potential.

13.7.8.4. GRID ISLANDING:

- In the event of a power failure of the electric grid, it is required that independent power-producing inverters attached to the grid; 'TURN-OFF' in a short period of time. This prevents the DC-to-AC inverters from continuing to feed power in to small sections of the grid, known as “islands.”

- Powered islands present a risk to workers who may expect the area to be un-powered and may also damage grid-tied equipment.

- The Roof-top or building façade PV system shall be equipped with islanding protection. In addition to disconnection from the grid (due to islanding protection), disconnection due to under and over voltage conditions shall also be provided.

- A manual disconnects 4pole isolation switch; beside automatic disconnection to grid; would be provided at utility-end to isolate the grid connection by the utility personnel to carry out any maintenance. This switch shall be locked by the utility personnel.

13.7.8.5. CAUTION SIGNS

The standard caution and danger boards or labels as per Indian Electricity Rules, the AC distribution box near the solar grid inverter and the building distribution board to which the AC output of the solar PV system is connected, shall be provided with a noncorrosive caution label.

13.7.9. MODULE MOUNTING STRUCTURE:

- The PV modules shall be mounted on fixed type structure or glass facade having suitable capacity and appropriate design to handle 'Fixed tilt SPV metallic structure' (in case of raised structure) and (in case of fixed modules) or thin films on glass, as per the site requirement.
- The support structure shall be hot dip galvanized steel and aluminium.

13.7.9.1. Detailed specifications for the mounting structure are given below:

Wind velocity withstanding capacity	180 km / hour
Structure material	Hot dip galvanized steel with galvanization thickness of min 80 micron.
Bolts, nuts, fasteners, panel mounting clamps	Stainless steel SS-304
Mounting arrangement for elevated structures	: The elevated structure has to be securely anchored to the supporting surface. . : Foundations of elevated structures shall be mounted directly on the pillar; bolted with anchor bolts of appropriate strength; mounted on RCC surfaces. : All anchoring on the RCC slabs shall be leak proof.
Installation	The structures shall be designed for simple mechanical arrangement for 'on-site installation'.
Minimum distance between roof edge & mounting structure (horizontal	≥ 0.50 m.
Minimum clearance between lowest part of panel and mounting	≥ 100mm or as per the tilt angle required at the site.
Access for panel cleaning and maintenance	All solar panels & Junction box must be accessible for cleaning from the bottom.
Panel tilt angle	North – south orientation with a fixed tilt angle suitable for required capacity of power plant (depending on location); south facing. Or as per design.

7.9.2 FOUNDATION:

The legs of the structure made with hot dip GI angles; will be fixed and grouted in the PCC foundation columns of size 300 mm x 300 mm or as per actual structure; made with 1:2:4 cement concrete.

- The minimum ground clearance from the lowest part of a module shall be 500 mm.
- While making foundation design; due consideration will be given to weight of module assembly & maximum wind speed of 180 km/ hr.
- The work includes excavation, concreting, back feeling, shoring and shuttering, water-proofing etc as required to erect, commission, operate and maintain the system at site.

13.7.10. 'SOLAR RADIATION' & 'AMBIENT TEMPERATURE' SENSORS AND REMOTE DATA ACQUISITION SYSTEM:

The Installer shall supply the following Components for remote data acquisition:

- Irradiation Sensor.
- Ambient temperature sensor.
- PV Module temperature sensor.

The remote monitoring / Data Acquisition System (DAS) shall be integrated with the local system to operate locally as well as remotely via the web using a standard / GSM modem.

- The Inverter manufacturer shall provide compatible software and hardware within the Inverter so that data can be transmitted via standard modem.
- Network / Internet service shall be provided by the client.

13.7.11. DOCUMENTATION

The Installer shall supply the following documentation:

a) System design, layout plan, calculations, description with working principles.

b) System single line diagram.

c) Solar PV array lay-out.

d) Routing diagram of cables and wires.

e) Data sheets and user-manuals of the solar PV panels and the solar grid inverter.

f) A system operation and maintenance manual.

g) Name, address, mobile number and email address of the service centre to be contacted in case of failure or complaint.

h) Warranty cards.

i) Maintenance register.

13.7.12. EST CERTIFICATES AND REPORTS TO BE FURNISHED

Test Certificates / Reports from IECQ / NABL accredited laboratory for relevant IEC / equivalent BIS standard for quoted components shall be furnished. Type Test Certificates shall be provided for the solar modules and the solar grid inverter to provide evidence of compliance with standards.

13.7.13. PROJECT ACTIVITIES IN THE SCOPE OF VENDOR

13.7.13.1. Engineering Services:

The scope shall cover System design (as per standards applicable), detail engineering, installation, testing, pre-commissioning and commissioning.

13.7.13.2. Procurement Services:

The scope shall cover supply of all material, sufficient in quantity to build, commission and operate the offered Solar PV power plant for

- DC part up to Inverter and including inverters**.**

- AC part after Inverter and up to HT Panel located inside the plant premises

13.7.13.3. Commissioning Services:

The scope shall cover:

- Installation of solar power plant as per the design, commissioning of each equipment involved in building power system & the solar power plant, individually and collectively in synchronization with each other.

- Statutory approvals from authorized Electricity body, strictly related to execution of erection and commissioning of the Solar Power Plant alone (CEIG of Power Plant, etc).

13.7.13.4. Support Services:

The scope shall cover technical assistance required by customer to get statutory approvals and clearances from Government and designated authorities as and when requested, as required under the scope of customer.

13.7.13.5. Ancillary Services:

The scope shall cover:

- Control Room & Inverter Room,
- Internal Piping for water outlet,
- WBM roads for internal access of PV array area,

- PV array yard lighting,
- Rain water soak pits.
- Apply for Duty Exemption for related components in the solar power plant.

13.7.13.6. GUARANTEE AND PERFORMANCE

The vendor shall guarantee the design, materials and workmanship as well as satisfactory operation of all items of the plant, machinery and equipment offered by him, with respect to all individual items and collective items comprising a group of equipment and for the whole plant and equipment in accordance with the performance requirements indicated in the tender documents. In this respect, the tenderer shall indicate clearly in his offer the details of various outputs, accuracy, consumption and performance test procedure as well as guarantees for the plant and equipment offered, the Penalties payable in case of non-fulfillment of performance guarantees up to acceptable tolerance limit

13.7.13.7. WARRANT

The mechanical structures, electrical works including power conditioners / inverters / charge controllers / maximum power point tracker units/distribution boards/digital meters/switch gear/storage batteries, etc. and over all workmanship of the SPV power plants / systems shall be warranted against any manufacturing/ design/ installation defects for a minimum period of 5 years.

13.7.13.8. INSURANCE

Transit insurance up to the arrival at destination and for 30 days storage thereafter, shall be arranged by the VENDOR and shall communicate details of goods as soon as these are dispatched. The VENDOR shall be solely responsible and held liable to pay for the loss incurred during transit.

13.8. PREFERRED MAKES

S. No.	DESCRIPTION	APPROVED MAKE
1.	PV Module Solar panel	JA Solar, Waree , Swaatvik , Solon, Jakson/ panasonic
2.	Inverter	SCHNEIDER / ABB / BONFIGLOLI / DELTA
3.	Array Combiner Box (Outdoor)	AEG / TRINITY/ ABB / SCHNEIDER
4.	SCADA Power Plant control Monitoring & Analytics	ABB / Siemens/ SCHNEIDER / SOLON/ VEGA
5.a	DC cabling- Solar Grade	SIECHEM /LAPP / POLYCAB
5.b	DC cabling-AJB to Inverter	PAGODA / FINOLEX / PLOYCAB / TOP / RPG

5.c	AC cabling	PAGODA / FINOLEX / PLOYCAB / TOP / RPG
6.	Cable tray	OBO / EAE / LEGRAND
7.	Step-Up Transformers	ELECTROTHERM / SERVOMAX / SCHNEIDER / ABB / ESENNAR
8.	LT-Panels	L&T / ABB / SCHNEIDER
9.	HT-Panels	L&T / ABB / SCHNEIDER
10.	Switch Yard / Metering	As per Local Electricity Board's Standards.
11	Earthing	As approved by CPWD / As per IS: 3043.
12	Battery Charger	SMA / Power-one-ups / Amar Raja

14. AUTOMATIC MAINS FAILURE CUM LOAD MANAGEMENT/ PLC PANEL

14.1. GENERAL

- AMF-LM Panel shall be PLC based; with the operational control of the DG sets in relation with Transformer's incomings. However, the essential safety controls shall be provided on a local control panel located inside the acoustic enclosure of the DG set.
- The AMF-LM Panel shall perform the following functions in the event of Mains failure (when the DG sets are not synchronized):
  - When 'Mains' power fails or has low voltage (less than a preset value - 25%), AMF Panel shall sense it as the absence of 'Mains Voltage' and initiate 'automatic start' of the DG set with the chargeable batteries provided for this purpose. Simultaneously, the 'Load' shall be disconnected from the 'Mains'.
  - As the Power generated by the DG set reaches the pre-determined voltage & frequency, the 'load' shall be connected to the DG set within a pre-determined time (variable).
  - If the DG set fails to start in three successive attempts and attain the operating speed with-in a preset time, it shall get disconnected and locked out automatically with annunciation to this effect.
  - When 'Mains' power supply restores to the normal voltage, the electrical load shall be automatically thrown back to the 'Mains' supply after a pre-set period. The DG set shall run at full speed for a pre–set duration and then switch off automatically if the 'Mains' power supply continues to be healthy.
  - "Manual over-ride" switch shall be provided In-case the automatic operation is not required.

14.2. CONSTRUCTIONAL REQUIREMENTS: AMF-LM PANEL

1	Construction	Free standing, floor mounted, indoor, compartmentalized cubicle, bolted construction, dust & vermin proof. TTA

		type as per the standards IEC 60439-1 & Form 4B. also it shall be as per seismic zone IV, CPRI tested.	
2	Electrical System	Rated voltage	: 415Volts, 3Phase, 4 wire, 50Hz.
		Insulation voltage	: Tested for 2.5KV for 60seconds.
3	Fabrication	Base Frame	: 3mm. thick mild steel sheet/rolled steel section.
		Main Frame	: 2mm thick C.R.C.A sheet steel
		Covers & Doors	: 1.6/2mm thick C.R.C.A. sheet steel.
4	Enclosure protection	Enclosure designed for IP: 42 degree of protection as per I S: 2147 (latest edition).	
5	Pre-treatment of fabrication	Fabricated parts shall be pre-treated for degreasing & pickling followed by phosphating & passivation through the '7/9 Tank Process' before painting.	
6	Painting	Powder coating Paint shade	: Thickness 50microns (minimum) : Siemens grey.
7	Bus bars	Electrolytic grade Aluminum bus bars insulated with colored heat shrinkable PVC sleeves & supported on SMC / DMC molded supports with anti-tracking barriers.	
8	Wiring	: A. C. Voltage circuit : D.C. Voltage circuit : Current circuit	: 1.5 Sq. mm. Cu. flexible wire. : 2.5 Sq. mm. Cu. flexible wire (Grey). : 2.5 Sq. mm. Cu. flexible wire : (C. T. secondary) (colored

14.3. CONTENTS OF AMF PANEL

Each section of the AMF-LM panel shall comprise of the following metering, annunciation, protection and control functions:

- METERING
  - Ammeter with selector switch
  - Voltmeter with selector switch
  - Frequency meter

- KW meter
- KWH meter

Alternatively; Multifunction Meter.

- ANNUNCIATION
  - Under / Over Voltage
  - Under / Over Frequency
  - Earth Faults
  - Over current & earth fault
  - Reverse Power Supply
- PROTECTIONS
  - Over speed
  - Earth Fault
  - Overload (on any one of the phases)
- CONTROLS
  - Circuit breaker 'On' indication
  - Circuit breaker 'Off' indication
  - D G set control Selection: Remote/Manual
  - 'Engine Emergency Stop' - push button
- BATTERY CHARGER

  One no. Battery Charging unit per DG set with Boost / Trickle charge facility shall be supplied for charging the battery set of the DG set when it is not in operation and also for the tripping circuits DC power supply to breaker / contactor for operation.

14.4. DG CONTROL & SYNCHRONIZING (AMF-LM) PANEL

Common Control–cum-Synchronizing Panel shall carry out the following functions:

- DG sets' Control, Monitoring and Protection with AMF function,
- Auto Synchronizing & Auto Load sharing facility of the DG sets,
- Control and Monitoring of the In-coming breakers of the Mains power from the Transformer(s).

14.4.1. 1OPERATING PRINCIPLE

AMF-LM panel shall be fitted with Microprocessor based programmable Controller(s) to control and load the D G Sets:

- AC Generator control, Monitoring & Protection,
- Load dependent Auto/Manual-Start/Stop, Auto/Manual Synchronizing,

Load Sharing, load transfer capability with AMF facility,

Preferably two PLCs shall be used, one for Interlock control & the other for DG sets' Load management.

14.4.2. SPECIFICATION

The control Panel shall:

- Confirm to	:	IEC 1000
- Voltage Input	:	415V ± 10%, 3 phase, 50 Hz ± 5%.
- Load sharing	:	within ± 5%

- Operating Conditions : Tropical, 0-45º C.
- Computer Compatibility : P C Interface

14.4.3. CONSTRUCTION

The constructional details shall be same as LT Panel.

14.4.4. OPERATOR INTERFACE & DISPLAY

The unit shall have:

- Key Pad for scrolling display-data, configuration & control key for 'up-down, enter, escape etc.'
- LCD display for monitoring various parameters as below:
  - AC Generator control, Monitoring & Protection,
  - Load dependent Auto/Manual-Start/Stop,
  - Auto/Manual Synchronizing,

15. PROGRAMMABLE LOGIC CONTROLLER (PLC)

15.1. GENERAL

A Programmable Logic Controller (PLC) is a type of computer used in commercial and industrial control applications for the task that it performs and the hardware and software it requires to perform this task. While the specific applications vary widely, the PLC:

- Monitors inputs and other variable values,
- Make decisions based on a stored program and
- Controls outputs to automate a process or machine.

➢ The type of input modules or points used by a PLC depends upon the types of input devices used.

- Some input modules or points respond to digital inputs which are either ON or OFF.
- Other modules or inputs respond to analog signals which represent machine or process conditions as a range of voltage or current values.

➢ The primary function of:

- A PLC's input circuitry is to convert the signals provided by these various switches and sensors into logic signals that can be used by the CPU.
- The CPU evaluates the status of inputs, outputs, and other variables as it executes a stored program.
- The CPU then sends signals to update the status of outputs.
- Output modules convert control signals from the CPU into digital or analog values that can be used to control various output devices.
- The programming device is used to enter or change the PLC's program or to monitor or change stored values. Once entered, the program and associated variables are stored in the CPU. In addition to these basic elements, a PLC system may also incorporate an operator interface device to simplify monitoring of the machine or process.

15.2. DESIGN CRITERIA

o Ambient Temp. : PLC shall function satisfactorily under the tropical conditions:

- Internal temperature : 0 to 55º C. without malfunction/distortion.

- Humidity : 95%, both not occurring simultaneously.

o Power Supply : PLC shall be suitable to work at the power supply system:

- System Voltage : 415V ± 10%, 3 Ph., 4 Wire.
- Frequency : 50Hz. ± 5%,
- System fault level : 45KA (rms.) for 1 Sec.

o Controls : Operation shall be through Push Buttons/Selector Switches provided on the Control Desk.

: The control shall be through PLC with equipment status indication on the Mimic and fault on the Solid State Annunciator.

: The Control philosophy shall be as agreed / altered through the PLC.

15.3. STANDARDS

PLC shall conform to the latest editions of

- IEC 61131 : Programmable Controllers.
- IEC 61131-3 : Programmable Controllers-recommendations for PLC programming.
- Indian Electricity Rules & Acts

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15.3.1. PROGRAMMABLE LOGIC CONTROLLER (PLC)

15.3.1.1. COMPONENTS:

- Power Supply Unit,
- Central Processor Unit (CPU),
- Memory Unit,
- Input / Output (I/O) Unit,
- Timer / Relay Cards,
- Programming Unit
- Video Display Unit (VDU),
- Key Board etc. as required to make the system complete and functional in all respects.

15.3.1.2. ISOLATION LEVEL:

- 1.5KV for 1 minute.
- Galvanic Isolation for I/O Units with CPU.

15.3.1.3. PROTECTION:

- Against Surge Voltage,
- Over Load of I/O devices,
- Over Temperature etc.

15.3.1.4. SELF DIAGNOSTIC:

Following self diagnostic features shall be provided for the PLC:

- Parity errors, Cycle errors and Under Voltage.

- Failure in CPU, Memory and Power Supply Units.
- Indication of the type of failure.
- Automatic switching 'OFF' of all Out puts on detection of 'Failure' as above.

15.3.1.5. ADDITIONAL FEATURES:

- All the modules including Power Supply & CPU shall be modular in construction; arranged in a standard 19" Rack or as per standard manufacturing procedure.
- Placement of Digital/Analog I/O modules shall be universal in the I/O racks without restriction.
- Each module shall be individually enclosed to form a rugged assembly guarded against dust and moisture; easy to handle and faster to make changes.
- PLC shall take commands from push buttons and selector switches etc. housed suitably (e.g. on the Control Desk). It shall also respond to the commands from a computer connected to it.
- The CPU of the PLC shall be provided with a 'Hot Stand by' to take over the whole control without any time loss, should the CPU develop a fault. (Refer BOQ).
- The CPU shall be capable to handle the number of I/Os required for the system in any mix of Analog & Digital I/Os.
- Diagnostics shall be centrally available.
- Applications shall be able to be immediately documented and duplicated faster & economically.

15.3.1.6. **ANNUNCIATION:**

Faults shall be monitored as follows:

o Tripping of any equipment shall be annunciated with cause of tripping including power failure.

o Annunciation shall be audio-visual.

- Audio signal shall activate a Hooter with a facility to 'Accept' the fault. 'Trip' and 'Warning' signals shall have different audio sounds.
- Visual annunciation shall be through 'Mimic Lamp (LED)' for the equipment under fault and a 'Fascia Window' for type of fault.
- Once the annunciation is 'Accepted', audio alarm shall stop but the lamp shall continue to 'flicker' till the fault is cleared and 'Reset' button is pressed. The lamp indication then becomes 'Steady'.

o The system shall monitor other faults without waiting for the previous fault acknowledged.

o Summary annunciation shall be provided for:

- Tripped on Over-load,
- Local switch operated
- Level indicator operated (warning annunciation)

15.3.2. **PROGRAMMER**

- A Micro-processor based 'Programmer' with its own CPU, VDU, RAM, Disc-drive & Key Board shall be provided. The programmer shall be compatible with the PLC.

- The programmer shall be portable with a sizable battery back-up and facilities to load the programs on 'EPROM' or other drive. The Programmer shall have Ultra-violet eraser for EPROM.

15.3.3. CONTROL DESK

The Control Desk-cum-Mimic Panel shall be a composite unit complete with PLC.

15.3.3.1. CONSTRUCTION

- Control Desk shall be free standing, floor mounted, fabricated from gauge (2 mm) thick MS Sheet with IP 31 degree of protection as per I S: 2147 (latest edition).
- The mimic diagram shall be vertically mounted, screen printed on a Fiber-Glass board.
- All push Buttons, Selector switches etc. shall be mounted on a 'Slanting Desk top', hinged on the panel so that it can be lifted to approach the down-side for ease of working.
- The PLC components shall be mounted on a 19'' rack at the back of the panel to facilitate easy approach.
- I / O racks shall also be housed at the back of the panel for ease of approach and termination of the field cables.
- The hinged rear door shall be lockable. Suitable gasket shall be provided to make the panel dust-free as far as practical.
- The panel shall be pre-treated to remove dust & grease and painted with two coats of base and two coats of Epoxy paint. Alternatively, it shall be powder coated in an acceptable shade.

15.3.3.2. MIMIC

- The mimic diagram shall display the 'flow chart' of the system and depict position of equipment (normal working / fault & tripping condition) in the selected flow chart.
- The mimic diagram shall be screen printed with different colors on a Fiber-Glass board of suitable size & thickness or it may be 'Dynamic' in nature.
- Inscriptions shall be painted (screen printed) on the Mimic.
- All the equipment shall be shown on the mimic board incorporating color scheme, signals and symbols.
- All push buttons, selector switches, lamps etc. shall be positioned in sequence with respect to the mimic.
- Background sheet and system streams shall be of different colors for ease of identification.
- Mimic lamps (LED) and other equipment shall be replaceable from front.

15.3.3.3. WIRING

- All internal wiring shall be carried out with 1.1K V grade, PVC insulated, 1.5sq mm. Multi-stranded (class 5 as per I S: 8130) wire conforming to I S: 694 (latest edition).
- Flexible wire shall be used to connect components mounted on the hinged doors / top surface.
- Both ends of the control wires shall be provided with lockable type ferrules for identification.
- All the terminals and Terminal Blocks shall be numbered for identification.

15.3.3.4. EARTHING

- A continuous earth bus of Cu of size suitable for a fault withstand level shall be provided.

- The earth bus shall be earthed at both ends.

15.3.3.5. CABLE ENTRY

- Removable gland plate of suitable size and thickness shall be provided for bottom entry in the control panel.
- Provision shall be made to fix the cable glands on the gland plate from inside the panel.

15.3.4. CONTROL PHILOSOPHY

Control philosophy shall be commensurate with the 'Flow diagram' and operational requirement of the project. However, the lamp signal scheme shall be as follows:

- Steady Glow : Equipment in running condition.
- Slow flicker : Equipment selected to work.
- Fast flicker : Equipment in faulty condition.
- Off : Equipment in idle condition.

Lamp-Test Facility shall be provided to check the health of all the mimic lamps.

16. BUSBAR TRUNKING SYSTEMS: SANSWICHED TYPE BUSDUCT/ RISING MAINS

16.1. SCOPE

This specification covers 'Sandwich' type busduct & rising mains for use as 'Feeder bus-bars for interconnection between electrical equipment / load centres' as follows:

- The specification comprises of design, performance, material, construction, manufacture, inspection, testing, packing forwarding, delivery at site, testing and commissioning as per site requirements.
- All busduct, rising mains and fittings (straight length, elbow, bends, tees, flanged ends, straight-joints, expansion-joints, flexible-joints, cable feed & tap-off boxes and circuit breakers etc. as required) shall be from the same manufacturer as the bus-duct / rising mains system.
- All Fixing elements directly connected to the bus-bar rising mains system for mounting/suspension of the bus trunking shall also be manufactures and supplied by the same manufacturer as the rising mains system.
- No drilling or welding process shall be allowed on the body of the bus-bar rising mains system for erection purposes.
- Rising mains shall have provisions for tap off boxes in every 0.5 meter.
- All hardware / fabricated supports required for mounting and installation of the bus rising mains shall be in the scope of work of the contractor.
- Whether specifically called for or not, all accessories and components required for normal operation of equipment are deemed to be considered as a part of the contractor's scope of supply. The contractor shall be responsible for preparing the drawings for routing the busduct & rising mains and co-ordinate with other services at site. Final site measurement shall be made by contractor prior to the release of the bus-duct / rising mains system for manufacturing.
- Responsibility of the installer shall be to follow the NBC 2016 in terms of fire safety specially as mentioned here-under:

- Clause 3.4.7 for electrical installations "the shaft shall be sealed at every floor with fire stop materials having the same fire resistance as that of the floor…"
- Clause 3.4.6.5for vertical opening, "every vertical opening between the floors of a building shall be suitably enclosed or protected."

- Clause 3.4.5.4 Service ducts and shafts, “the space between the cables/conduits and the walls/slabs shall be filled in by a fire stop material having fire resistance rating of not less than 120 min….”

16.2. MANUFACTURER'S CAPABILITY

The manufacturer shall have:

- o An established track record in the design and manufacture of sandwich bus rising mains and should have supplied bus duct systems for at least 10 years.
- o The manufacturer shall have ISO 9001 certification for design, manufacture and testing of busduct & rising mains systems.
- o Where both; sandwich bus ducts and cast resin bus ducts are required, both shall be manufactured by the same company, with inter-connectivity as specified.

16.3. SYSTEM DETAILS

The rising mains shall be suitable for operation on a 415V ± 10% & 50Hz ± 5% system & insulation voltage of 1100V having TP+N bus with 100% neutral and internal earth. The earth bus shall be a continuous piece without bolting on the housing as per the stipulation of the IEC 61439, pt-6 & IS: 8623, Part-2.

Electrical power supply system may be either earthed or unearthed as per the local power distribution system.

16.4. STANDARDS

The Bus rising mains shall be designed and manufactured in accordance with the following international standards (latest edition):

- IS: 8623, pt-2, IEC-61439, pt-6 : Low voltage switch-gear & control-gear-Particular requirements of bus duct system.
- IEC 60529, I S: 2147 : Degree of protection.
- I S: 375, 1963 : Marking & arrangement of Bus-Bars.
- The bus ducts shall conform to IEE / NEMA BU1 / JIS Seismic protection certification and Local authority's requirements as applicable at site.
- The busbar, of full range and each rating, should pass full type tests specified in IEC 61439 Part 6 (2012).
- The certificate shall be issued by an international independent testing authority (e.g. ASTA, KEMA, UL).
- A product safety mark (e.g. KEMA-KEUR, ASTA DIAMOND, UL) should be on the product offering a visible assurance to all of full product safety testing, factory inspection and ongoing surveillance under independent authority to ensure the ongoing safety of product.
- The busbar trunking system should pass seismic tests with actual physical product and being certified complying with UBC seismic Zone 4 condition by an international recognized earthquake research body, e.g. Asian Pacific Network of Centers for Earthquake Engineering Research (ANCER).

16.5. DESIGN REQUIREMENTS

16.5.1. GENERAL

The bus bars shall be of sandwich construction, non-ventilated design.

- o It shall be possible to mount the bus bar system in any orientation without affecting the current rating.
- o The bus bars shall of high conductivity Copper or Aluminium as specified in the tender.

- Where an earth conductor is required:
  - It shall be a separate, integral earth conductor of the same high conductivity material as the phase conductors and at least 50% cross section of the phase conductor.
  - However, if the body is of the same material as the phase conductors, it may be accepted as earth conductor as specified by IEC: 61439-6.
- If the body of the bus rising mains is made of GI sheet, the earth conductor shall be:
  - A separate, integral earth conductor of the same high conductivity material as the phase conductors and at least 50% cross section of the phase conductor provided internally in the Bus duct body.
  - If the protective conductor is not of the same high conductivity material as the phase conductors, the cross-sectional area of the protective conductor is to be determined in a manner which produces a conductance equivalent to that which results from the application of Table IV of IS: 8623 (Part 1); 1993 / IEC Pub 439 - 1 (1985).
  - GI body will not be acceptable as earth conductor.
- It shall be possible to provide a 200% Neutral where specified.
- A bus bar rising mains fire barrier unit shall be designed to prevent the propagation of fire, for 120 minutes as per ISO 834, under fire conditions, when the bus bar trunking system passes through horizontal or vertical building divisions (for example, wall or floor).

16.5.2. ENVIRONMENTAL CONDITIONS

- Max. Temp rise above ambient : 55° C
- Ambient temperature : 40^{0} C peak (35^{0} C average) as per IEC 61439-6.
- Current rating : As specified in the BOQ

16.5.3. RATING DETAILS

- Rated Operational Voltage : 1000V,
- Protection Degree : IP-55 / IP-65 (indoor)
- Standard insulation Voltage : 1000 V.
- Rated frequency : 50Hz.
- As per ampere rates, minimum short circuit values shall be like below:

Aluminium / Copper conductor:

Rating	KA/1 sec.	KA Peak	Rating	KA/1 sec.	KA Peak
630A	25	50	2500A	75	165
800A	40	84	3200A	90	198
1000A	50	105	4000A	100	220
1250A	50	105	5000A	120	264
1600A	60	132	6000A	120	264
2000A	60	132			

16.5.4. CONSTRUCTION

The bus rising mains system shall pass seismic tests and certified complying with UBC seismic Zone 4 condition by an international recognized earthquake research body, e.g. Asian Pacific Network of centres for Earthquake Engineering Research (ANCER) etc.

16.5.5. ENCLOSURE

Bus bar system shall have “Epoxy Insulated-Compact” structure.

- Enclosure shall be either:
  - o Thermal processed, extruded aluminium body to reduce hysteresis and eddy current loses and provided with a suitable protective finish.
    - The aluminium body shall be electro-static powder coated, shade RAL-7038 / as specified.
  - o CRCA sheet steel of minimum thickness 1.6mm (14 Gauge).
    - Steel sheet metal shall undergo pre painting treatment using 7 tank process and finish with powder coating of battle-ship grey colour or RAL-7038 / as specified.
- Conductors shall be packed and placed in the housing without leaving air-gap to reduce reactance.
- Front cover of the Rising Mains shall be bolted on the body using Neoprene gasket for enclosure protection. Cover shall be cut in suitable sections for convenient handling.
- Busduct, Rising Mains shall be designed for IP-55 / IP-65 protection to the latest edition of I S: 2147 (refer BOQ).
- Expansion joints shall be provided to take care of the differential expansion between the bus bars and the enclosure:
  - For horizontal/vertical runs, an expansion unit shall be used at every 40M and at expansion points of the building as per IEC 61439, pt-6.
  - For vertical applications, a vertical expansion unit shall be used at every floor.
- For a compact system, width of Rising Mains enclosure shall be kept same for all sizes and depth appropriate with rating.
- The busduct, rising Mains shall be firmly secured to the structural walls / supports with the help of brackets. Supporting / fixing brackets shall be provided as per the recommendations of the manufacturer (minimum 2 nos. per 3m length). It shall be possible to re-locate them at places required along the bus bar length to suit site conditions.
- The whole busduct, rising Mains system shall be capable of withstanding the short circuit of the electrical installation without damaging the electrical and mechanical arrangement due to thermal stress under fault condition at a service voltage of 1000V, 50Hz.
- Busduct, Rising Mains shall:
  - Be built of suitable sections connected to each other by clamped connections / joints.
  - Clamps shall be located in the insulated enclosure with inspection windows provided to check the tightness of the joints & to inspect the joint.
  - Have mechanical interlock system at the joints to prevent wrong installation.
  - Have all necessary accessories (elbows, offsets, panel-transformer connections, reductions, expansion joints etc.). The manufacturer shall supply special dimensioned units in short time, if the project conditions requires.
- I P Rating**:**

Application	IP Rating

a) Indoor application for areas like:	IP 54
: Inside Sub-Station area	-- do --
: Inside LT Panel Rooms	-- do --
: Inside DG Set Room	-- do --
: Inside Shafts / Risers / Electrical Rooms / Electrical Shafts.	-- do --
b) Indoor application for areas like:	
: In Basement Parking / Garages	IP 55 / IP 65
c) Outdoor application (over ground)	IP 65 and in addition a canopy need to be provided or IP 66.

Note: The protections listed above are minimum and have to be adhered to even if not mentioned in the Schedule of Quantities or as mentioned in the schedule of Quantities.

16.5.6. BUS BARS

- Bus-bar system shall have following configuration of bus ducts (Enclosure: Aluminium):

3P+1N	3 Phase, 100% Neutral, Enclosure (as earth)
3P+1N+1/2 E	3 Phase, 100% Neutral, 50% Internal Earth bus, Enclosure
3P+2N	3 Phase, 200% Neutral, Enclosure (as earth)
3P+N+1E	3 Phase, 100% Neutral, 100% Internal Earth bus, Enclosure

NOTE:

- Where there is no internal earth bus along with the phase and neutral bus-bars, the bus duct enclosure (Al) itself shall be the earth bus. It should be rated for minimum 50% capacity.
- In case of aluminium housing, the housing itself acts as earth bus as specified by IEC: 61439-6 which states 'If the body is of the same material as the phase conductors, it may be accepted as earth conductor'.
- In case of housing other than aluminium, separate earth bus needs to be run along the body of the bus duct. (Two runs of earth bus shall be provided).

- Bus bars shall be of Electrolytic copper of 99.9% purity or aluminium of grade 63401 WP and shall have radial edges rounded off.
- Aluminium or Copper conductors shall have plating along the entire length as follows:
  - Aluminium Bus bar system shall be Nickel and Tin-plated (6101 - class conductors).
  - Copper, Tin-plated Electrolytic conductors.
- Maximum current density (Amps/mm²) shall be 1.0 in case of Aluminium and 1.6 in case of Cu Bus or as specified in the IEC specification.

- Bus bars shall be supported at suitable intervals on non-hygroscopic, class B/F insulators.
- The polarity between the power-bus shall be maintained throughout the length of the bus duct.
- The temperature-rise at external surface of bus-way shall not exceed 55°C above the ambient temperature when operating at rated load current as per IEC: 61439-6 standards.
- 'Tap off' points shall be provided every 500mm along the Rising Mains for insertion of 'Tap-off Boxes'. Tap off points, not in use, shall be closed by insulated flap tightened by screws. Flaps shall form integral part of Rising Mains length. Tap-off point opening shall be shrouded to provide finger touch protection.
- Wherever the rising mains passes through a floor/wall opening, fire barriers of 2Hrs rating shall be provided.
- Thrust Pads shall be provided at the bottom of the rising mains to support the weight of the bus-bars as also to restrict the bus bar movement.
- Conductor and housing expansion differences shall be absorbed at the joints using "Z" shaped offsets.
- Bus rising mains system shall be terminated by end enclosure.

16.5.7. INSULATION

The bus ducts shall be insulated throughout their length by epoxy coating / PET / Mylar insulation.

- The insulation material used shall be of Class B/ Class F (130° C /155° C) as specified.
- The insulation shall be 100% water resistant even for IP-42 trunking.
- The insulation shall comply with UL 94 V-O. It shall be Halogen Free.
- Rated insulation voltage of the system shall be 1000V.

16.5.8. JOINT STRUCTURE

- Electrical and mechanical connection shall be made at joints by "single bolt" joint construction and each joint shall have two "Belleville" washers.
  - Insulators of the joint shall be manufactured of glass-reinforced polyester.
  - Joints shall be realized by a torque spanner (wrench) set at 55 Nm.
  - To prevent the joints from transportation damages, they shall be protected by metal caps which shall be removed before installation.
  - Joint bolt shall be locked from both sides (Bolt head and nut).
- The joints shall be provided:
  - Between sections so as to provide flexibility during installation.
  - To account for expansion / contraction of bus duct during operation.
- The joint construction shall have the following features:
  - Thermal expansion of at least 3mm per joint.
  - The joint insulation shall be of one piece moulded design and not have any cut edges which can absorb moisture.
  - The joint construction shall allow a ± 10mm adjustment (or better) at the time of installation for ease of adjusting to site measurement variations.

- The joint bolt shall be insulated with a bolt insulator. The bolt insulator shall be of moulded one piece design.
- The joint system shall be designed in a way that the installer cannot insert the bus duct length too far and damage the bolt insulator.
- The bus duct ends shall not have holes or slots at the joints – the electrical continuity shall be through pressure plates, achieving a high area of joint cross section and expansion capability.
- It shall be possible to install and remove the joints without disturbing the bus duct run.

16.5.9. NEUTRAL & EARTH CONDUCTORS

- Neutral and Earth conductors shall be provided as per the 'Bus Bars Configuration' mentioned above in the specification.
- Where an Earth conductor is required in case of GI enclosure, it shall be a separate, integral earth conductor of the same high conductivity material as the phase conductors and at least 50% cross section of the phase conductor.
- GI body / GI strips shall not be acceptable as earth conductors.
- Neutral & Earth conductor shall also be type tested for SC capacity (60% of Phase conductor).

16.5.10. FIRE RATING

Bus rising mains shall have capability to operate (without short circuit) minimum 2 hours in 1000° C fire conditions without de-ration.

16.5.11. END FEED – RISING MAINS

- Top of the rising mains shall be closed by a suitable cover.
- 'End feed unit' shall have a thrust pad to support the weight of the bus bars in the rising mains. It also restricts the downward expansion of the bus.
- At the bottom, 'End feed unit' shall be provided to connect the in-coming supply of the Rising Mains' Bus bars directly or through MCCB / Switch Fuse Units / ON Load Isolator as required.

16.5.11.1. TAP-OFF UNITS

Where specified, tap off locations shall be provided for insertion of plug-in tap off units. The tap off locations shall be covered by hinged plates.

Tap off unit's safety features:

- When the door cover is open, it shall not be possible to turn the MCCB 'ON'. This shall be achieved by means of mechanical safety locking system and not by the rotary handle of the MCCB.
- The door shall be provided with a lock and keys.
- When the lever is in 'ON' position, even with the key unlocked, the operator should not be able to remove the box or open the tap-off location cover.
- During insertion, the earth conductor shall make contact first; before the phase conductors. This shall follow the sequence of first-in last-out concept.
- The tap off unit handle shall be flexible in the sense that the 'ON/OFF' handle can be attached to the left or right side of the box, depending on the site situation.
- When the box is open; the live conductors shall be safe-guarded by a transparent insulation plate which allows visible inspection but not touching of the live conductors.

- In the event of a MCCB requiring maintenance or changing, the mechanical interlock shall allow easy access by removing only the front plate and not interrupting the adjacent linkages.
- For IP-55 bus-trunking, the tap off unit arrangement also shall achieve IP-55 without requiring any additional sealing at site. The complete arrangement with the tap off unit shall be tested for IP rating by an independent test authority.
- For IP-55 bus-trunking, the tap off unit arrangement also must be covered through 1.6mm thick GI Sheet canopy.
- The tap off boxes will be suitable for accommodating MCCB or other accessories, as required. The tap off units shall allow the flexibility of accommodating different, reputed MCCB makes, to be mutually agreed depending on the tender requirements.

16.5.11.2. ACCESSORIES

- A full range of accessories like bends, end flanges, end feed units, and support brackets etc. shall be available as required.
- Rising mains, in addition, shall be complete with tap-off points, end feed units, end covers, thrust pads and spring hangers at each floor.
- Bus trunking systems shall be complete in all respects. All accessories shall be quoted along with the unit rate of straight length of the bus-duct and rising mains.

16.6. INSTALLATION

- Hanger spacing shall be noted on layout drawings and shall not exceed manufacturer's recommendations.
- Bus ducts running along the wall, shall be supported at intervals not exceeding 1.5m.
- In case of branching, there shall be support on all branches at a distance of 300mm from the point of branching,
- Support shall not be less than 40x40x6mm GI angle secured in an approved manner.
- Supports may also be provided in the form of brackets fixed to walls where the duct runs along the wall.
- In case of ceiling suspended bus ducts, supports made out of 40x40x6mm GI angle iron shall be provided.
- The horizontal distance between two such supports shall not be more than 1200mm.
- The ducts supports shall be suspended from suitable approved suspension devices provided in the ceiling.
- For Bus Duct horizontal runs, a horizontal expansion unit shall be provided at every 40m if required by design, and at expansion joints of the building structure and the system shall be supported at every 1.5m or as per the site conditions.
- Fire barrier shall be provided at each floor/wall crossing as per relevant I S code.

16.7. TESTS

16.7.1. TESTS AT WORKS

The Rising Mains and Bus Ducts shall be tested in accordance with IEC: 61439-6; 2012 and the related test certificate shall be from a national / international recognized test house / authority or carried out and witnessed at manufactures premises.

- The bus bars shall be type tested at a reputed international test laboratory (ASTA or CPRI, ERDA – ASTA accredited laboratory) for short-circuit withstand capacity. The test shall be for a minimum duration of 1second as per the international standards.

Tests shall be performed over a range of current ratings covering the different frame sizes of the manufacturer.

- Degree of ingress protection (IP rating) shall also be tested at any reputed independent laboratory (ERDA – ASTA accredited laboratory etc.). This test shall be for IP-68 in the case of cast resin bus bars and for IP-42 / IP-54 / IP-66 for sandwich bus bars.
- 750° C fire test (for cast resin bus bars) at an independent laboratory as applicable. (750° C for Copper bus duct, 600° C for Aluminium bus duct).

The following factory tests shall be carried out and test results recorded:

a. Temperature rise (Type test with no extra cost).

b. Insulation resistance shall be tested with 1000V megger. It shall be not less than 100mega Ω.

c. Earth continuity test

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16.7.2. TEST AT SITE

The following tests shall be carried out at site as per I S: 8084-1976 & IEC: 61439-6 standards and test results recorded:

a. Physical check including checking damage/crake in any components, tightness of bolts and connections etc.

b. Insulation resistance shall be tested with 1000V megger and shall be not less than 100MΩ.

c. Earth continuity test.

17. SURGE PROTECTION DEVICES (SPD)

17.1. STANDARDS

o	IEC 62305	:	Protection against Lightning
	- Part 1	:	Basic Principles
	- Part 2	:	Risk Assessment
	- Part 3	:	Protection of structures
	- Part 4	:	Electrical & Electronic equipment within structures
o	IEC 61643-1	:	Surge Protective Devices Connected to Low-Voltage Power Systems: Performance requirements and testing methods.
o	IEC 61643-12	:	Surge Protective Devices Connected to Low-Voltage Power Systems: Selection and application principles.
o	IEEE C62.41, 1991	:	Sizing of Surge Protective Devices.
o	IEEE C62.45, 1992	:	Coordination of Surge Protective Devices.
o	Type of Network	:	3 phases, 4 wires, TT earthing system.

17.2. TYPE OF SURGE PROTECTION

The typical protection devices such as fuses, circuit breakers etc. have a response time of milli-seconds. These devices, therefore, are ineffective for protection against lightning or switching surges which have a response time of neno-seconds. The surge protection devices (SPDs) have a response time of 10 to 100neno-seconds required to protect against the lightning / switching surges.

The SPD (Surge Protection Device) has superseded the terminology TVSS (Transient Voltage Surge Suppressor) since 2007.

Classification of SPD as per international standards:

IEC	EN	VDE
		Class A
Class I	Type 1	Class B
Class II	Type 2	Class C
Class III	Type 3	Class D

17.3. PROTECTION AGAINST LIGHTNING & SWITCHING SURGES

ACCORDING TO IEC 61643 protection against lightning & switching surges shall be done at various levels as follows (Class I, Class II and Class III devices shall be from same manufacturer to achieve the co-ordination).

The earthing system, as applicable in India, shall be TT system, therefore SPD for only TT system shall be applicable unless specified otherwise.

17.3.1. MAINS INCOMING PANEL

Protection against lightning & switching surges at the main incomer of the power supply system-3phase, 4wire (TT); at the Main Power Distribution Board (after the incoming breaker) shall be done by using:

CLASS-B / CLASS-I / TYPE-1 SPD

The technical specification of these SPDs are mentioned in the table below.

3 numbers of SPD for connection between Phases & Neutral and one number between Neutral & Earth with the following ratings: (1 no for each phase).

S N	PARAMETERS	Line to Neutral (L-N) (3 nos.)	Neutral to Earth (N-PE) (1 no)
1.	Type	Metal encapsulated/Non-exhausting Spark-gap	
2.	Nominal Voltage, Un	230V, 50/60 Hz	
3.	Over Voltage withstand capacity	440V for 120minutes	

4.	Lightning Impulse Current	50KA (10/350 µsec)	125KA (10/350 µsec)
5.	Voltage Protection Level, Up	≤ 1.5KV including Fuse (L-N)	
6.	Current extinguishing capability	100kA	
7.	Current limitation/Selectivity	No tripping of a 20 A gL/gG fuse up to 50 kArms between L-N.	
8.	Response Time	< 100Nano-seconds	
9.	Operating temperature range	-40°C to +85°C	
10.	Mounting on	Din Rail	
11.	Degree of Protection	IP 20	
12.	Max. Back-up fuse	500A gL/gG	NA
13.	Mechanical indication for both the states	Green for 'healthy' and Red for failure	
14.	Tested & certified by KEMA	As per latest and valid IEC 61643-11:2011 or EN 61643-11:2012	

17.3.2. MAIN DISTRIBUTION BOARD (MDB / LT PANEL)

Second Stage Protection at the MDB / LT panel, the device shall be suitable for 3 phase 4 wire or 1 Phase 2 wire system with nominal voltage parameters of 415 Vac ±10% between L-L and 230 Vac ±10% between L-N, shall be:

CLASS B+C / CLASS I+II / TYPE 2+3.

- Between Line and Neutral : 3 nos. of pluggable Zinc oxide type surge arrester with potential free contact, thermal dis-connector & provision for inbuilt common remote indication for defective arresters.
- Between Neutral and Earth : One number arrester (Spark-gap type) to connect of following ratings including base element & pluggable arresters.
- The technical specification of these SPDs are mentioned in the table below.

Sl. No	Parameters	Specifications	
		Line to Neutral (L-N) (3nos)	Neutral to Earth (N-PE) (1 no)

1.	Type	Single MOV with built- in thermal fuse	Spark-Gap Encapsulated / Non-exhausting
2.	Nominal Voltage, Un	230V, 50/60 Hz	
3.	Maximum Continuous Operating Voltage, Uc	≥ 320 Volt	255 Volt
4.	Nominal Discharge Current I_n	30KA (8/20 μsec)	50KA (8/20 μsec)
5.	Maximum Discharge Current I_{max}	50KA (8/20 μsec) switching surge	
6.	Lightning Impulse Current	7KA (10/350 μsec)	25KA (10/350 μsec)
7.	Voltage protection level at 1KA	≤ 750 volts	<1200 Volt
8.	Response Time	< 25Nano seconds	<100Nano-secs
9.	Operating temperature range	-40°C to +80°C	
10.	Mounting on	Din Rail with Plug-in option to change cartridge without disconnection.	
11.	Degree of Protection	IP 20	
12.	Max. Back-up fuse	160 A gL/gG	NA
13.	Tested & certified by KEMA	As per latest and valid IEC 61643-11:2011 or EN 61643-11:2012	

- Visual Indication of the flag in the surge arrester (Line to Neutral)
  - Healthy condition : Green Color
  - Faulty condition : Red Color
- In case the next MDB or DB is more than 4m away from the above panel / MDB, the same type of SPD shall be repeated in that MDB or DB.

17.3.3. EQUIPMENT LEVEL (DBs, UPS, MCB DB'S CNC MACHINE/DRIVES, ETC)

Protection for Sensitive Equipment at the input of the end equipment like UPS, CNC machine, VFD or at Important MCB DB feeding 230V, 1phase, (3wire-TT earth system) power to Computer / Server etc. shall be:

CLASS C / CLASS II / TYPE 2

- Between Line and Neutral : 1 number of pluggable Zinc oxide type surge arrester with potential-free contact, thermal dis-connector & provision for inbuilt remote indication for defective arrester.

- Between Neutral and Earth : One number arrester (Spark-gap type) to connect of rating including base element & pluggable arrester.
- The technical specification of these SPDs are mentioned in the table below.

Sl. No	Parameters	Specifications	
		Line to Neutral (L-N)	Neutral to Earth (N-PE)
1.	Type	Single MOV with built-in thermal fuse	Spark-gap Encapsulated / Non-exhausting
2.	Nominal Voltage, Un	230V, 50/60 Hz	
3.	Maximum Continuous Operating Voltage, Uc	> 320 Volt	255 Volt
4.	Nominal Discharge Current In	20KA (8/20 µsec)	50KA (8/20 µsec)
5.	Max Discharge Current I max	40KA	50KA (8/20 µsec)
6.	Voltage Protection Level (1kA)	< 1000 Volts	< 1200 Volts
7.	Response Time	< 25 Nano secs	< 100 Nano secs
8.	Operating temperature range	-40°C to +80°C	
9.	Mounting on	Din Rail with Plug-in option to change cartridge without disconnection.	
10.	Degree of Protection	IP 20	
11.	Back-up fuse	125 A gL/gG	NA
12.	Tested & certified by KEMA	As per latest and valid IEC 61643-11:2011 or EN 61643-11:2012	

- Visual Indication of the flag in the surge arrester (L-N & N-PE)
  - Healthy condition : Green Color
  - Faulty condition : Red Color

17.3.4. EQUIPMENT LEVEL (ELECTRONIC EQUIPMENT, DATA & COMMUNICATION TECH)

Protection for Sensitive electronic equipment (at the input end) like Computers, TV, Wi Fi system etc. shall be:

CLASS D / CLASS III / TYPE 3

- Since the power supply for these equipment shall be single phase, the Zinc oxide SPD used; shall be between Line and PE: 1 number of pluggable type surge arrester with potential free contact, thermal dis-connector & provision for inbuilt remote indication for defective arrester.

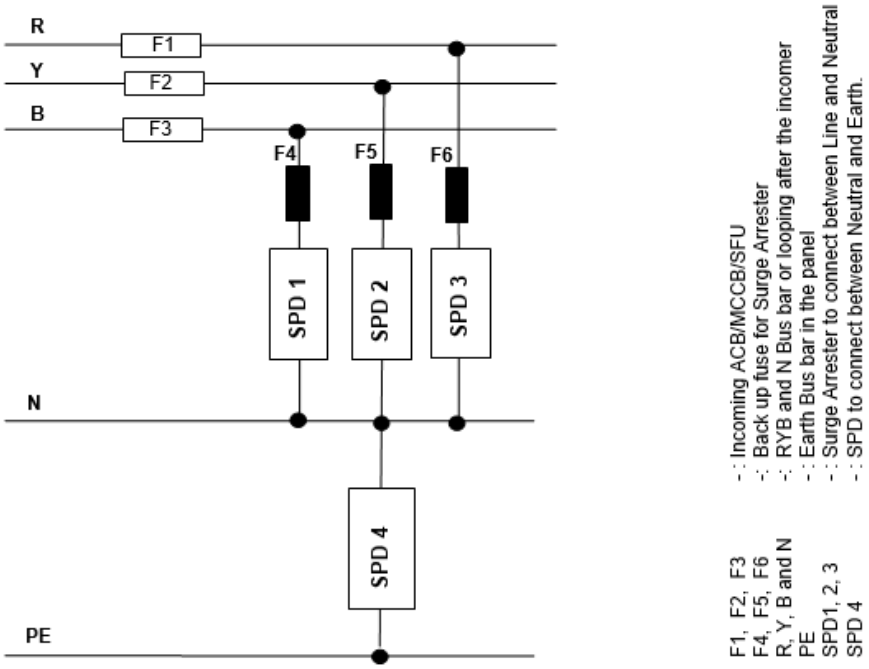
o The technical specification of these SPDs are mentioned in the table below.

S N	Parameters	Specification
1.	Nominal Voltage, Un (V)	230
2.	Maximum Continuous voltage, Uc (V)	275
3.	Nominal Discharge Current I_n	3 KA (8/20 µsec)
4.	Voltage Protection Level, Up	< 1.5KV
5.	Nominal Load Current, IL	16A
6.	Back-up fuse	16A
7.	Response Time	< 25 Nano secs
8.	Mounting on	Din Rail with Plug-in option to change cartridge without disconnection.
9.	Tested & certified by KEMA	As per latest and valid IEC 61643-11: 2011 or EN 61643-11: 2012

o Visual Indication of the flag in the surge arrester (L-N & N-PE)

- Healthy condition : Green Color
- Faulty condition : Red Color

Connection diagram for SPD for 3 phase 4 wire network



17.3.5. ELV DATA LINE PROTECTION (D.C.)

All elv, LAN, Telephone lines at PABX, MDF, R F communication and CCTV shall be protected from Lightning interference using special SPD as follows:

Sl. No	Parameters	Specifications		
		TELEPHONE LINE	R F PROTECTION	CCTV
1.	Nominal Voltage, DC	180 V DC	180 V DC	48 V DC
2.	Maximum Continuous C Voltage	180 V DC	180 V DC	48 V DC
3.	Nominal Discharge Current In	10KA (8/20 µs)	20KA (8/20 µs)	10KA (8/20 µs)
4.	Max Discharge Current I max	5KA (10/350 µs)	5KA (10/350 µs)	0.5KA (10/350 µs)
5.	Voltage protection Level	< 500 Volts		< 700 Volts
6.	Cut off Frequency		0-2.5 GHz	100MHz
7.	Mounting on			Din Rail
8.	Tested & certified by	As per latest IEC 61643-21/ EN 61643-21 and shall be UL approved.		

18. DISTRIBUTION BOARD (DB) / SUB DB (SDB)/ MCBS

18.1. GENERAL

- All DB/SDB, recessed/surface mounted as shown in the drawings, shall be suitable for 415 Volts, three phase or 240 volts single phase with in-coming RCBO/MCB-ELCB (100mA sensitivity or as specified).
- Short circuit current with-stand level of the DB/SDB shall not be less than 10KA at 415V.
- The DB / SDB shall be lockable with key-lock.

18.2. STANDARDS

The distribution boards and their components shall comply with the requirements of the latest edition of the following Indian standards:

- IS: 13032/IS: 8623-1 & 3 : Construction of MCB-DB.
- IS: 2147/IEC 60529 : Degree of ingress protection for enclosures.
- IEC 62262 : Degree of impact protection for enclosures.
- IS: 12640-1, 2000 Current IEC 61008-1 : Earth Leakage Circuit Breaker (ELCB) / Residual Circuit Breaker (RCCB)
- IS/IEC: 60898-1, 2003 : Miniature Circuit Breaker
- IS: 694 & IS: 8130 : PVC insulated Cables and Al. Conductor.

18.3. CONSTRUCTION FEATURES

18.3.1 DISTRIBUTION & SUB DISTRIBUTION BOARDS (DB & SDB)

- DB/SDB shall be standard type; factory fabricated from sheet steel & shall conform to the latest editions of IS: 13032 & IS: 8623-1 & 3.
- The thickness of DBs shall be as per ISO specification.

DB/SDB shall have double doors such that only the rocker of the MCB shall be available when front door is opened and the live parts remain concealed behind the inner door.

- The enclosure for double doors DB/SDB shall have IP 43 (minimum) degree of protection as per IS: 2147/IEC 60529 (latest edition) and IK-9 for degree of impact protection as per IEC 62262.
- The enclosure for single door DB/SDB shall have IP 30 (minimum) degree of protection as per IS: 2147/IEC 60529 (latest edition) and IK-8 for degree of impact protection as per IEC 62262. All the doors shall be provided with rotary knob.
- All the doors shall be provided with EPDM (Ethylene Propylene Diene Monomer) or Polyurethane foam Gasket and rotary knob with flexibility to change to Key lock on field. DB shall be provided with door earthing arrangement.
- Centre plate of double door DB, shall be provided with installer friendly plastic stud for safe and ease of removal from U-box.
- DBs shall be supplied with 100A rated Insulated Bus-bars made of Copper with Tin plating to avoid copper oxidation.
- The 3-Phase DB shall have three compartments; each compartment shall have Phase, neutral & earth Bus bar with Incomer as DP RCBO for single phase out-goings. When three phase out-goings are required, the DB shall be non-compartmentalized with TP bus-bars.
- DBs shall be provided with side-mounted shrouded & isolated 100A rated Brass Neutral Bar. Neutral Bar shall be fastened on the U-box. The brass Earth bar shall be separately mounted.
- When Incomer is a RCBO, 3 separate Neutral bars shall be provided, however, the Earth bar shall be common for all phases.
- The DIN rail shall be Zinc plated and must not have any injurious sharp corners. DIN rail shall be provided with MCB stopper arrangement in order to achieve the comfort in center plate assembly. All the TPN DBs shall be provided with removable DIN rail chassis for mounting the plug-in type MCB.
- DBs shall be provided with removable Gland plates on top and bottom with adequate numbers of knock-out holes of appropriate size and mounted on DB with minimal possible screws to save installation time.
- The DBs shall have two nos. of external Earth Studs to ensure better Earth continuity and shall have embossed earthing symbol for easy identification.
- All DBs/SDBs shall have identification plates (DB name, I/C from & supply to).
- All DBs/SDBs shall have minimum 10% spare feeders.
- The DB/SDB enclosure metal surface shall be cleaned using the 7 Tank- process, passivated and coated with two coats of primer followed by synthetic stove enamel/Powder coated, color Siemens gray or as specified.
- A circuit identification card in clear plastic cover on the inside of front door shall be provided for each DB/SDB.
- TPN DBs shall be ready to upgrade to Per Phase Isolation DB configuration, so as to give better continuity of supply and only respective phase isolation in case of earth fault on any phase.

- Cement spill protector shall be provided with the DBs, so as to avoid entry of dust & dirt at the time of the civil work. Also, full length plastering guide shall be provided to help easy and correct levelling of plaster along the DB sides.
- DB shall be provided with suitable holes for easy mounting on wall.
- The supplier must submit the test report for IP and IK testing by neutral testing authority (viz. ERDA or CPRI) as per above mentioned standards.
- DB shall be able to accommodate all types of Modular devices viz. Protection Devices (MCBs, RCDs, SPD & Auxiliaries), Controlling Devices (Isolators, Changeover switches, Contactors, Impulse Relays, Push Buttons) and Indication Devices (Indicators, Meters etc.) as required.

18.3.2 INTEGRAL SDB/UPS DB

- The SDB/UPS DB shall be clubbed together as required to be housed in one box having a separator sheet in between them. A separate set of In-comers & Bus-bars shall be provided in each compartment. The ratings of the components shall be as per SLD.
- Other construction & technical parameters shall be same as for DB/SDB.
- All the doors shall be lockable with key-lock.

18.3.3 BUS BAR CONNECTION

- The bus bars in the DB/SDB shall be electrolytic grade copper; as specified in Single Line Diagram/BOQ and of rectangular cross section suitable for full load current as the In-comer rating for phase.
- The bus bars in a TPN DB shall be color coded.
- The bus bars shall be supported on unbreakable, non-hygroscopic, non-flammable insulated supports at regular intervals to withstand the force arising from short circuit in the system.
- Neutral bus bars in the DB/SDB shall be provided with the same number of terminals as single ways on the board (suitable to terminate the size of wires used) in-addition to the terminals for incoming mains and mounted on the insulated supports.
- An earth bus-bar of similar size and configuration as the neutral bus-bar, shall also be provided in the DB/SDB.
- Phase barrier shall be fitted between the different phases and all live parts shall be screened from the front. Ample clearance shall be provided between all live metal and the outer case connected to 'earth' and adequate space for all incoming and outgoing cables/wires.

18.4. ELECTRICAL COMPONENTS

All the electrical components shall be as per the SLD & selected as per good engineering practice. The specification of the components shall be as follows:

18.4.1 MINIATURE CIRCUIT BREAKER (MCB)

- MCB shall be quick make/break type and conform to IS/IEC: 60898-1, 2003 (latest edition).
- The MCB housing shall be of heat resistant insulating material having high impact strength.
- The fault current shall not be less than 10KA at 230 Volts.
- MCB for lighting circuits shall have fault with-stand current of 10KA and trip characteristic as:
  - `B' series MCB shall be used for LED and FTL fixtures.

- `B' series MCB shall be used for all small power circuits.
- 'C' series MCB shall be used for all motor loads.
- `D' series MCB shall be used for all UPS and Inverter circuits.

o MCB shall be DIN channel mounted and provided with trip-free manual operating lever and `ON/OFF/TRIP' indications.

o The position of handle shall give positive indication; whether the MCB is:

- `ON' (Top),
- `OFF' (Down),
- `Tripped' (Mid Way).

o The main breaking contacts shall be provided with 'Arc Chutes' to quench the arc quickly. Contact indication for 'make/break' position shall also be provided.

o MCB shall be provided with thermal & magnetic releases for over-current and short-circuit protections.

o The over-load and short-circuit device shall actuate a common trip bar in the case of DP, TP, 4P and TPN miniature circuit breakers to trip all the poles of the MCB simultaneously.

18.4.2 EARTH LEAKAGE CIRCUIT BREAKER (ELCB) / RESIDUAL CURRENT C. B. (RCCB)

Residual Current Device shall be:

o Manufactured in accordance with current IS: 12640-1; 1988/IEC 61008-1 (RCCB).

o Manufactured in accordance with current IS: 12640-2; 1988/IEC 61009-1 (RCBO).

o Suitable for operation at 230V/415V, 50Hz supply.

o A voltage independent and purely current operated device to operate on the principle of measurement of differential current using a current balance transformer and tripping a switching device through a bi-polar 'electro-magnetic' relay.

o Of an elegant design in 2 and 4 pole versions.

o Having a body made of flame-extinguishing plastic insulation material with high impact resistance with IP-20 degree of enclosure protection shall be ensured to prevent electrical shocks by accidental touch to any live parts, by providing finger touch proof terminals.

o With basic technical parameters, rating, operating voltage, etc. printed on front face of RCDs for ease of identification.

o With an operating mechanism trip-free ensuring that the ELCB (RCD) cannot be re-closed/reset if the earth leakage/fault persists. Operating knob shall have provision to lock in ON / OFF condition without affecting any automatic tripping.

o Manufactured with material used to manufacture it suitable for 100% recycling and shall comply with RoHS and REACH standards.

o With a test push button to check the correct operation of the unit in 4 pole design.

o Suitable for field-fitting Protection auxiliaries (viz. Over-voltage release, Under-voltage release, Shunt trip) and Indication Auxiliaries (like Auxiliary Contact, Trip alarm contact) and shall be communication-ready to indicate the status of the device for BMS.

18.5. EARTHING

G.I earth wires of suitable size (as per B.O.Q) shall be used for the DB & SDB, firmly connected to both sides of the enclosure frame work. Provision shall be made for connection from this earth to the main earth bar on both sides of DB/SDB.

18.6. LABELS

Plastic transparent label holder shall be provided on all incoming and out-going feeder control devices. Circuit diagram showing the arrangement of the circuit inside the distribution boards shall be pasted on inside of the DB door and covered with transparent laminated plastic sheet.

18.7. INSPECTION & TESTING

18.7.1 PRELIMINARY INSPECTION

- The DB/SDB shall be supplied duly packed for transportation. These shall be unpacked and items checked as per inspection manual of the supplier.
- MCB, RCCB, RCBO etc. shall be checked for any damage in transit.

All mechanical fasteners shall be checked and tightened before installation.

18.7.2 TESTING

Prior to commissioning of DB/SDB, following tests shall be carried out:

- Insulation resistance between phases and earth.
- All the internal connections of the DB/SDB shall be checked as per the manufacturer's drawings.

19. SIGNAGE LIGHTING FIXTURES - LED

The Signage light fixtures and accessories shall be assembled and installed in position; complete in- accordance with drawings, manufacturer's instructions and to the satisfaction of the Engineer-in-charge. These lighting fixtures shall fulfill two distinct objectives:

- Exit Signage : They help in locating the escape/exit door.
- Escape route lighting : They help in reaching the escape/exit safely during power outage.

19.1. STANDARDS

The LED Lighting Signage fixtures and their associated accessories such as reflectors, housings, starters etc. shall comply with the latest applicable standards as follows:

- SP: 7: 2016 : National Building Codes of India.
- IS: 9457-2005 : Codes of practice for safety colours and safety signs.
- IS: 10322:2:22, P-5 Emergency Sec 8: 2013 : Luminaires, Pt 5: Particular Requirements Section 8 Lighting.
- IS: 12349, 1988 : Fire protection – Safety signs.
- IS: 13716 : Code of practice for Fire Safety of hotels.
- IS: 1644, 1988 : Code of practice for fire safety of buildings (general) Exit requirements and personal hazard.
- IS: 1646 installation. : Code of practice for fire safety of buildings: Electrical
- IS: 12407, 1988 : Graphic symbols for fire protection plans.
- NLC: 2010 : National Lighting Code, India.
- I S: 3528; 1966 : Water-proof electric light fittings.
- I S: 3553; 1966 : Water-tight electric light fittings.
- I S: 4012; 1967 : Dust-proof electric light fittings.
- I S: 4013; 1967 : Dust-tight electric light fittings.

- o I S: 10322 : Pt 1, 1982 : Luminaires-general requirements.
  - - do- : Pt 2, 1982 : Luminaires-construction requirements.
  - - do- : Pt 3, 1984 : Luminaires-screw & screw-less terminals.
  - - do- : Pt 4, 1982 : Luminaires-methods of testing.
- o I S: 13383; 1992 : Methods of Photometry-Luminaires.

19.2. Visibility OF SIGNAGE

'Visibility' i.e. how well and accurately the average human eye can see. Visibility can be affected by a variety of factors such as:

- Contrast : Luminance of object to luminance to background.
- Time : Visibility increases with increasing viewing time.
- Colour : Influences related to contrast and Luminance factors.
- Luminance : Task Luminance effects visibility.
- Size : Larger the retinal image, it make one easier to see.

The signage design shall take in to consideration all these factors for their proper visibility.

19.3. GREEN COLOUR FOR EMERGENCY EGRESS SIGNAGE

The international code allows the 'EXIT signs' to be either red or green, however, both colors are considered as the 'traditional' colors depending on the area of use. The 'EXIT signs' to be green in color to avail the following advantages:

- o EXIT sign illumination shall be GREEN for three reasons:
  - They are easier to read, especially through smoke and haze.
  - They will never be confused with the actual fire in case of emergencies.
  - They create a soothing atmosphere.
- o The human eye is not uniformly sensitive to wavelengths of light across the visible spectrum, from red to green to blue.
  - Green color is very soothing to the human eyes.
  - The human eyes sensitivity is at its peak in green zone of the visible spectrum.
- o This means that:
  - The average human eye cannot see red light easily.
  - Since the human eye is more sensitive to the green part of the spectrum, green signs have a higher visibility and readability, which makes the green EXIT signs easily visible.
  - This is especially important in emergency situations, where the atmosphere might be obscured by smoke or haze.

19.4. OBJECTIVE OF ESCAPE ROUTE LIGHTING

The Escape route lighting shall switch ON automatically if the main lighting fails. The Escape route lighting shall ensure that work can continue for a certain amount of time, even during a power failure. The Escape route lighting shall serve the following requirement during emergency:

- o The Escape route lighting shall enable people; trapped during a power failure; to exit swiftly and safely.
- o Escape route lights shall:
  - Enable people to orient themselves and for emergency exit.

- Help people identity and seek the closest point and escape to safety in a short time.
- Illuminate the escape route with a minimal light level.
  : The horizontal luminance at floor level on the centreline of an escape route; shall not be less than 10 lumen/m².
  : The escape route shall be up to 2m wide, 50% of the route width shall be lit to a minimum of 5 lumen/m².
- In auditoriums, theatres, concert halls and such other places of assembly, the illumination of floor exit/access may be reduced during period of performances to values ≥ 2 lux.
- Help to negotiate obstacles such as stairs and locate safety equipment.

o Escape route lighting shall prevent people from panicking during a power cut; thereby putting themselves in danger. It shall typically help to locate and go for:

- Lifts, escalators and exit large rooms.
- The Escape route lighting (anti-panic) may be integrated into the general lighting.

o Escape route lighting in dangerous areas shall ensure stoppage of systems, processes or machine safely in case of a power failure.

19.5. CONSTRUCTION AND MAINTENANCE OF 'EXIT' & 'ESCAPE ROUTE' LIGHT

o The construction of Escape route Lights shall conform to the following standards:

- EN 50172 : "Safety Lighting Systems"
- IS 10322 : Construction and maintenance of Emergency Egress Route Lighting.

o The 'Egress' and 'Emergency Egress Route' Light shall be 'Edge-lit', surface or recessed mounted with IP20 ingress protection. The transparent sheet of required thickness shall be UV protected.

- The fixture shall be complete with chargeable Lithium or NI-Cd battery suitable for minimum 2-4 hrs (as required) duration and suitable battery charger to operate at 230V, 50Hz AC power. The 'Constant current' charger shall be capable to fully charge the battery in 16 to 24hrs.
- There shall be a LED 'ON' indicator on the luminary to show the battery being charged.
- The battery and charger equipment shall be housed in a 22guage (minimum) CRCA white powder coated housing.
- The display type and dimensions shall be as per the relevant standards.
- The Signage for out-door use shall have IP65 ingress protection.
- The LED wattage shall be commensurate with the use of the fixture.

19.6. DISPLAY AND ILLUMINATION REQUIREMENT FOR SCAPE ROUTE LIGHTS

In general, following is the summary requirement for the **Escape route lights:**

o Escape routes shall:

- Be illuminated with a least 1 lux in a width of 2 meters.
- Have the ratio of the brightest to the darkest point not exceeding 40:1.
- Have the lights installed such that they do not dazzle.

o The Emergency Lighting must be provided in:

- The areas to clearly point out the escape route and illuminate it.

- In every room, at least one safety sign must be visible as follows:
- Rooms with large gathering or rooms > 60m².

  Rooms open to the public that are bigger than 8m or facilities for physically challenged people. This includes toilets, changing rooms and waiting rooms etc.

  Lifts and escalators. (Panic or danger of injury during a power cut).
- Electrical switching and fuse systems, control rooms and walkways within covered car parks.

o Luminaries installed < 2 meters above the floor; must be protected against mechanical damage.

o Escape route lighting luminaires shall be sited to cover the following locations:

- Near each intersection of corridors,
- At exits and at each exit door,
- Near each change of direction in the escape route,
- Near each staircase so that each flight of stairs receives direct light,
- Near any other change of floor level,
- Outside each final exit and close to it,
- Near each fire alarm call point,
- Near firefighting equipment, and
- To illuminate exit and safety signs as required by the enforcing authority.

o 'EXIT signs', which should comply with the graphic requirements of the relevant Indian Standards, shall be provided:

- Where exit access is provided through corridors/paths, the occupants shall be able to easily identify the way to exits.
- At all exits, emergency exits and escape routes.
- Exit signs shall be provided such that no point in an exit access is more than 30 m from a visible exit.

o The recognition distance must be adhered to and shall be calculated as follows:

$$D = S \times P$$

Where:

- D is the recognition distance,
- P is the height of the safety signs, and
- S is a constant. (S=100 for illuminated signs, S=200 for back-lit signs).
- For the anti-panic lighting the following requirements apply:
  - : The lighting strength at floor-level must be at least 0.5 lux.
  - : The ration of the brightest to the darkest point must not exceed 40:1,
  - : The anti-panic lighting must not dazzle.

o Photo luminescent markings shall be pasted at:

- Internal hydrant boxes.
- Hose reels.
- Fire Alarm Panel.

- Manual Call Points.
- Hand-held Fire Extinguishers.
- Fire Buckets.
- First Aid Box.
- Fire doors.
- Lifts: 'In case of fire, do not use lift, use stairs'.
- Fire related operating point etc.

19.7. TESTING

For automatic testing devices, checking the status display is sufficient.

- The Emergency/Scape route Lighting must be tested in accordance with EN 60598-2-22.
- In addition to monthly testing, the operating duration of the light must be tested in emergency operation once a year. The operating duration depends on the duration allocated.
- The EN 1838 "Applied Lighting Technology-Emergency Lighting" standard is a constituent of the EN 50172 standard. It describes the lighting requirements of emergency lighting.

20. PASSENGER LIFTS

20.1. SCOPE

This specification calls for Planning, designing, Supply, Installation, Testing and Commissioning of the Lifts at site. all Statutory clearance from the inspecting authorities for the safe operation of the lifts shall form a part of the scope of work of the bidder & shall be obtained prior to putting the lifts in service. Lift capacity, size, speed and dimensions etc shall be as per NBC 2016 guidelines. All design calculations regarding lift capacity and speed etc. shall be furnished for verifications and client approval.

20.2. STANDARDS

- The passenger lifts shall conform to the following I S standards as applicable:
  - IS: 4666-1980 : Specification for electric Passenger & Goods Lifts.
  - IS: 2332-1963 : Nomenclature of Floors & Stories.
  - IS: 14665, pt-1, 2000 / goods, IS: 3534 : Guide lines for out-line dimensions for passenger, service Lifts.
  - IS: 14665, pt-2, 2000 : Recommended elevator speed for passenger, goods services & Lifts.
  - IS: 14665, pt-3, 2000 : Safety rules for passenger, goods, service Lifts.
  - IS: 14665, pt-4, 2000 : Components for passenger, goods, service Lifts
    - Section-1/ IS: 9803 : Lift Buffers.
    - Section-2/ IS: 11615 : Lift Guide Rails and guide shoes.
    - Section-3/ IS: 10191/ IS: 11706 : Lift Car frame, car, counter weight & suspension.
    - Section-4/ IS: 9878 : Lift Safety gears and governors.
    - Section-5/ IS: 10448 : Lift Retiring Cams.
    - Section-6/ IS: 7759 : Lift doors, locking devices and contacts.
    - Section-7/ IS: 7759/ : Lift Machines and brakes.

IS: 10913

- Section-8/ IS: 8216 : Lift Wire ropes.
- Section-9 : Lift Controller operating devices.

o IS: 14665, pt-5, 1999 / IS: 14671 : Inspection manual for passenger, goods, service & lifts.

o IS: 8151 :Induction motors for electric Passenger & Goods Lifts.

o IS: 4289-1967 :Specification for lift Cables.

➢ The Installation of Lifts shall conform to:

o IS: 1860-1980 / IS: 6620 maintenance of : Code of Practice for Installation, Operation electric & Passenger & Goods lifts.

o IS: 3043-1966 : Code of Practice for earthing.

o National Building Code-Chapter VIII-2016.

o Lifts Acts and Rules,

o Indian Electricity Rules and Acts.

o Local authorities' requirements, if any.

20.3. TECHNICAL SPECIFICATION

20.3.1 SITE PREPARATION

The site where the Lift has to be installed, shall have following basic requirements:

➢ MACHINE ROOM:

Lifts with Geared mechanism and machine room shall be preffered. Number of lifts and their orientation with respect to each other shall determine the size of the Lift machine room. All the overhead machines and control panels for each lift shall be located in the common Machine room. if machine room less (MRLS) lifts are required, it has to be planned and provided based on clients requirement & approval.

➢ LIFT SHAFT:

Each lift shall have its own shaft having a size determined by the no. of passengers to be carried in the Lift carriage. The shaft shall be in plumb as per I S: 14665 pt. 2, 2000.The shaft shall serve each floor in which suitable opening shall be available. An opening shall be available in the wall at each landing for fixing the landing door. Size of the opening shall be commensurate with the lift Carriage door size.

➢ LIFT PIT:

A suitably sized 'Pit' shall be made available below the first landing floor, free of moisture/water etc. The depth of the pit shall be suitable to accommodate the passenger carriage and the 'Shock absorbing springs 'required to be installed in the base of the shaft.

20.3.2 LIFT FEATURES

➢ PASSENGER CARRIAGE

Size of the Passenger Carriage shall be determined by the number of passengers to be transported at a time.

- The door of the carriage shall be 'Centrally opening type in two halves' or telescopic type, opening in one side.
- Door may be manually / automatically operated – electrically.
- The internal finish of the Passenger Car and the Door shall be as per the standard practice of the lift manufacturer and as agreed with the Client/Consultant.

- The lift shall be operable with/without an attendant. The controls shall be operation friendly, matching with the ambience.
- The floor of the car shall be durable, abrasion resistant.

➢ FLOOR LANDING DOOR:

It shall have a fire rating as per I S Standards. It shall be made of M. S. painted. / Stainless Steel as agreed with the Client/Consultant.

➢ SPEED OF TRAVEL:

As per I S standards and as agreed with the Client/Consultant.

➢ TYPE OF DRIVE:

The type of 'Drive' may be Single speed / Two Speed / A C Variable Voltage, Variable frequency (VVVF) drive. The type of drive shall be selected depending on the use; the lift shall be put to.

➢ TYPE OF CONTROL:

The type of 'Control' shall be selected best suited for the use of the lift in consultation with the Client, Consultant and the manufacturer of the Lift. The control shall be one of Automatic Push Button / Dual Push Button / Duplex Down-Collective Control / Duplex Collective- Selective Control / Triplex Down-Collective Control / Triplex Collective-Selective Control.

➢ FIREMAN'S CONTROL:

Required for one lift as per IS & local Fire Department's standards.

➢ OPERATIONAL FEATURES:

Operational features shall be as per the specific requirements of the lift and as agreed with the Lift manufacturer.

20.4. ADDITIONAL FEATURES REQUIRED

a. FIREMAN'S SWITCH

A fireman's toggle switch shall be provided in a break glass for the specified elevator at ground floor to enable firemen to bring the elevator non-stop to ground floor from any location and to cancel hall calls until the car is operated on attendant control.

b. ANTI - NUISANCE

If number of calls registered is in excess of corresponding car load, all car calls shall be cancelled.

c. HOME LANDING FACILITY

A car shall return to a pre-determined landing after the last call is answered.

d. LOAD NON STOP

When the car load exceeds a predetermined limit the elevator shall not respond to hall calls.

e. SEPARATE DOOR TIMES

When a car responds only to hall calls or only to car calls, the door shall open for a shorter time than when responding to both car and hall calls.

f. DOOR FAILURE OPERATION

When an obstruction prevents a door from opening, the controller shall attempt its removal by repeated opening and closing, failing which the car shall travel to the next floor.

g. NUDGING DOOR OPERATION

When the doors remain open for more than a predetermined period a buzzer shall sound and the door shall close automatically. The door sensing device shall be rendered inoperative but the Door Open button and the safety shoe shall remain operative

h. SELF - DIAGNOSTIC FACILITY

The Controller shall perform self - diagnostic tests and report the health of the system. The system shall take care of minor faults like door operation and motor overheating.

i. CAR FAILURE OPERATION

In case of car mal-function, the system shall make a self - diagnostic check and then allow the car to travel to the nearest floor at slow speed, if safe.

j. SELECTIVE FLOOR SERVICE

Programming for selective floors services shall be software driven.

k. AUTO FAN OFF

In case no call is registered for pre-set time, the cabin fan shall be automatically switched off.

l. AUTOMATIC RESCUE DEVICE (ARD)

- In case of mains power failure and elevator control system failure, the elevator's own rechargeable and maintenance free battery power shall move the car to the nearest floor or GF and the door shall open automatically for automatic rescue of passengers. A battery run-down indicator / alarm shall also be provided.
- Compulsory Automatic Rescue Device shall be provided for all the Elevators.

20.5. SPECIFIC TECHNICAL REQUIREMENTS

➢ SITE REQUIREMENTS

The lift shall meet the following site requirements:

o	Lift machine type & control:		Gearless machine in machine room directly above lift well or MRLS as required.
o	No. of lifts	:	xx (Ref Dwg).
o	Type of Lift	:	Passenger/goods lift.
o	Lift Capacity	:	---- Passengers / ---- Kg (Ref Dwg/NIT/ as per std.).
o	No. of operating floors	:	Basement to top / each tower -- (Ref Dwg).
o	Distance between floors	:	------ mm (Ref dwg).
o	Lift Well dimension	:	---- - - mm, plaster finished (Ref Dwg/BOQ).
o	Speed of Travel	:	1.5~2.5M/second or as directed by Engg.in charge.
o	Type of drive	:	AC variable voltage, variable frequency (VVVF) drive.
o	Type of Control	:	Duplex collective-selective control (Ref BOQ).
o	Fireman's Control	:	Required for one lift.
o	Lift operation	:	With & without attendant.
o	Machine Room	:	Refer enclosed Drawing/ as per client.
o	Type of Lift Door	:	Center opening (Horizontal), automatic door with ACVF drive, door made of stainless steel.
o	Floor Landing Door	:	It shall have a fire rating of 2Hrs. It shall be made of MS 'Duco' painted. / Stainless Steel (Ref BOQ).
o	Type of Car Interior	:	Stainless steel interior (Ref BOQ).

Car suspended ceiling	Stainless steel Hairline finish with LED fixture for car lighting.
Car flooring	Granite/marble flooring. Or finishes shall be as per approval.
Natural mirror in car	Provided
Handrail	Round handrail in Stainless steel finish on 3 walls of car.

- Car operating panel : 2 nos. full height with operating push buttons.
- Landing operating panel : Common landing operating panel for each elevator
- CCTV : Provisions for 4MP, IR, Mini dome camera, PA, Tel. shall be considered inside.
- Inside the lift shaft there shall be arrangement of one light point at each floor level and one light point at overhead top, & one light point in lift pit. All light points shall be in group controlled and wired with 2.5 sq mm FRLS copper wires. 15-amp power plug and 5-amp power plug shall be provided at each floor level. Wiring of these power plugs shall be done with 4.0 sq mm FRLS copper wires. LED Bulk head fittings of suitable rating to provide inside shaft. Average 100 lux shall be planned with each light point of lift shaft.

➢ OPERATIONAL FEATURES:

- Over-load control (non-start with audio-visual warning indication).
- Landing Calls automatic By-pass on lift-car loading > 80% rated load.
- Emergency power control (with DG set) (on Mains failure; lift to come on nearest landing when DG Power available; lift door opens. Same operation repeats with next lift and so on).
- Emergency Rescue Device (with Battery power for each lift – same as above). (Ref BOQ)
- Up / Down direction indication on all floors.
- Emergency Alarm & Light inside the lift-cabin with chargeable battery.
- Auto-shut-off of car fan when lift car is empty.
- Two way Intercom device in Car (One set in the Car-cabin & the other in Warden's office within 10Meters).
- Infra-red full door safety Screen in addition to the mechanical Al. nose safety shoes.
- Audio-visual announcement of lift on approaching the landing with single stroke of gong.
- Voice announcement in the lift car on approaching the landing.
- Music in the Lift-Car.
- Door closing over-ride through push button in lift car.
- Anti-Nuisance of empty car operation & car-call cancellation on reverse direction.
- Braille signage shall be provided in Lifts.
- Potential free contacts for BMS use.
- Flame retardant travelling cable, O/L & phase reversal protection.

20.6. FACILITIES TO BE PROVIDED BY THE CONTRACTOR/ VENDOR

The lift well of the specified dimension shall be made available in finished condition.

- Minimum Entrance door opening of 800 (W) x 2000 (H) mm on each floor without door / door-frame. (or as per NBC 2016)
- Machine room for the lifts shall be made available along with the approach ladder, natural and forced ventilation as per the lift vendor's requirement.
- The owner shall make available the three phase, 415V, 4 Wire, 50Hz. power supply at one point in the Lift Machine room through a 63Amps TPN MCB.
- Two nos. building Earth connection shall be extended up to the Lift machine room.
- The power distribution and control of the lifts shall be the responsibility of the Lift supplier.
- All inserts, grouting, minor civil work etc. including the Scaffolding required shall be carried out by the lift vendor.
- Illumination and 15amps power points at each landing shall be arranged by the vendor.

20.6.1 VENDOR'S RESPONSIBILITY

- All arrangements other than specifically mentioned as Owner's responsibility, as required for installation, testing & commissioning of the lifts to make them functional in a safe manner shall be made by the Lift vendor.
- The vendor shall also be responsible to obtain the Certificate from the 'Inspector of the Lifts' as well as the 'local fire department' as applicable for safe operation of the lift.

20.7. SITE TESTS

- Following tests shall be carried out on the lift on completion of erection in addition to any other tests that may be required to determine the safe operational requirement:
- Insulation of Electrical system (should be > 0.5MΩ.)
- Earth continuity tests.
- Function of Motor, Brake control equipment and Door locking devices.
- Rated Load-Test of the lift.
- Rated speed test at full load & No load.
- Safety gear stopping the Lift on Landings at rated Load.
- Any other test required by local authorities.

20.8. PERFORMANCE & TYPE TEST

- Consignee will inspect the lift at manufacturing stage at firm premises to carry out all the routine tests. The performance test at site shall be carried out in the presence of inspector of local authorities and certificate thereof shall be supplied to the consignee. The testing shall be in accordance with I S: 4666/68. The contractor has to arrange the Inspection by Lift Inspector Local Govt.

20.9. GUARANTEE

The standard guarantee for a period of 12 months after final commissioning for trouble free performance against defective workmanship or manufacture, wear and tear in parts not attributable to the negligence, shall be given along with tender.

20.10. FREE POST COMMISSIONING MAINTENANCE SERVICE

The supplier must give minimum one year free post commissioning service which shall be all inclusive.

20.11. DRAWINGS & LITERATURE

- The supplier shall provide general arrangement layout drawing of the elevator on award of the contract. Necessary number of final approval layout drawings is to be provided for purchasers records.
- In addition to the elevator drawing wiring diagram, maintenance and lubricating check charts are also to be supplied on completion of installation.
- One schematic wiring diagram is to be displayed in the machine room as per applicable lift code.
- Screen printing data of major equipment with date of commissioning is also to be displayed in the machine room.

21. ELV

21.1. CCTV

	NVR	
S. No.	Required Specification	Offered Specification
1	Channel Options	Available in 32 channels
2	Video Resolution	Supports up to 12 MP HD (UHD) with 4K HDMI output
3	Regulatory Compliance	NDAA Section 889 compliant
4	Data Protection	Failover redundancy supported (N+1)
5	System Integration	Compatible with Maxpro VMS and ONVIF Profile S
6	Video Compression	Supports H.265 HEVC, H.264 and Smart Codec
7	Playback Capability	Synchronized playback up to 16/32/64 channels
8	Audio Support	Two-way audio with 3.5 mm line-in / line-out
9	Audio Format	G.711 supported
10	Internal Storage	Up to 8 HDDs, maximum 96 TB storage
11	External Storage	Supports eSATA, NAS, USB and PC client storage
12	RAID Support	RAID 5 / RAID 6 storage
13	Recording Modes	Continuous, Manual and Event-based recording
14	ANR	Automatic Network Replenishment supported
15	Encryption	TLS1.2 / TLS1.3, AES128/256 encryption
16	Secure Boot	Supported with Honeywell cybersecurity standards
17	PCI-DSS Compliance	Meets PCI-DSS security standards

18	Video Security	Video watermarking supported
19	Remote Monitoring	P2P mobile access for iOS and Android devices
20	Video Analytics	Search by object type and attributes
21	Fisheye Support	Multiple dewarping options supported
22	Installation	Plug-and-play setup with 35 series cameras
23	Network Connectivity	Dual network ports for IPC and remote access
24	User Interface	Installation wizard and intuitive interface
25	Power Supply	100–240V AC, 50/60 Hz
26	Operating Temperature	-10°C to 55°C
27	Storage Temperature	-40°C to 60°C
28	Relative Humidity	Less than 90% RH
29	Certifications	FCC, CE, UL, RoHS, UKCA, RCM, UAE
30	Warranty	5 Years
31	Alarm & Events	Camera/system alarms with buzzer, push notification, email, recording
32	PTZ Control	Supports direction, zoom, focus and presets
33	Privacy Protection	Up to 4 privacy masking areas
34	Language Support	Multi-language support

	BULLET CAMERA	
S. No.	**Required Specification**	**Offered Specification**
1	Camera Type	5 MP IP Bullet Camera
2	Frame Rate	5 MP @ 30 FPS
3	Housing Rating	IP67 weatherproof & IK10 vandal resistant
4	Image Sensor	1/2.8" CMOS Sensor
5	Lens	Automatic Varifocal Lens
6	Focal Length	2.7 – 12.8 mm

7	Wide Dynamic Range	120 dB WDR
8	IR Illumination	Intelligent IR up to 65 m with adjustable intensity
9	Video Streams	Four Streams with H.265 compression
10	Video Analytics	Motion Detection, Scene Change, Tamper Detection
11	Smart Analytics	Smart Motion, Intrusion, Loitering, Line Crossing
12	Advanced Analytics	Unattended Object, Missing Object Detection
13	People Analytics	People Counter, Queue Monitoring, Crowd Gathering
14	Heat Mapping	Heat Map supported
15	Face Detection	Supported
16	Audio Communication	Two-way full duplex audio
17	Alarm Interface	1 Alarm Input / 1 Alarm Output
18	Edge Storage	Encrypted SD Card storage up to 2 TB
19	Image Stabilization	Gyro sensor based image stabilization
20	ONVIF Compatibility	ONVIF Profiles S, G, T, M
21	Network Protocols	IPv4, IPv6, TCP/IP, HTTP, HTTPS, RTSP, RTP, RTCP
22	Additional Protocols	IGMP/Multicast, SMTP, SNMP, DHCP, NTP, DNS, DDNS
23	Security & Network	CoS, QoS, 802.1X, TLS, SFTP
24	Other Protocols	UPnP, mDNS (Bonjour), UDP, ICMP, ARP
25	Safety Certification	UL listed to UL/CSA 62368-1
26	BIS Certification	BIS IS 13252 (Part 1) / IEC 69050-1
27	Additional Certifications	BIS ER & STQC
28	Operating Temperature	-20°C to +55°C or better
29	Humidity	Up to 95% non-condensing
30	Mounting	Pole mount arrangement
31	Vehicle Detection	Capable of detecting and tracking moving vehicles

	DOME CAMERA	
S. No.	Required Specification	Offered Specification
1	Camera Type	5 MP IP Dome Camera
2	Image Sensor	1/2.8" CMOS Image Sensor
3	Lens Type	Motorized Focus & Zoom (MFZ) with DC-Iris
4	Focal Length	2.8 – 12.5 mm
5	Aperture	F1.6 – F3.5
6	Video Streams	Quad Stream Supported
7	IR Illumination	Integrated Surround IR up to 45 m
8	Minimum Illumination	Color: 0.005 Lux @ F1.6 / B&W: 0 Lux (IR ON)
9	Wide Dynamic Range	125 dB WDR
10	Electronic Shutter	1/2 to 1/100,000 sec
11	Basic Analytics	Motion Detection, Scene Change, Tamper Detection
12	Smart Analytics	Smart Motion, Intrusion, Loitering, Line Crossing
13	Advanced Analytics	Unattended Object & Missing Object Detection
14	People Analytics	People Counter, Queue Monitoring, Crowd Gathering
15	Heat Mapping	Heat Map supported
16	Face Detection	Supported
17	Analytics Operation	All analytics can run simultaneously
18	Day/Night Profiles	Separate profiles with automatic scheduling
19	Housing Protection	IP66 weatherproof & IK10 vandal resistant
20	Edge Storage	SD Card support up to 2 TB
21	Storage Security	AES encrypted storage on memory card
22	Image Stabilization	Gyro-based image stabilization
23	ONVIF Compatibility	ONVIF Profiles S, G, T & M
24	Network Protocols	IPv4, IPv6, TCP/IP, HTTP, HTTPS, RTSP/RTP/RTCP

25	Additional Protocols	IGMP, Multicast, SMTP, SNMP, DHCP, NTP, DNS, DDNS
26	Network Security	CoS, QoS, 802.1X, TLS, SFTP
27	Other Protocols	UPnP, mDNS (Bonjour), UDP, ICMP, ARP
28	Firmware Security	Firmware encrypted and digitally signed
29	Storage Security	SD card encryption supported
30	User Security	User account/password protection, IP filter, HTTPS
31	Authentication	Digest authentication & device certificate
32	Encryption	TLS 1.2 / TLS 1.3, AES128 / AES256 stream encryption
33	Network Hardening	SSH/Telnet disabled
34	Compliance Standard	PCI DSS compliant
35	Secure Boot	Supported
36	Attack Protection	Brute-force attack prevention
37	Logging	Audit user access, system and event log management
38	Mounting	Pole mount from same OEM
39	Operating Temperature	-20°C to +55°C or better
40	Humidity	Up to 95% non-condensing
41	Regulatory Compliance	BIS-ER & STQC certified

21.2. DATA

TECHNICAL SPECIFICATION

STRUCTURED CABLING SYSTEM PASSIVE

CAT6A COMPONENT:-

	Parameter	Minimum Specification	Compliance Yes/No	Remarks

CAT6 UTP 23 AWG Solid bare copper cable				
1	Conductor Material	Bare Copper		
	Shape of Conductor	Solid		
	Wires Diameter	Nom. 0.50 ± .025mm		
	Insulation Material	Polyethylene		
	Diameter (Nom.)	0,96± 0,03		
	Laying	4 Pair laid Together with cross filler		
	OUTER SHEATH Material	PVC/LSZH		
	Overall Diameter	6 mm ± 0.3mm		
	Characteristics Impedance	100 ± 5 Ohms		
	Weight of cable (kg/km)	36 ± 10%		
	Packing Length	305 Mtr.		
	Min. bending radius when laying (mm)	25mm		
	Maximum attenuation (dB/100 m)	32.9		
	Return Loss (dB)	17.3		
	NVP	64%-69%		
	Standards	ANSI/TIA 568.2-D, ISO/IEC 11801, IEEE 802.3bt : PoE++		
	Fire rating	IEC 60332-1-2, IEC 61034-2, IEC 60754-2		
	Usage temperature	– 20 to + 70 °C		
24 Port Cat 6 19" Modular Patch Panel				

2	Type	Cat 6 UTP Flat/Angled 24 Port Patch Panel - Loaded		
	Material characteristics Panel:	Galvanised sheet steel		
	Size	19"Inch 1U Toolless Mooting Solution		
	Cassette	Cassettes based RJ45 Cat. 6/6A connectors with toolless fast connection, marked 568 A/B.		
	Earthing	Earthing with Rack/Cabinet		
	RJ45 Termination	Toolless Termination Connectors, front access.		
	Cassette In-Out	Button extraction		
	Contacts:	Gold/nickel, minimum thickness of gold > 0.8 µm. Metal parts: Bronze, nickel, platinum, gold. Polycarbonate PBT		
	Electrical characteristics	Breakdown voltage ≥ 1000 V. Contact resistance ≤ 20 mΩ. Insulation resistance ≥ 500 mΩ at 100 Vdc. “Tested and independently certified to comply with IEC 60512-99-001 and IEC 60512-99-002 for PoE support up to 90w (Type 4)		
	Locking Nut	RJ45 connectors with a locking mechanism, Do not require a special tool and can be re-wired if a mistake is made.		
	POE	IEEE 802.3af , IEEE 802.3at , IEEE 802.3bt : ‘‘Power over Ethernet”, Types 1 to 4, up to 90w		
	Temperature	Storage temperature : 10°C to +70°C Operating temperature : -10°C to +60°C		
Cat 6 Copper Patch Cord				

3	Type	Unshielded Twisted Pair, Category 6, TIA / EIA 568-C.2 &ISO/IEC 11801		
	Conductor	Cat6 Patch Cord should be 4 Twisted Pair, 24/28 AWG Stranded Bare Copper Conductors.		
	Length	1, 2, 3, 5, 10 Meter		
	Electrical Features	Loop resistance < 2Ω Contact resistance < 20 mΩ Total resistance of the cord < 5Ω Resistance per 100m of cable with cords < 14Ω DC dielectric strength 1 kV/1 min Characteristic impedance from 1 to 250 MHz 100Ω ± 15		
	Plug Protection	Factory fitted Strain relief boots on either side		
	Jacket	PVC/LSZH		
	Outer Diameter	6±0.2mm		
	Insertion Life	The patch cord should have Insertion Life of 2200 better mating cycles.		
	Compatible	‘‘PoE’’ remote power supply up to 90W (IEEE 802.3af, IEEE 802.3at, IEEE 802.3bt) Standards ISO/ IEC 14763-2:2019 and/or and EN 50174-2:2018		
	Tensile strength of the cord	≥50 N		
	Third Party Verification	4 Connector ETL/3P Certified.		
	Temperature	Storage and transport temperature: -20 to +75°C Operating temperature: -20 to +60°C Installation temperature : 0 to +60°C		
CAT 6 UTP RJ45 Connector/Jack User End				
4	**Parameter**	**Minimum Specification**		

	Type	Cat 6 TIA / EIA 568-2.D &ISO/IEC 11801		
	Contacts:	gold/nickel, minimum thickness of gold > 0.8 µm		
	Metal parts:	bronze, nickel, platinum, gold,PBT polycarbonate		
	Breakdown voltage:	≥ 1000 V		
	Contact resistance :	≤ 20 mΩ		
	Insulation resistance :	≥ 500 MΩat 100 V DC		
	Max. number of connections and disconnections:	5 without refreshing the wiring.		
	Endurance:	2200 movements (plug insertion/withdrawal)		
		IK03		
	Insertion Life	The patch cord should have Insertion Life of 2200 mating cycles.		
	RJ45 Termination	Toolless Connectors are connected at the front without a special tool		
	Bandwidth Support	250Mhz.		
	Data Transmission:	1G		
	Compatible:	‘‘PoE’’ remote power supply up to 90W (IEEE 802.3af, IEEE 802.3at, IEEE 802.3bt) Standards ISO/ IEC 14763-2:2019 and/or and EN 50174-2:2018		
	Standards	ANSI/TIA 568.2-D		
	Fire rating	IEC 60332-1-2		
	Usage temperature	– 10 to + 60 °C		
Cat 6 Faceplate				
5	Faceplate Style	Single Gang square plate, 86mmx86mm, British Style		

	Screw hole covers	Screw hole covers - to be supplied with plate, Plug in Icons - Icon tree - to be supplied with plate		
	Universal RJ45 Installation	Should be able to support variety of jacks -UTP, STP, Fiber, Coax etc.		
Mounting Box/ Backbox for Face Plate				
6	Make	Mounting Box of the same OEM or equivalent good brand		
	Size	86mmx86mm		
	Material	Metal Backbox		

42U RACK:-

MODUCAB NETWORKING / SERVER RACKS			**Compliance Yes/No**	**Remarks**
Sr. No.	**Parameter**	**Specifications for Perforated door**		
1	Basic Frame	Multi hollow extrusion Aluminium profile frame		
2	Construction	Modular Constuction of the rack made of 4 vertical , 4 horizontal & 4 depth extruded aluminum alloy multi hollow profiles bolted and joined together with Links and Corner Block. 2/3 pairs of support channel to equate the load evenly		
3	Top & Bottom Cover	Bolted to Frame with Cable entry cut outs		
4	Front Door	Lockable hexagonal Perforated steel Door - Single / Double		
5	Rear Door	Lockable hexagonal Perforated steel Door - Single / Double		
6	Lock for doors	Cam Lock / 3 point lock		
7	19” Mounting Angle	4 No Adjustable. 19” verticals with Punched 9.5mm Squarer Hole and Universal 12.7 mm-15.875 mm-15.875 mm alternating hole pattern offers greater mounting flexibility, maximizes usable mounting space.		
8	Standard Finish	Epoxy polyester Powder coated 60-80 micron thickness		

8	Standard Colour	Combination of RAL 7035 & 7037 **OR** RAL 9005		
9	Standard Mounting	Caster wheels (2 with Brake & 2 without Brake) and Levellers **OR** Plinth		
10	Static Load	Upto 1200 KG.		
11	Accessories	Power distribution unit, Metal Cable manager, Hardware packet, Monitor Shelf, Cantilever Shelf, Blank Panels, Support angles, Keyboard tray, Metal cable channel		
12	Equipment cooling	4 Fan Mount provision on top cover		
13	Corrosion Resistance	Salt spray test according to ISO 9227 (NSS test) and IEC EN 60068-2-11 (Ka test) for 168 hours: degree of Rusting Ri1 according to ISO 4628-3, propagation ≤1 mm according to ISO 4628-8.		
14	Rack Standards	IS 9606-1980, UL 2416, IEC EN 60529, IEC EN 62262, ISO 9001:2008, ISO14001: 2015		
15	Degree of Protection	IP 20 according to IEC 60529, IK08 according to IEC EN 62262		
16	Warranty	One year		
17	Size	**Floor stand with single side panels**		
		42U - 800W x 1000D		

9U RACK:-

AUTOTEK WALL MOUNT			**Compliance Yes/No**	**Remarks**
Sr. No.	**Parameter**	**Specifications for IP54**		
1	Size	600W x 600D		
2	Form factor	9U		
3	Basic Frame	CRCA Steel frame		
4	Construction	Robust Steel Sheet Welded Construction consisting of top, bottom, rear and side panels together		
5	Front Door	Lockable Metal Plain Door with filter and hood		
6	Top Cover	Top cover with Fan and IP54 compatible filter. Rain canopy is provided over the top cover for protection		
7	Bottom Cover	Bottom cover with Single Plain Gland Plate		

8	19” Mounting Angle	4 No Adjustable. 19” verticals with Punched 9.5mm Squarer Hole and Universal 12.7 mm-15.875 mm-15.875 mm alternating hole pattern offers greater mounting flexibility, maximizes usable mounting space.		
9	Std. Equipment Mounting	9.5mm Sq. Slots and Universal 12.7mm-15.875mm-15.875mm alternating hole pattern		
10	Powder coating Shade	Pure polyester paint applied by electrostatic dusting. RAL 7035 Structure – 80 to 100uM.		
11	Rack Standard	IS 9606-1980, IP54/IP55 certified product according to IEC 60529:2013, ISO 9001:2008, ISO14001: 2015		
12	Accessories	Horizontal power distribution unit, Metal Cable manager, Hardware packet and Cantilever Shelf		
13	Warranty	One year		

TECHNICAL SPECIFICATION

IP-PBX

Sr. No	Specifications	Compliances
1	Should provide 2 x 10/100 interfaces or 2 x 10/100/1000 interfaces	
2	Gateway should be modular with minimum 1 slots for voice interface	
3	Shall support variety of Voice interfaces like FXO, FXS, VOIP Channelized PRI (E1)	
4	Should be provided with minimum 2x E1 ports Day 1 to terminate minimum of 2 PRIs.	
5	16 Analog Extensions with licences (from same OEM without any third party hardware)	
6	It shall support redundant power supply	
7	The system should provide a single management interface window for all application management. The management software should be based on web browser	
8	The System should be expandable to 300 extensions with single CPU and 500 with 2 CPU; the expansions should be achieved through addition of interface boards. There should not be any change of the CPU or the system software during expansions.	
9	System should offer Hot-Desking functionality for minimum 150 Users.	

10	System should have very simple and same type of Licenses for all users (irrespective of user type whether Analog, Digital, IP, license Type should remain same)	
11	System should support built-in Contact center functionality just by enabling licenses (No need to have any external Hardware)	
12	System to support Intelligent call routing	
13	System to have BHCA value upto 1500	
14	System to support SSL V3 and HTTPS for secured sessions	
15	**Voice features:**	
15.01	The system should support the following voice terminals:	
15.02	Analog telephones	
15.03	High - end IP hard phones	
15.04	High- end IP soft phones	
15.05	Client / server based CTI solutions	
15.06	Music on hold (up to 2mn customizable)	
15.07	Personal assistant	
15.08	Voice mail	
15.09	Call forwarding	
15.10	Call transfer	
15.11	Call Back	
15.12	Park / Retrieve	
15.13	3-way conference	
15.14	6 Party meet me conference	
15.16	Company greeting	
15.17	Hunting group (cyclical, sequential, parallel)	
15.18	External loudspeaker broadcasting	
15.19	Pick up (group, individual, supervised line...)	
15.20	Manager / Secretary profile	
15.21	Automatic Route Selection (ARS)	

15	The system should have in-skin voicemail expandable to 8 ports with 200 hrs of storage. The system should be offered with 2 ports, 60 minutes of recording	
16	The voice mail should be Easy to use: User should be able to navigate through the voice mail features using voice prompts and the digital phones with soft keys should provide display for accessing the voice mailbox.	
17	Following features should be supported:	
18	Direct access to any message whatever its rank, Record online function, Screening function.	
19	Notification by message LED	
20	External notification (on mobile, phone pager, home set, …)	
21	Unconditional / on busy / on no answer forward on voice mail with specific message.	
22	Different options should be offered to the callers to reach different destinations like secretary, mobile phone, outside number, operator, voicemail.	
23	The system should support VOIP features without any additional cards. IP users should register directly on processor	
24	It should support: IP Telephony, IP trunking SIP	
25	QOS features should be supported. It should be able to tag the voice packets at the level 3 (IP) using TOS and DiffServ.	
26	The system should support the following compression algorithm for VOIP:	
27	G711 when packets will stay in the LAN,	
28	G722, G723.A and G729.AB	
29	System to offer Multi-level and Multi group Auto Attendant functionality	
30	**Networking:**	
31.01	Branch office and remote ext IP solutions	
31.02	It should be possible to have Remote IP phones in the branches, managed by the call server in the headquarters. The IP phones at the remote site should have exactly the same features as they would at the headquarters.	
31.03	The system should be compliant with QSIG standards.	
31.04	ISDN	
31.05	Basic call	
31.06	Block dialing	
31.07	Call forwarding indication on Cent. OP	

31.08	Called party state indication on Display	
31.09	Caller's report CDR	
31.1	Web dialing Extension	
31.11	CLIP/CLIR & COLP/COLR	
31.12	Diversion / Dynamic Routing	
31.13	DTMF transparency	
31.14	Optimized path in case of Forwarding	
31.15	Optimized path in case of Transfer	
31.16	Private / public call differentiation	
31.17	Transfer	

IP PHONE:-

Sr. No.	Features	Specification Required	Compliance
1	Description	SIP Phone	
2	Number of fixed Function Keys	Min. 4	
3	Number of Programmable keys with tri-colour LED	Min. 16	
4	Minimum Main display Screen size (inches)	Min. 3.5	
5	Network Interface Port Min. 2 Nos	10/100/1000	
6	Display Type.	Coloured	
7	Number of entries for call history, missed, received, placed etc.	Min. 300	
8	Number of lines of Display	Min. 10	
9	DSS Keys display should be available		
10	It should be compatible for cisco telepresence video communication server Rail-Bhawan.		
11	Warranty	Min. 30 Month	
	Power	• Power over Ethernet (IEEE 802.3af)	

	Audio characteristics	• Comfort Handset with Hearing Aid Compatible (HAC)	
		• Full-duplex speakerphone, acoustic echo cancellation, Comfort noise generation (CNG)	
		• G711 (A-law and Mu-law), OPUS codec, G722, G729 AB	
	Environmental Conditions	• Operating Temperature: -0°C to +45°C	
		• Relative humidity: 10% to 90%	
		• Storage/Transportation Temperature: -10°C/+60°C	
		• IP class: IP 20	
	Maintenance	Syslog mode, Port mirroring	
	Keypad	• Navigator: 4 way navigation + OK + Cancel	
	Connectivity	• Dual RJ-45 Gigabit Ethernet 10/100/1000 Network Interface for LAN and PC connection or Dual Homing	
		• RJ-9 connector for corded headset	
	Languages	Multi-language support (menu)	

TECHNICAL SPECIFICATION

ACTIVE COMPONENT

24 PORT POE ACCESS SWITCH: -

Technical Specification		Compliance Yes/No	Remarks
Interface	24xGE-Tx POE & 4xGE-SFP		
Switching capacity	56Gbps		
Forwarding rate	41.7Mpps		
Dimensions mm (W×D×H)	440×280×44		
MAC	8K		

Jumbo Frame	9K		
Power consumption	<45W		
Power supply	AC: 100V-240V, 50Hz±10%		
POE/POE+	Support with 370W POE Budget		
Environment	Operating temperature/humidity: 0℃-50℃, 10%-90% non-condensing		
	Storage temperature/ humidity: -20℃-70℃; 5%-95% non-condensing		
MAC switching function	Static configuration and dynamically learning of MAC address		
	Check and delete MAC address		
	Configuring of MAC address aging time		
	Limit on MAC address learning number		
	MAC address filtering function		
VLAN	4K VLAN entries		
	GVRP		
	1:1 and N:1 VLAN Mapping		
	QinQ		
	Private VLAN		
STP	802.1D (STP), 802.1W (RSTP), 802.1S (MSTP)		
	BPDU protection, root protection and ring protection		
Multicast	IGMP v1/v2/v3		
	IGMP Snooping		
	IGMP Fast Leave		
	Multicast group policy and multicast number limit		
	Multicast traffic cross VLAN duplication		
IPv4	Static routing		

IPv6	ICMPv6, DHCPv6 and IPv6 Telnet		
	IPv6 Neighbor Discovery		
	MLD v1/v2		
	MLD Snooping		
QoS	Traffic classification of each field of L2/L3/L4 protocol headers		
	CAR traffic control		
	802.1P/DSCP priority remark		
	Multiple queuing algorithms such as SP, WRR or SP+WRR		
	Tail-Drop, WRED		
	Traffic supervision and traffic shaping		
Security features	Identification and filtering of L2/L3/L4 based ACL		
	Defend against DDoS attack, SYN Flood attack of TCP or UDP Flood attack		
	Suppression of broadcast, multicast and unknown unicast packet		
	Port isolation		
	Port security, IP+MAC+port binding		
	DHCP Snooping, DHCP Option 82		
	IEEE 802.1x authentication		
	Radius and TRTacacs+ authentication		
	Command line authority control based on user levels		
Reliability	Static/LACP link aggregation		
	EAPS and ERPS(single ring)		
	ISSU		
Management and Maintenance	Console, Telnet, SSH 2.0		
	WEB based management style		
	SNMP v1/v2/v3		

	Upload and download of TFTP files		
	RMON		

TECHNICAL SPECIFICATION

WIFI SYSTEMS

INDOOR ACCESS POINT:-

S.No	Description of Specification	Compliance (Yes/No)	Remarks
1	The Access Point should have auto-sensing 10/100/1000 Mbps RJ-45 port with 802.3af/802.3at POE support..		
2	The APs should support the IEEE 802.11a,802.11b,802.11g,802.11n, 802.11acWave2 & 802.11ax standards with OFDMA. It should support minimum 2 MU-MIMO clients simultaneously.		
3	Should support minimum 2x2:2 MU-MIMO on both radio bands for an aggregate capacity of more than 2.900Gbps (500 Mbps on 2.4Ghz and 2400 Mbps on 5Ghz)with upto 1024-QAM, and 20/40/80/160 MHz channel size.		
4	The access points should be centrally managed through Cloud Controller or On premises Server based Appliance or standalone mode operation .		
5	The access point should support 802.1q VLAN tagging.		
6	The access point should support WPA3-SAE , WPA 3-Enterprise , WPA2 (CCMP, AES, 802.11i), WPA2 Enterprise (802.1x/EAP), WEP , ePSK , OSEN , OWE , Open etc..		
7	Implement Wi-Fi alliance standards WMM, 802.11d, 802.11h and 802.11e and 802.11r .		
8	AP should provide minimum EIRP 27 dBM on 5 Ghz & 27 dBm on 2.4 Ghz bands . (EIRP should be limited as per govt regulation for indoor AP's).		
9	AP should support minmium Antenna Gain 5 dBi at Both Bands .		
10	Should support Transmit power tuning in 1dB increments in order to reduce interference and RF hazards		
11	Upto 16 SSIDs per AP for multiple differentiated user services (e.g. voice).		
12	Should support up to 128 clients per Radio		

13	Should support IPv4 and IPv6 from day one		
14	For troubleshooting purposes, the administrator should have the ability to online packet capture and / or 802.3 frames from an access point without disrupting client access		
15	The access point should support following security mechanism: WPA3, WPA2 (CCMP, AES, 802.11i), WPA2 Enterprise		
16	System should support Authentication via 802.1X, mac authentication to support for external RADIUS and Active Directory.		
17	AP should support RESTful management and statistics API Presence location APIs		
18	Should be WiFi Alliance and Passpoint 3.0 certified.		
19	Operating Temperature: 0°C - 50°C		
20	AP shall be multi-purpose, also providing RF monitoring and wireless intrusion detection (WIDS).		
21	The AP shall have the ability to detect and contain rogue AP devices on either the same or separate channel as data traffic while simultaneously providing client services with no performance impact.		
22	AP shall support rogue AP detection without requiring dedicated APs or controllers for this purpose.		
23	The AP shall support reporting on rogue APs		
24	The AP shall support rogue AP containment.		
25	The AP shall be able to block traffic between clients on a per-SSID basis		
26	The AP shall provide Management Frame Protection		
27	AP shall support to prevent below DOS attacks from the wired and wireless network side IP Spoof attack Smurf attack ICMP Fragment attack IP Spoof Log		
28	The AP support Honey Pot Attack.		
29	WLC /AP shall integrate with existing firewall		
30	AP shall support Protocol, Port Number, IP and Network based ACL configuration per SSID		

31	AP shall support DNS based URL filter option (IP DNS ACL)		
32	AP shall support MAC filter Rule		
33	AP shall support Layer 7 filter rules		
34	AP shall support traffic shaping on Layer 7 filter rules		
35	AP shall support to drop L2 and L3 multicast and broadcast traffic on wireless interface to minimize network congestion		
36	Operating Humidity: upto 95% non-condensing.		
37	Should be UL 2043 plenum rated and comply to WEEE/RoHS.		
38	AP Power consumption should not be more than 11W .		
39	Should be EN 60601-1-2 Medical compliant & IEC 60950, FCC, IC , ETSI , CE , UL 2043, EN 61373		
40	Mechanism for physical device locking using padlock /Kensington lock / Twist lock or equivalent		
41	APs should have TEC Certificate as perr DOT Guidline by Govt of India.		

Wireless Controller :-

Sr No	Item	Minimum Technical Specification	Compliance (Yes / No)	Remarks
1	General Fetures	Proposed WLC should be cloud based or Software On Premises based controller and should support minimium License for Access Point & Switching adoption based on access points & Switching count from Day 1. WLC should support Minimum no. of 5000 Wi-FI Access Points & Switching without change Hardware / Software . IF WLC Controller is cloud then it should be hosted in India only .		
		Controller should have capability to support 50,000 or more concurrent users.		
		Software based controller should support multiple platform installation like : VMWare ESXI 6.5 and above Citrix Hypervisor (XenServer) Windows latest Hyper-V		

		VLANs 802.1Q (1 per BSSID), dynamic VLAN		
		Solution should have Integration of External DHCP server is supported		
		Should be able to Tunnel wireless user traffic to 3rd party wireless gateway using common tunneling protocols like L2TPv2 or L2GRE or any other equivalent tunneling protocols		
		Software On Premises controller shall support attaching at least two 1G / 10G ethernet interface ports .		
		WLC -on premise should supports L2 HA through a active-standby (1+1) architecture or Cloud WLC should support Redundant Cloud Services		
		Client dashboard must show the roaming history, SNR,RSSI and Data Rate of the client		
		WLAN system shall support Mobile data offload as a feature		
2	Configuration	WLC Should Support Scans device configuration and generates an assists score which is disaplayed as a percentage of succesful evaluations		
		WLS Should Support Assists summary scores are available for System, Network, Site, Tower, and Device levels in the hierarchy.		
		WLC Assists Dashboard presents the Assists Score and the list of evaluated Assists.		
		WLC Assurance uses the power of Artificial Intelligence to analyze client connections and related data to detect issues and failures. It discovers failure and success patterns across many client connections, and it identifies root causes when problems occur. This features will be available with cloud WLC .		
		WLC Assurance should Support step by step for root cause of issues , reason for issues & how it can be fixed to help IT Admin for better manage & troubleshooting the networks . This features will be available with cloud WLC .		
		WLC should support Email notification for Minor,Major and Critical Alarms & It should support Minimum 5 subscribers emails address can be added for receiving alarms (x)		

		Software On Premises controller shall Option to support management users authentcaion from multiple data base like : Local Data base or TACACS Server Radius Active Directory/LDAP OpenID Connect SAML		
	Security	WLAN Solution should adhere to the strictest level of security standards, including 802.11i Wi-Fi Protected Access (WPA/WPA2 and WPA3), integrated/external 802.1X with multiple Extensible Authentication Protocol (EAP) types, including Protected EAP (PEAP), EAP with Transport Layer Security (EAP-TLS), EAP with Tunnelled TLS (EAP-TTLS)		
		WLC should support integarted Radius Server or 3rd Party external Radius Server integartion.		
		WLC should have profiling of devices based on protocols like HTTP/DNS/DHCP and more to identify the end devices on the network		
3	Guest Wireless	WLC should provide Guest management system Supported with multiple integarted Captive Portal like : Self Registartion portal , Sponsered Guest portal , Onboarding portal , Voucher based code , local SMS server integration for OTP like : Fast SMS, SMS Country, SMS GUPSUP TWILLO, Victroy LINK SMS , etc. . . Solution should have API option to integrate all 3rd party SMS providers & Should support 3rd party External Captive Portal integration .		
		WLC should Support Microsoft Azure authentication & Google Login Authentication Integration . This features will be available with cloud WLC .		
		It should also provide Guest access policy based on time, bandwidth and quota (bandwidth consumption).		
		Wlan Solution Shall support guest users detatils capture and export same details like Guest Users Session start time MAC address, Cell number when authenticated using OTP E-mail address Access Point details WLAN details for security audit purpose		
		WLC solution should support open roaming.		

		WLAN support Fast secure roaming and handover between APs		
		Must support internal and external web authentication.		
4	Functionality	Must be able to set a maximum per-user bandwidth limit on a per-SSID basis.		
		Wlan should support Band Steering & Support to Steers wireless clients to the Concurrent operation in the 5 GHz band.		
		WLC Should Supports bulk loading mac address using csv file .		
5	Application Visibility	WLC /AP should support client application visibillity and inspection		
		WLC /AP should support dashboard view of Total bytes ,Top Application,Streaming Media and Top User for last 24 hr and 7 days		
		WLC Graphical representation of Application History (pie chart) where the application usage is shown in %		
		WLC Application History usage shown in line graph where the usage analysis shown in time vs bytes , where time is shown in X axis and usage (MB/GB) is shown in Y axix		
		The WLC should support defining custom appllication rules to identify specific traffic and apply policies on that		
		The WLC should Support Applying filter rules to deny or allow specific custom application		
		The controller should support policy enforcement firewall (PEF) & deep packet inspection to classify and block, prioritize, or limit bandwidth for thousands of applications in a range of categories.		
	Association ACL	WLC Should Support supports provision to centrally manage client access (deny or permit) the wireless client based on client mac address. It should support bulk loading mac address using csv files .		
	Market APP	WLC should Support , MarketApps Installer that gives MSPs the ability to delegate device onboarding and activation to their installers via a single webpage, no need to onboard them to WLC		

		& That provide a clean dashboard for installers. This features will be available with cloud WLC .		
	Reporting	Wi-Fi system Must have feature for recovery without re-authentication of the client in the event of LAN and WLAN infrastructure disruption to deliver a non-stop client session		
		Shall support Multiple profile(AP-groups) can be configured, but any given point of time, only one profile(ap-group) can be attached to the AP.		
		WLC must support retrieving upto 30 days of historical data for Device (AP), AP performance , Active Alarms , Alarm History and Events		
		Should provide real-time charts showing interferers per access point, on a per-radio, per-channel basis.		
		Should support encrypted mechanism to securely upload/download software images to and from wireless controllers.		
		Shall support Google location view for Wi-FI site and support placing APs on floor plan and visual indication of AP online and offline		
		WLC should support to upload a floor plan at site level		
		Software on Premises Controller support supports graphical chart to represent imortant parameter of the system over last , 24 hour , 1 week . The monitoring chart is available for below parameter: CPU Utilization , CPU Load , Memory utilization , etc..		
		WLC should support audit Logs .		
		Software On premises controller support Audit Syslog & Event Syslog .		
		Should support following Information through SNMP/API.: i) Connected APs (count) , Connected Clients (count). ii) Connected Stations (count), Admin Status (on/off) ,Broadcast SSID (on/off). iii) AP name , AP IP address ,AP Model , AP uptime , AP admin status , Ethernet speed , number of clients and AP mode .		

22. FAS

ADDRESSABLE FIRE ALARM SYSTEM

PART-1 GENERAL

22.1. RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections:

- Division 01 General Requirements
- Division 07 Thermal and Moisture Protection (Penetration Firestopping)
- Division 08 Openings, Section (Door Hardware)
- Division 21 Fire Suppression (Agent or pre-action/foam)
- Division 23 Heating Ventilating and Air Conditioning Monitoring & Control (HVAC).
- Division 26 Electrical, (Common Work Results for Electrical)
- Division 28 Electronic Safety and Security

22.2. SUMMARY

A. Section Includes:

- This specification describes an addressable Fire Detection and alarm signaling system. The control panel shall be intelligent device addressable, analog detecting, low voltage and modular, with digital communication techniques, in full compliance with all applicable codes and standards. The features and capacities described in this specification are required as a minimum for this project and shall be furnished by the successful contractor.
- The system shall be in full compliance with National and Local Codes.
- The system shall include all required hardware, raceways, interconnecting wiring and software to accomplish the requirements of this specification and the contract drawings, whether or not specifically itemized herein.
- All equipment furnished shall be new and the latest state-of-the-art products of a single manufacturer, engaged in the manufacturing and sale of analog fire detection devices for over ten years.
- The system as specified shall be supplied, installed, tested and approved by the local Authority Having Jurisdiction, and turned over to the owner in an operational condition.
- In the interest of job coordination and responsibilities, the installing contractor shall contract with a single supplier for fire alarm equipment, engineering, programming, inspection and tests. The installing contractor shall be capable of providing a “UL Listing Certificate” for the complete system.
- All systems approved shall meet all the requirements spelled out in this specification. System approval shall be in writing by the Engineer and a copy shall be submitted with the system submittals.
- The system shall support approved smart-infrastructure integration (SII) and be capable of bi-directional data exchange with other building systems where required.

22.3. DEFINITIONS

a) ASME: American Society of Mechanical Engineers.

b) Broadcast Media: The speakers, radio, cell phone, and other media that will carry the selected message to the selected audience.

c) FACP: Fire alarm control panel.

d) NAC: Notification Appliance Circuit. A circuit used to monitor and activate notification appliances or devices.

e) FM: FM Global (Factory Mutual).

f) Furnish: To supply the stated equipment or materials.

g) Install: To set in position and connect or adjust for use.

h) LED: Light-emitting diode.

i) NFPA: National Fire Protection Association. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

j) NICET: National Institute for Certification in Engineering Technologies.

k) Provide: To furnish and install the stated equipment or materials.

l) UL: Underwriters Laboratories.

m) VESDA: Very Early Smoke-Detection Apparatus.

n) AHJ: Authority Having Jurisdiction. Local authority (such as a fire marshal), presiding over the occupancy of the building(s).

o) ASSD: Air Sampling Smoke Detection

p) VEWFD: Very Early Warning Fire Detection

q) NRTL: National Recognized Testing Lab (UL, ULC, FM, ETL etc.)

22.4. SYSTEM DESCRIPTION

A. The system shall be a complete, electrically supervised fire detection and notification system, with a microprocessor-based operating system having the following capabilities, features, and capacities:

1. Up to 32 nodes shall be networkable in a peer-to-peer configuration.

2. Communications between network nodes, each supporting an interactive, self-standing, intelligent local control panel, with system wide display. Any network node shall be capable of supporting a local system with the same capacities and features specified herein.

3. The local system shall provide status indicators and control switches for all ofthe following functions:

- Audible and visual notification alarm circuit zone control.
- Status indicators for sprinkler system water-flow and valve supervisory devices.
- Any additional status or control functions as indicated on the drawings, including but not limited to; emergency generator functions, fire pump functions, door unlocking and security with bypass capabilities.

22.5. PERFORMANCE REQUIREMENTS

A. General Performance: Comply with NFPA 72 and all contract documents and specification requirements.

B. All interconnections between this system and the monitoring system shall be arranged so that the entire system can be UL-Certificated.

C. The system shall have Class X (Former Class A Style 7) circuits for each floor. The system shall operate in the alarm mode upon actuation of any alarm initiating device. The system shall remain in the alarm mode until all initiating device(s) are reset and the fire alarm control panel is manually reset and restored to normal.

D. The system shall be capable of the following configurations. Both configurations are permitted on the same network.

- The system shall support up to 252 addressable devices, which may be divided in any ratio of one, two, three, or four separate, isolated Class B (formerly style 4) circuits.
- The system shall support two loops of 252 addressable devices, each of which may be divided in any ratio on one, two, three, or four separate, isolated Class B (formerly style 4) circuits.

E. The system shall support addressable modules and manual stations with built-in isolation capability. The system display shall provide the specific device which has detected a loop short trouble, when a loop short is present anywhere on the data communication line.

F. The system shall have an optional digital alarm communication transmitter.

G. The system shall provide an off-normal warning prior to reset for all active devices.

H. The system shall be capable of remote monitoring via a proprietary software system that provides a graphical representation of the fire alarm control panel at a remote PC when connected via Ethernet to the system. The display will show the exact state of the panel, including blinking LEDs, and with menu buttons for control.

I. The system shall be capable of being configured via a PC Tool.

J. In networked systems, each of 5 control panels shall be configurable to be a global annunciator, capable of viewing all other control panels on the network.

K. The system shall provide the following functions and operating features:

- The FACP and auxiliary power panels shall provide power, annunciation, supervision and control for the system.
- Provide Class B (formerly style 4) initiating device circuits.
- Provide Class A (formerly style 7) signaling line circuits for the network.
- Provide two Class B (formerly style 4) notification appliance circuits. Arrange circuits to allow individual, selective, and visual notification by zone. Notification appliance circuits shall be zoned to correspond with the building fire barriers and other building features.
- Audibles shall be synchronized throughout the entire building.
- Provide electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control panel.

L. The system shall provide a field test function where one person can test the complete system or a specific area while maintaining full operational function of other areas not being tested. Alarms, supervisory signals, trouble signals shall be logged in system history during the walk-test.

M. Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.

N. Fire alarm signal initiation shall be by one or more of the following devices:

- Manual pull station
- Heat detector

- Addressable area smoke detectors
- Addressable Multi-criteria, dual optical smoke detectors
- Standard Addressable Duct smoke detector
- Specialized Duct Smoke detector
- Automatic sprinkler system water flow switch.
- Other systems connected via addressable modules, as applicable.

O. Activation of any system fire, supervisory, trouble, or status initiating device shall cause the following actions and indications at all network Person Machine Interfaces using an LCD display with multiple detail screens.

1. Fire Alarm Condition:
   - Sound an audible alarm and display a custom message defining the building in alarm and the specific alarm point initiating the alarm on an LCD display.
   - Log into the system history archives all activity pertaining to the alarm condition.
   - Sound the ANSI 117-1 signal with synchronized audible notification appliances and synchronized strobes throughout the facility.
   - Audible signals shall be silenced from the fire alarm control panel by an alarm silence switch. Visual signals shall be programmable to flash until system reset or alarm silencing, as required.
   - A signal dedicated to sprinkler system water flow alarm shall not be silenced while the sprinkler system is flowing at a rate of flow equal to a single head.
   - Activation of any smoke detector in a single elevator lobby or an elevator equipment room shall, in addition to the actions described, cause the recall of that bank of elevators to the 1st floor and the lockout of controls. In the event of recall initiation by a detector in the first-floor lobby, the recall shall be to the alternate floor as determined by the AHJ.
   - Where indicated on drawings heat detectors in elevator shaft and machine rooms shall activate an elevator power shunt trip breaker. The heat detectors shall be rated at a temperature below the ratings of the sprinkler heads in respective locations to ensure that the power shall be shut off before activation of sprinkler system.
   - System operated duct detectors as per local requirements shall accomplish HVAC shut down.
   - Door closure devices shall operate by floor or by local requirements.
2. Supervisory Condition:
   - Display the origin of the supervisory condition report at the local fire alarm control panel LCD display.
   - Activate supervisory audible and dedicated visual signal.
   - Audible signals shall be silenced from the control panel by the supervisory acknowledge switch.
   - Record within system history the initiating device and time of occurrence of the event.
3. Trouble Condition
   - Display at the local fire alarm control panel LCD display, the origin of the trouble condition report.

- Activate trouble audible and visual signals at the control panel and as indicated on the drawings.
- Audible signals shall be silenced from the fire alarm control panel by a trouble acknowledge switch.
- Trouble conditions that have been restored to normal shall be automatically removed from the trouble display queue and not require operator intervention. This feature shall be software selectable and shall not preclude the logging of trouble events to the historical file.
- Trouble reports for primary system power failure to the master control shall be automatically delayed for a period of time equal to 25% of the system standby battery capacity to eliminate spurious reports as a result of power fluctuations.
- Record within system history, the occurrence of the event, the time of occurrence and the device initiating the event.

P. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

22.6. SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Complete manufacturer's catalog data including supervisory power usage, alarm power usage, physical dimensions, and finish and mounting requirements.

B. Power calculations. Battery capacity calculations. Battery size shall be a minimum of 125% of the calculated requirement. Provide the following supporting information:

- Supervisory power requirements for all equipment.
- Alarm power requirements for all equipment.
- Power supply rating justification showing power requirements for each of the system power supplies. Power supplies shall be sized to furnish the total connected load in a worst-case condition plus 25% spare capacity.
- Voltage drop calculations for wiring runs demonstrating worst-case condition.
- NAC circuit design shall incorporate a 20% spare capacity for future expansion.

C. Submit manufacturer's requirements for testing Signaling Line Circuits and device addresses prior to connecting to control panel. At a minimum the following tests shall be required; device address, the usage (Alarm, Supervisory etc.), environmental compensation, temperature ratings for thermal detectors and smoke detector sensitivities. This requirement shall need approval before any wiring is connected to the control panel.

D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Complete drawings covering the following shall be submitted by the contractor for the proposed system:
   - Floor plans in a CAD compatible format at a scale of 1/8" = 1'-0" showing all equipment and raceways, marked for size, conductor count with type and size, showing the percentage of allowable National Electric Code fill used.

- Provide a fire alarm system function matrix as referenced by NFPA 72, Figure A-7-5.2.2 (9). Matrix shall illustrate alarm input/out events in association with initiation devices. Matrix summary shall include system supervisory and trouble output functions. Include any and all departures, exceptions, variances or substitutions from these specifications and/or drawings at time of bid.

4. Installation drawings shop drawings, and as-built drawings shall be prepared by an individual experienced with the work specified herein.
5. Incomplete submittals shall be returned without review, unless with prior approval of the Engineer.

E. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Light fixtures.
2. HVAC registers
3. Fire protection equipment interfaces
4. Special suppression system interfaces

F. Qualification Data: For qualified Installer, Applicator, manufacturer, fabricator, professional engineer, testing agency, and factory-authorized service representative.

G. Source quality-control reports.

H. Field quality-control reports.

I. Operation and Maintenance Data: For all fire alarm equipment, to include in operation and maintenance manuals.

J. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

22.7. QUALITY ASSURANCE

A. Manufacturer Qualifications: The publications listed below form a part of this publication to the extent referenced. The publications are referenced in the text by the basic designation only. The latest version of each listed publication shall be used as a guide unless the authority having jurisdiction has adopted an earlier version.

1. FM Global (Factory Mutual (FM)):FM Approval Guide
2. National Fire Protection Association (NFPA)
   - NFPA 70 National Electrical Code
   - NFPA 72 National Fire Alarm Code
   - NFPA 90A Standard for The Installation of Air Conditioning and Ventilating Systems
   - NFPA 101 Life Safety Code
3. Underwriters' Laboratories, Inc. (UL) equipment standards, Latest Edition
   - UL Fire Protection Equipment Directory
   - UL Electrical Construction Materials Directory

- UL 38 – Manually Actuated Signaling Boxes for Use with Fire Protection Signaling Systems
- UL 228 – Door Holding Devices
- UL 268 - Smoke Detectors for Fire Protective Signaling Systems
- UL 268A - Smoke Detectors for Duct Application
- UL 464 - Audible Signal Appliances
- UL 497A – Secondary Protectors for Communications Circuits
- UL 521 - Heat Detectors for Fire Protective Signaling Systems
- UL 864 - Control Units for Fire Protective Signaling Systems
- UL 1283 – Electromagnetic Interference Filters
- UL 1449 - Transient Voltage Surge Suppressors
- UL 1971 - Signaling Devices for the Hearing Impaired
- UL 2075 – Gas and Vapor Detectors and Sensors
- UL 2572 – Mass Notification Systems

4. International Code Council
   - International Building Code
   - International Fire Code.
5. State and Local Building Codes as adopted and/or amended by The Authority Having Jurisdiction, ADA, and/or State and local equivalency standards as adopted by The Authority Having Jurisdiction.
6. California State Fire Marshal
7. The manufacturer shall have a minimum of 15 years production experience in the manufacture and design of high sensitivity Air Sampling type smoke detection systems.
8. ISO 9002

B. Supplier Qualifications

1. The manufacturer of the supplied products must utilize multi-channel product distribution on a national basis to be considered for this bid. The manufacturer must have factory branches as well as independent distributors to allow the end user with the ability to utilize factory trained and authorized competitive service providers after system installation and commissioning.
2. Provide the services of a factory trained and certified representative or technician, experienced in the installation and operation of the type of system provided. The representative shall be licensed in the State if required by law.
3. The technician shall supervise installation, software documentation, adjustment, preliminary testing, final testing and certification of the system. The technician shall provide the required instruction to the owner's personnel in the system operation and maintenance.
4. The suppliers shall furnish evidence they have an experienced service organization, which carries a stock of spare and repair parts for the system being furnished.
5. The equipment supplier shall be authorized and trained by the manufacturer to calculate, design, install, test, and maintain the air sampling system and shall be able to produce a certificate stating such upon request.

➢ Installer Qualifications:

- Before commencing work, submit data showing that the manufacturer has successfully installed fire alarm systems of the same scope, type and design as specified.
- The contractor shall submit copies of all required Licenses and Bonds as required in the State having jurisdiction.
- The manufacturer representative shall employ on staff a minimum of one NICET certified designer, technician and/or a professional engineer, registered in the State of the installation, as required by the AHJ.
- The contractor shall be qualified by UL for certifying fire alarm systems.
- Contractors unable to comply with the provisions of Qualification of Installers shall present proof of engaging the services of a subcontractor qualified to furnish the required services.
- Testing Agency Qualifications: Qualified for testing indicated.
- Source Limitations for fire alarm equipment: Obtain fire alarm equipment from single source.
- Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- Pre-installation Conference: Conduct conference at Project site.

22.8. DELIVERY, STORAGE, AND HANDLING

A. Deliver products to project site in original, unopened packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, and shelf life if applicable.

B. Store materials inside, under cover, above ground, and kept dry and protected from physical damage until ready for use. Remove from site and discard wet or damaged materials.

22.9. PROJECT CONDITIONS

A. Installed products or materials shall be free from any damage including, but not limited to, physical insult, dirt and debris, moisture, and mold damage.

B. Environmental Limitations: Do not deliver or install products or materials until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

22.10. WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire alarm equipment that fail(s) in materials or workmanship within specified warranty period.

1. Warranty Period: 1 year from date of Substantial Completion.

22.11. SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for 1 year.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

22.12. EXTRA MATERIALS

A. Furnish 10% extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. The parts should include, but are not limited to, main system equipment (motherboards, processors, cards, etc.) and peripheral components (field devices such as initiating devices and notification appliances).

PART-2 PRODUCTS

22.13. MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements.

1. Siemens

22.14. CONTROL PANEL

A. The fire alarm control panel shall be microprocessor based using multiple microprocessors throughout the system providing rapid processing of smoke detector and other initiation device information to control system output functions.

B. There shall be a watchdog circuit, which shall verify the system processors and the software program. Problems with either the processors or the system program the panel shall activate a trouble signal, and reset the panel.

C. The system modules shall communicate with an RS 485 network communications protocol. All module wiring shall be to terminal blocks.

D. The system shall be capable of the following configurations. Both configurations are permitted on the same network.

1. The system shall support up to 504 addressable devices, which may be divided in any ratio on one, two, three, or four separate, isolated Class B circuits.

2. The system shall support two loops of 504 addressable devices, each of which may be divided in any ratio on one, two, three, or four separate, isolated Class B circuits.

E. The system shall be capable of supporting unshielded wiring applications.

F. System Components

1. The system periphery board shall be capable of supporting two system drivers of 252 intelligent devices distributed between one, two, three, or four Class B SLC circuits, for a total panel capacity of 504 addressable devices. Any trouble on one circuit shall not affect the other circuit. This module controls the signaling from the initiation devices reporting alarms and troubles to the control panel. This module shall also provide the signaling to the field devices for the controlling the output of specific initiation devices. The on-board microprocessor provides the periphery board with the ability to function even if the main microprocessor fails. LED's on the board shall provide annunciation for the following: Power, Gnd. Fault, Alarm, and Trouble. This board is integral to the system.

2. The Signal Line Circuits (SLC) shall be tested for opens, shorts and communications with all addressable devices installed before connection to the control panel. Systems without this capability shall have a test panel installed for initial testing to eliminate any possible damage short term or long term to the control panel. After initial testing replace the test panel and proceed with complete testing.

3. The standard Operator Interface shall have the ability to view events, acknowledge, silence, and reset the system and any networked fire safety control panels, when configured as a global display. The standard operator interface can acknowledge, silence, and reset panels via Global Display.

4. The LED Operator Interface shall have the ability to view events, acknowledge, silence, and reset the system and any networked control panels, when configured as a global PMI. Additionally, the operator interface provides twelve multicolored configurable LEDs for annunciating system status

5. The System Periphery Board shall contain 2 Class B NAC circuits rated at 3 amps each with power-limited outputs. The zones shall be isolated and independently supervised. There shall be at least 6 unique codes/signals for each circuit based on system logic. These signals shall be Temporal Code 3 (Evacuation), Steady, Temporal Code 4 (for CO alarms), March Time 120ppm, March Time 60ppm, and March Time 30ppm. The card shall have the following LEDs to provide trouble shooting and annunciation; Power, Gnd. Fault, Zone Activation or Trouble. This functionality shall be integral to the system.

6. The control panel shall be equipped with four Form C relays for alarm, trouble, supervisory, and programmable output. The system shall provide the mounting of all system cards, field wiring, and panel's inter-card wiring. All power limited field wiring shall be separated from all non-power limited internal wiring.

G. System response time from alarm to output shall comply with UL requirements.

H. All system cards and modules shall have Flash memory for downloading the latest module firmware.

I. Passwords

1. Technician Level Password - There shall be a 8-character password that a user must enter into the control panel in order to perform such maintenance- and control-related functions at the panel as:

- Arming and disarming devices.
- Activating, deactivating or modifying detector ASD and sensitivity settings.
- Activating and deactivating the History Log function, and deleting obsolete entries.
- Changing the system time and date.

2. Maintenance Level Password - There shall be a 8-character password that a user must enter into the control panel in order to access the panel's reporting functions and walktest functions.

3. Acknowledge Silenceable Reset Access - There shall be a key required to open a locked cabinet that a system user must use in order to acknowledge events, turn silenceable audibles and visuals on and off, and perform panel resets.

J. Networking:

1. Digital communication capabilities supporting Class B or Class A communications using either DC digital or fiber optics technologies or combinations of both as required for the control panel to communicate with up to 4 FACPs networks.

2. Digital communication capabilities supporting Class B or Class A communications using either DC digital or fiber optics technologies or combinations of both as required for the control panel to communicate with up to 32 network nodes.

3. Communication protocol shall be of the RS-485 type.

K. Network Fiber Modules

1. Multimode and single mode.
2. The network fiber interface modules shall be used to transmit RS-485 communications between intelligent addressable fire alarm control panels. Each module shall have power, transmit and receive status LEDs. The module can act as a repeater or end-point unit, in a daisy chain configuration.
3. The network fiber modules can be mounted in a one-height-unit or two-height unit enclosure, and can operate in a daisy-chain configuration. The connection between single-mode fiber-optic modules uses two (2), high-quality duplex 9/125 fiber optic cables and ST-style fiber connectors. The duplex fiber-optic cable has two (2) cables in a single shield similar to an electrical zip cord. Each segment of the fiber network can be up to approximately 10mi (16km). The connection between multi-mode modules uses two (2), high-quality duplex 50/125 or 62.5/125 fiber-optic cables and ST-style fiber connectors. The duplex fiber-optic cable has two (2) cables in a single shield similar to an electrical zip cord. Each segment of the fiber network can stretch up to 3,937ft (1.2km). For both single-mode and multi-mode installations, overall system fiber length is limited by the communication delay across the entire fiber network. Total network length should not exceed approximately 63,000feet / 12.4mi (20 kilometers). Each segment of the fiber network can be up to 1.9mi (3.06km). The fiber module shall have a minimum operating power output budget of -13dB for 62.5/125 cable and -9dB for 50/125 cable.
4. The Network Card shall provide internode communication between enclosures. The communication shall support Class B or Class A wiring (in a ring configuration). This card shall plug into the system operator interface.
5. The Modular Ethernet Switch serves as a network connector between fire-only FACPs and with intelligent voice systems. Panel-to-panel communication is transmitted via CAT5, single-mode fiber or multi-mode fiber. One (1) or two (2) Ethernet modules are supported by each Modular Ethernet Switch.
6. The Electric Ethernet Module serves as a network connector between Siemens' fire-only FACPs and with intelligent voice-communication systems.
7. The Multi-Mode Ethernet Module serves as a network connector between fire-only FACPs and with intelligent voice-communication panels, via multi-mode fiber-optic cables.
8. The Single-Mode Ethernet Module serves as a network connector between fire-only FACPs and with intelligent voice-communication panels, via single-mode fiber-optic cables.

L. Degrade Mode Alarm Activation:

1. Each panel shall operate as a stand-alone fire alarm control panel with complete functionality in the event of loss of communications with other panels on a network.

M. Software Modifications: The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made. Systems that require the use of externalprogrammers or change of EPROMs are not acceptable.

N. Logic: The fire alarm system shall support generic functions that deal with binary states (True/False, high/low), and produce desired outputs from one or more binary inputs (for example, alarm outputs from detector or manual station inputs). AND, OR, NOT, Any N, Latches, Start Timer, Delay Timer, Restart Timer are generic functions. Generic functions can be used as inputs to other function. The system shall support 500 logic functions.

History: The system shall store 10,000 events in history. Trouble warnings will occur when the History buffer is full.

Reports:

1. The system shall have the ability to provide configuration, status, queue and history reports.
2. Configuration reports shall provide the following information
   - Custom Messages
   - Database Information
   - Entity Type
   - Zone usage
   - Device Category
   - Firmware revision
3. Status reports shall provide the following information
   - Disarmed cards and devices
   - ASD settings
   - Sensitivity in %/foot
   - Alarm threshold in %/foot
   - Temperature in degrees F
   - Walktest
4. Queue reports shall provide the following information
   - Alarm events with custom message and event time
   - Gas alarm events with custom message and event time
   - Supervisory events with custom message and event time
   - Trouble events with custom message and event time
   - Status events with custom message and event time
   - Information events
5. History reports shall provide Address, History Type, Description, Time & Date and Custom Message. The following event types shall be reported:
   - Alarm events
   - Gas alarm events
   - Supervisory events
   - Status changes
   - Alarm verification
   - Output activation from logic

- System Reset
- Event Acknowledgements
- Block Acknowledgements
- Audible Silence System Flag Changes
- Sensitivity Changes
- Arm / Disarm Commands
- Arm / Disarm By Logic
- Manual Output Overrides
- Output Overrides By Logic
- Time Changes
- Menu Logins
- ASD Changes
- Walktest
- Device Input to Logic Activations/Deactivations

22.15. POWER SUPPLY

A. The system Power Supply shall be a 170 Watt, 6.5-amp that provides 24VDC power for system operation. The power supply shall be filtered and regulated. The power supply provides power for all system operation, including signaling line circuits, notification appliance circuits, auxiliary power, battery charger, and all optional modules. The power supply shall be rated for 120/240VAC 50/60Hz.

B. The system Power Supply shall be a 300 Watt, 11.5-amp that provides 24 VDC power for system operation. The power supply provides power for all system operation, including signaling line circuits, notification appliance circuits, auxiliary power, battery charger, and all optional modules. The power supply shall be rated for 120/240VAC 50/60Hz.

C. The battery charger shall be able to charge the system batteries up to 100AH batteries. Battery charging shall be microprocessor controlled and programmed to select battery sizes.

D. Transfer from AC to battery power shall be instantaneous when AC voltage drops to a point where it is not sufficient for normal operation.

22.16. REMOTE POWER SUPPLY FOR NON-VOICE NOTIFICATION APPLIANCES

A. The power supply unit shall be an addressable NAC distributed controller to provide power to visual strobe circuits or supply auxiliary power to such items as Door holder circuits. The power supply unit shall communicate on the SLC loop to the Fire Alarm Control Panel. It shall provide status monitoring, device level fault indications and individual NAC control using a single address on the SLC. The power supply unit shall provide a constant 24VDC nominal output voltage to each NAC-independent of voltage fluctuations on the primary or secondary power source.

B. Shall be a self-contained unit with 24VDC power supply and batteries housed in its own locked enclosure. Enclosure shall be made of 16 GA cold rolled steel, lockable and having the same key as the other control enclosures. Shall have 2 sizes (1 unit and a 2 unit) and colors (red and black).

C. Power supply unit shall be UL 864 listed and available in 6A and 9A models and 120 or 240VAC.

D. The power supply unit shall be able to support up to 18AH batteries in a single unit and 35AH in a 2-unit enclosure. Shall be able to support up to 100AH batteries in a separate enclosure.

E. The power supply unit shall have four independent 3 amp rated NAC circuits, expandable to a total of eight (8) Class B or four (4) Class A circuits or a mixture of each.

F. Ability to add one of two types of expansion cards which take one additional address on the SLC:

   1. An expansion card that shall provide additional NAC circuits and can be configured with two (2) Class B or one (1) Class A releasing circuits with on board service disconnect switches.

   2. An expansion card that shall provide for four (4) Class A or B conventional detection zone input circuit or shorting device (non-alarm) input circuits

G. The power supply unit shall be a class X isolating device residing on the SLC loop.

H. Each NAC output can be configured as an Aux Power output or a non-alarm closure input circuit.

I. Complete status monitoring to the individual circuit level at the main FACP and on-board LED status and diagnostic indicators.

J. The power supply unit shall be fully configurable through the manufacturer's system configuration tool.

K. The power supply unit output circuits shall be configurable individually as Steady On, Temp 3, Temp 4, March Time 30, 60 or 120PPM.

L. All NAC circuits shall have synchronized strobe outputs. Any combination of power supplies and expansion cards, up to a total of 32, shall be able to synchronize on the same loop.

M. The power supply shall have a dedicated Bell Follower circuit that can be used to achieve synchronization across multiple SLC loops.

N. Shall be able to accept a range of End of the Line (EOL) resistor values (2.2K to 24KΩ) without having to program or configure unit.

22.17. SYSTEM ENCLOSURE

A. Provide the enclosure as specified. Provide the color as to the local AHJ requirements.

B. Provide two-height-unit backbox as part of the intelligent non-voice-communication system hardware for use with 2HU system enclosures. Specifically, each backbox is used to fasten with a 2HU outer door.

C. Provide Red cabinet enclosure.

22.18. REMOTE ANNUNCIATOR

A. LCD Annunciator Panel: Provide LCD remote annunciator(s) as indicated on the drawings. The remote annunciator shall provide visual indication of all system status changes including alarm, supervisory, trouble, and system status. Display shall include text descriptions as programmed at the main panel for all device status and system status. The remote annunciator shall optionally provide key-lock switch protected functionality including reset, signal silence/un-silence, and acknowledge. The remote annunciator shall be available in both red and black housings.

22.19. INTELLIGENT INITIATING DEVICES

A. General

1. All initiation devices shall be insensitive to initiating loop polarity except when programming initiating devices in isolation mode. Specifically, the devices shall be insensitive to plus/minus voltage connections.

B. Smoke Detectors – Advanced with ASA (advanced signal analysis) - Multi-Criteria Addressable Series

1. The detectors shall be guaranteed in writing not to false alarm when configured by the factory trained certified technician. The detectors must provide up to 26 different environmental algorithms that allow the detector to provide superior false alarm immunity without the need for additional alarm verification delays.
2. The detectors shall have a tri-color LED to streamline system maintenance/inspection by plainly indicating detector status as follows: green for normal operation, amber for maintenance required, red for alarm.
3. Detectors shall utilize state of the art forward/backward light scattering technology, with improved detection for smoldering and flaming fire signatures. The detectors shall replace the need for ionization detectors due to improved response characteristics to flaming fires.
4. Detectors shall provide pre-alarm signal at 0.2% obs/ft. and a full alarm at 1.0% obs/ft. to meet the performance requirements of National Fire Protection Association Standard 76, Fire Protection of Telecommunications Facilities as a Very Early Warning Fire Detector (VEWFD).
5. The forward/backward light scattering technology shall provide improved immunity to spurious activation (deceptive phenomena). The detectors shall have a “No False Alarm Guarantee”.
6. The detectors shall be RoHS-compliant: it shall meet standards for Reduction of Hazardous Substances (RoHS) by reduction in lead content and other restricted substances.
7. The multi-criteria fire detectors shall be an intelligent digital photoelectric detector with a programmable heat detector. Detectors shall be listed for use as open area protective coverage, in-duct installation and sampling assembly installation and shall be insensitive to air velocity changes. The detectors’ communications shall allow the detectors to provide alarm input to the system and alarm output from the system within four (4) seconds. So as to minimize the effort required by the installing and maintenance technician to appropriately configure the detector to ensure optimal system design, the detectors shall be programmable as application specific. Application settings shall be selected in software for a minimum of 19 environmental fire profiles unique to the devices installed location.
8. The detectors shall be designed to eliminate the possibility of false indications caused by dust, moisture, RFI/EMI, chemical fumes and air movement while factoring in conditions of ambient temperature rise, obscuration rate changes and hot/cold smoke phenomenon into the alarm decision to give the earliest possible real alarm condition report.
9. The detectors shall be capable of being field programmed for simultaneous and /or independent functionality, depending on the application. For example, the detectors shall be capable of utilizing the optical, heat, and/or CO sensors together for enhanced fire detection (multi-criteria) and simultaneously provide independent outputs for CO gas life-safety, smoke, and heat detection. Any combination of the sensors is possible.
10. The detectors shall be UL listed for operation in a 95% relative humidity (RH) environment.

11. The detectors shall be designed to eliminate calibration errors associated with field cleaning of the chamber.
12. The detectors shall support the use of a relay, or LED remote indicator without requiring an additional software address. Low profile, white case shall not exceed 2.5 inches of extension below the finish ceiling.
13. The detectors shall support the use of an ambient temperature warning signal at the panel. This temperature shall be user-configurable for the set temperature of the warning and the event type generated by the warning. This event can be used to trigger system logic.
14. For the detectors where required, there shall be available a locking kit and detector guard to prevent unauthorized detector removal.
15. UL Listed as “direct in-duct” mounting.
16. UL 268 7th edition listed or greater.
17. Detectors shall include optional built-in short circuit isolation.
18. Available models:
    - Multi-Criteria incorporating 2 Optical sensors and 2 Thermal sensors with an operating temperature range of 32°F(0°C) to 120°F(49°C). Nineteen selectable profiles. Polarity insensitive installation wiring. Three color LED.

C. Smoke Detectors – Standard Addressable Detectors:

1. The smoke detectors must provide at least 2 environmental parameter sets to assist in device sensitivity configuration.
2. The detectors shall have a tri-color LED to streamline system maintenance/inspection by plainly indicating detector status as follows: green for normal operation, amber for maintenance required, red for alarm.
3. The detector shall be RoHS-compliant: it shall meet standards for Reduction of Hazardous Substances (RoHS) by reduction in lead content and other restricted substances.
4. The detectors shall be UL listed for operation in a 95% relative humidity (RH) environment.
5. The detectors shall be designed to eliminate calibration errors associated with field cleaning of the chamber.
6. The detectors shall support the use of a relay, or LED remote indicator without requiring an additional software address. Low profile, white case shall not exceed 2.5 inches of extension below the finish ceiling.
7. For the detectors where required, there shall be available a locking kit and detector guard to prevent unauthorized detector removal.
8. Detectors shall include optional built-in short circuit isolation.
9. Available models:
    - Multi-Criteria incorporating 1 Optical sensor and 1 Thermal sensor with an operating temperature range of 32°F(0°C) to 100°F(38°C). Available in four parameter sets. Polarity insensitive installation wiring. Three color LED.
    - Photoelectric Smoke detector with an operating temperature range of 32°F(0°C) to 120°F(49°C). Available in three parameter sets. Polarity insensitive installation wiring. Three color LED.

D. Heat Detectors – Addressable

1. Thermal Detectors shall be rated at 135°F (57°C) fixed temperature and 15°F (8.3°C) per minute rate of rise. Detectors shall be constructed to compensate for the thermal lag inherent in conventional type detectors due to the thermal mass, and alarm at the set point of 135 degrees Fahrenheit. The choice of alarm reporting as a fixed temperature detector or a combination of fixed and rate of rise shall be made in system software and be changeable at any time without the necessity of hardware replacement.
2. The detectors furnished shall have a listed spacing for coverage up to 2,500 square feet and shall be installed according to the requirements of NFPA 72 for open area coverage.
3. Detectors shall include optional built-in short circuit isolation.
4. Advanced heat detector shall have the following temperature settings:
   - Fixed temperature at 135°F(57°C), 145°F(63°F), 155°F(68°F), 165°F(74°F), 174°F(79°C)
   - Rate of Rise at 15°F/ min (8.3°C) at 135°F (57°C)
   - Rate of Rise at 15°F/ min (8.3°C) at 174°F (79°C)
   - Low temperature warning at 40°F (4.4°C)

E. Duct Smoke Detectors – Addressable

1. For duct detector applications, the smoke detector shall be an intelligent digital photoelectric detector. Detectors shall be listed for use as open area protective coverage, in duct installation and sampling assembly installation and shall be insensitive to air velocity changes.
2. The detector communications shall allow the detector to provide alarm input to the system and alarm output from the system within four (4) seconds. The detector shall be mounted in a duct detector housing listed for that purpose. The duct detector shall support the use of a remote test switch, relay or LED remote indicator. The duct detector shall be supplied with the appropriate sampling tubes to fit the installation.
3. Where duct detectors are exposed to the weather a weatherproof enclosure shall be available. A NEMA-3R and NEMA-4X option shall be available. The duct housing cover shall include a test port for functional testing of the detector without cover removal. The duct housing shall include a cover removal switch capable of indicating cover removal status to the fire alarm control panel.
4. An intelligent duct detector shall be available. Where required there shall be available a duct housing with an on-board relay. Also, where required, there shall be a standalone housing available with its own power supply and test/reset switch that does not require connection to a fire alarm control panel.
5. Duct smoke detector housing shall allow use in duct systems with air velocity ranging from 100 to 4,000 feet per minute, within temperature ranges of 32°F(0°C) to 120°F(49°C) per minute, and with relative humidity ranging from 0 to 95%.
6. Detectors shall include optional built-in short circuit isolation.
7. Duct Housings and Accessories:
   - Air Duct Housing for Conventional and Addressable Detectors
   - Air Duct Housing for Addressable P2 Detectors with Relay Application
   - Air Duct Housing for Conventional Detectors with Relay Application
   - Air Duct Housing for Conventional Detectors with Relay Application and Built-in Power Source

- Weather-Proof housing to accommodate all versions of Air Duct Housings
- Remote Test Lamp for Conventional Detectors

F. Detector Bases – Addressable

1. Detector bases shall be low profile twist lock type with screw clamp terminals and self-wiping contacts. Bases shall be installed on an industry standard, 4in square or octagonal electrical outlet box.
2. Multi-Criteria Fire Detector shall be listed as providing CO detection in duct application.
3. The large standard base shall be a 6in version.
4. The small standard base shall be a 4in version.

G. Manual Pull Stations – Addressable

1. Provide addressable manual stations where shown on the drawings, to be flush or surface mounted as required. Manual stations shall contain the intelligence for reporting address, identity, alarm and trouble to the fire alarm control panel. The manual station communications shall allow the station to provide alarm input to the system and alarm output from the system within less than four (4) seconds.
2. The manual station shall be equipped with terminal strip and pressure style screw terminals for the connection of field wiring. Surface mounted stations where indicated on the drawings shall be mounted using a manufacturer's prescribed matching red enamel outlet box.
3. A single action pull station shall be available. It shall provide built-in isolation capability. The operator display shall indicate which specific device has detected a wiring fault on the data communication line.
4. Where required, there shall also be available pull stations with break glass, capable of explosion proof installation, capable of weatherproof installation, reset key operation, and metal housings.
5. Pull stations shall include optional built-in short circuit isolation.

H. Addressable Interface Devices

1. Addressable Interface Devices shall be provided to monitor inputs (contacts) and control outputs (relays) to and from the fire alarm system and associated devices. These interface devices shall be able to monitor single or dual contacts. An address will be provided for each contact. Where remote supervised relay is required the interface shall be equipped with a SPDT relay rated for 4 amps resistive and 3.5 amps inductive.
2. Where needed, a Conventional Zone Module shall connect to the Signal Line Circuit, which will allow the use of conventional initiation devices. This module shall have the ability to support up to 15 conventional smoke detectors and an unlimited number of contact devices.
3. Devices include (but not limited to)
   - Single or Combination input/output control modules.
   - Remote test lamps
   - Remote test switches
4. Monitoring applications include (but not limited to):
   - Water-flow switches
   - Tamper switches

- PIV switches
- Damper position – All 3 states on one input
- Conventional devices (e.g., Smoke detectors, beam detectors, flame detectors, etc.)
- Duct Detectors

5. Control applications include (but not limited to)
   - Notification appliance circuits (NAC)
   - Telephone zones
   - Speaker zones.
   - Damper position
   - Solenoids for sprinklers
6. Where applicable, all interface devices shall have built in isolation.
7. Where applicable, all interface devices shall meet NFPA 72 Class X requirements for survivability.

22.20. DEVICE PROGRAMMING UNIT

A. Device Programming Unit: The programming tool shall program the intelligent devices with addresses. The unit shall test the device to respond to its address. Dipswitches and rotary switches shall not be acceptable. The programmer shall be available with carrying case.

22.21. ADVANCED FIRE ALARM NOTIFICATION APPLIANCES (LED based)

A. Horns, Strobes, and Horn/Strobes

1. Strobes and horn/strobes shall be listed for UL Standard 1971 (Emergency Devices for the Hearing Impaired) for Indoor Fire Protection Service.
2. Audibles devices shall be UL Listed under Standard 464 (Fire Protective Signaling).
3. All appliances shall meet the requirements of FCC Part 15 and ICES-003.
4. Visual appliances shall produce a flash rate of one (1) flash per second over the Regulated Voltage Range and shall incorporate a Light Emitting Diode (LED) as the light source with a rugged Lexan® lens.
5. The appliance shall be a “low profile” device.
6. The appliances shall be of low current design.
7. The LED strobe flash duration shall be 20ms. Where Multi-Candela appliances are specified, the strobe intensity shall have 4 field selectable settings at 15, 30, 75, and 110 candela for wall mount applications.
8. The selector switch for selecting the candela shall be tamper resistant.
9. Audible appliances shall have a minimum of two (2) field selectable settings for dBA levels and shall have a choice of continuous or temporal (Code 3) audible outputs.
10. The strobes shall not drift out of synchronization at any time during operation. If the sync fails to operate, the strobe shall revert to a non-synchronized flashrate and still maintain (1) flash per second over its “Regulated Voltage Range”.
11. Finish shall be red or white.
12. Special lettering, ALERT, CO and No lettering, shall be available.

13. The appliance shall also be designed so that the audible signal may be silenced while maintaining strobe activation

B. Low Frequency Sounders and Sounder/Strobes

1. The sounders shall be UL Listed under UL 464 for Fire Protective Service and to the requirements of UL 2034 for CO applications and ULC S525.
2. Sounders equipped with strobes shall be listed under UL 1971 for Emergency Devices for the Hearing-Impaired and ULC S526.
3. The appliances shall be Restriction of Hazardous Substances (RoHS) compliant and contain no mercury or other hazardous substances.
4. The sounder strobes shall meet the requirements of FCC Part 15 and ICES-003.
5. The sounder Strobe shall produce a flash rate of one (1) flash per second over the Regulated Voltage Range and shall incorporate a Light Emitting Diode (LED) as the light source with a rugged Lexan® lens.
6. The LED strobe flash duration shall be 20ms.
7. The strobe intensity shall have a 110 candela for wall mount applications.
8. The audible shall have a minimum of four (4) 520Hz modes of operation: T3 (fire), T4 (CO), Continuous, T3/T4 Sync Control.
9. The sounder and sounder strobe shall incorporate a mounting plate with a snap-on grille cover and shall mount to standard electrical hardware requiring no additional trimplate or adapter.
10. The appliance shall be a “low profile” device.
11. Finish shall be red or white.
12. Special lettering, ALERT, CO and No lettering, shall be available.
13. The strobes shall not drift out of synchronization at any time during operation. If synchronization fails to operate, the strobe shall revert to a non-synchronized flashrate and still maintain (1) flash per second over its Regulated Voltage Range.
14. The appliance shall also be designed so that the audible signal may be silenced while maintaining strobe activation

PART-3 EXECUTION

22.22. EXAMINATION

1. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

22.23. INSTALLATION

1. Perform work in accordance with the requirements of NFPA 70, NFPA 72 and NECA 1-2006, Standard of Good Workmanship in Electrical Contracting.
2. Fasten equipment to structural members of building or metal supports attached to structure, or to concrete surfaces.
3. In the event that limited energy cable installation is allowed, all cable runs shall be run at right angles to building walls, supported from structure at intervals not exceeding 3ft (1m) and where installed in environmental air plenums, be rated for such use and tied/supported by components listed for environmental air plenums installation.
4. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

5. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
6. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
7. Provide primary power for each panel from normal/ emergency panels as indicated on the Electrical Power Plans. Power shall be 120VAC service, transformed through a two-winding, isolation type transformer and rectified to low voltage DC for operation of all circuits and devices.

22.24. BOXES, ENCLOSURES AND WIRING DEVICES

1. Boxes shall be installed plumb and firmly in position.
2. Extension rings with blank covers shall be installed on junction boxes where required.
3. Junction boxes served by concealed conduit shall be flush mounted.
4. Upon initial installation, all wiring outlets, junction, pull and outlet boxes shall have dust covers installed. Dust covers shall not be removed until wiring installation when permanent dust covers or devices are installed.
5. "Fire alarm system" decal or silk-screened label shall be applied to all junction box covers.

22.25. CONDUCTORS

6. Each conductor shall be identified as shown on the drawings at each with wire markers at terminal points. Attach permanent wire markers within 2in (51mm) of the wire termination. Marker legends shall be visible.
7. All wiring shall be supplied and installed in compliance with the requirements of the National Electric Code, NFPA 70, Article 760, and that of the manufacturer.
8. Wiring for strobe and audible circuits shall be a minimum 14 AWG, signal line circuits minimum 18 AWG twisted.
9. All splices shall be made using solder-less connectors. All connectors shall be installed in conformance with the manufacturer recommendations.
10. Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.
11. The installation contractor shall submit for approval prior to installation of wire, a proposed color code for system conductors to allow rapid identification of circuit types.
12. Wiring within sub panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.

22.26. DEVICES

1. Relays and other devices to be mounted in auxiliary panels are to be securely fastened to avoid false indications and failures due to shock or vibration.
2. Wiring within panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.
3. All devices and appliances shall be mounted to or in an approved electrical box.

22.27. IDENTIFICATION

1. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
2. Permanently label or mark each conductor at both ends with permanent alphanumeric wire markers.

3. A consistent color code for fire alarm system conductors throughout the installation.

22.28. FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Testing General:

1. All Alarm Initiating Devices shall be observed and logged for correct zone and sensitivity. These devices and their bases shall be tagged with adhesive tags located in an area not visible when installed, showing the initials of the installing technician and date.
2. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Resistance, current and voltage readings shall be made as work progresses.
3. The acceptance inspector shall be notified before the start of the required tests. All items found at variance with the drawings or this specification during testing or inspection by the acceptance inspector shall be corrected.
4. Test reports shall be delivered to the acceptance inspector as completed.
5. All test equipment, instruments, tools and labor required to conduct the system tests shall be made available by the installing contractor. The following equipment shall be a minimum for conducting the tests:
   - Ladders and scaffolds as required to access all installed equipment.
   - Multi-meter for reading voltage, current and resistance.
   - Two-way radios and flashlights.
   - A manufacturer recommended device for measuring air flow through air duct smoke detector sampling assemblies.
   - Decibel meter.
   - In addition to the testing specified to be performed by the installing contractor, the installation shall be subject to test by the acceptance inspector.

22.29. ACCEPTANCE TESTING

A. A written acceptance test procedure (ATP) for testing the fire alarm system components and installation will be prepared by the engineer in accordance with NFPA 72 and this specification. The contractor shall be responsible for the performance of the ATP, demonstrating the function of the system and verifying the correct operation of all system components, circuits, and programming.

B. A program matrix shall be prepared by the installing contractor referencing each alarm input to every output function affected as a result of an alarm condition on that input.

C. The installing contractor prior to the ATP shall prepare a complete listing of all device labels for alphanumeric annunciator displays.

D. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests shall be witnessed by the owner and test results recorded for use at the final acceptance test.

E. Preliminary Testing: Conduct preliminary tests to ensure that all devices and circuits are functioning properly. After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable. The letter shall state that each initiating and indicating device was tested in place and functioned properly. The letter shall also state that all panel functions were tested and operated properly. The Contractor and an authorized representative from each supplier of equipment shall be in attendance at the preliminary testing to make necessary adjustments.

F. Final Acceptance Test: Notify the owner in writing when the system is ready for final acceptance testing. Submit request for test at least 14 calendar days prior to the test date. A final acceptance test will not be scheduled until megger test results, the loop resistance test results, and the submittals required in Part 1 are provided to the owner. Test the system in accordance with the procedures outlined in NFPA 72.

1. Verify that the control unit is in the normal condition as detailed in the manufacturer's operating and maintenance manual.
2. Test each initiating and indicating device and circuit for proper operation and response. Disconnect the confirmation feature for smoke detectors during tests to minimize the amount of smoke or test gas needed to activate the detector.
3. Test the system for all specified functions in accordance with the contract drawings and specifications and the manufacturer's operating and maintenance manual.
4. Visually inspect all wiring.
5. Verify that all software control and data files have been entered or programmed into the FACP.
6. Verify that Shop Drawings reflecting as-built conditions are accurate.
7. Measure the current in circuits to assure that there is the calculated spare capacity for the circuits.
8. Measure voltage readings for circuits to assure that voltage drop is not excessive.
9. Measure the voltage drop at the most remote appliance on each notification appliance circuit.

G. The acceptance inspector shall use the system record drawings in combination with the documents specified in this specification during the testing procedure to verify operation as programmed. In conducting the ATP, the acceptance inspector shall request demonstration of any or all input and output functions. The items tested shall include but not be limited to the following:

1. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
   - Open, shorted and grounded signal line circuits.
   - Open, shorted and grounded notification circuits.
   - Primary power or battery disconnected.
2. System notification appliances shall be demonstrated as follows:
   - All alarm notification appliances actuate as programmed
   - Audibility and visibility at required levels.
3. System indications shall be demonstrated as follows:
   - Correct message display for each alarm input at the control display.
   - Correct history logging for all system activity.

4. System off-site reporting functions shall be demonstrated as follows:
   - Correct zone transmitted for each alarm input
   - Trouble signals received for disconnect
5. Secondary power capabilities shall be demonstrated as follows:
   - System primary power shall be disconnected for a period of time as specified herein. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period as specified.
   - System primary power shall be restored for forty-eight hours and system-charging current shall be normal trickle charge for a fully charged battery bank.
   - System battery voltages and charging currents shall be checked at the fire alarm control panel.

22.30. DOCUMENTATION

A. System documentation shall be furnished to the owner and shall include but not be limited to the following:

1. System record drawings and wiring details including one set of reproducible drawings, and a CD ROM with copies of the record drawings in DXF format for use in a CAD drafting program.
2. System operation, installation and maintenance manuals.
3. System matrix showing interaction of all input signals with output commands.
4. Documentation of system voltage, current and resistance readings taken during the installation, testing and ATP phases of the system installation.
5. System program showing system functions, controls and labeling of equipment and devices.
6. All applicable NFPA 72 commissioning reports.

22.31. PROTECTION

A. Remove and replace devices and panel components that are wet, moisture damaged, or mold damaged.

22.32. DEMONSTRATION

A. Instructor: Include in the project the services of an instructor, who shall have received specific training from the manufacturer for the training of other persons regarding the inspection, testing and maintenance of the system provided. The instructor shall train the employees designated by the owner, in the care, adjustment, maintenance, and operation of the fire alarm system.

B. Training sessions shall cover all aspects of system performance, including system architecture, signaling line circuit configurations, sensor and other initiating device types, locations, and addresses, fire alarm control panel function key operation, and other functions as designated by the owner.

C. Required Instruction Time: Provide 8 hours of instruction after final acceptance of the system. The instruction shall be given during regular working hours on such dates and times as are selected by the owner. The instruction may be divided into two or more periods at the discretion of the owner. One training session shall be videotaped by the contractor. Videotapes shall be delivered to the owner.

D. Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a conspicuous location observable from the FACP. The card shall show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory and trouble. The instructions shall be approved by the owner.

E. Comprehensive system troubleshooting training shall be provided for a single individual designated by the owner. This session shall be separate and distinct from the above-described sessions.

F. All training sessions shall be conducted following final system certification and acceptance. Three additional training sessions shall be provided for all security personnel on all shifts six months after final system certification.

G. All training sessions shall be conducted by an authorized fire alarm system distributor representative, who has received specific training from the manufacturer for the training of other persons regarding the inspection, testing, and maintenance of the system provided.

23. PAS

23.1. General description

The contractor shall supply, install, test ,and commission a high quality fast-acting Public Address and Voice Alarm System complying strictly with BS 5839 part8 and EN60849 and shall be TUV or Equivalent Agency approved. The Public Address and Voice Evacuation System shall comprise of Audio Matrix Units, High quality speakers, Audio rack all mounted on a 19” Rack and fully connected and integrated on the fire alarm loop. The system shall be used for Professional Sound Reproduction for all the areas where possible special events take place.

Prior to placing order for any equipment, the contractor shall submit comprehensive document comprising working drawings, catalogues and descriptive literature of components, acoustic calculation to meet with BS5839 part8 RASTI (Room Acoustic Speech Transmission Index) requirements of 0.5 on the STI scale and 0,7 on the CIS scale. The contractor shall be required to train and instruct client's personnel in the correct use, operation and supervision of the system, preferably prior to the handing over of the project.

To ensure whole site integration capability, the fire and voice alarm system will be awarded to a single specialist local supplier who will be responsible for the design, global operation, management and interfacing of the system. The contractor shall make sure that all power tapping of the speakers must be carried out as specified, even if the acoustic calculations indicates less power tapings. The contactor must endure minimum of 10dB above the ambient noise levels are achieved.

The system shall be fully programmed to accommodate fire alarm and voice communication zones as indicated on the drawings and schematics. The system shall be configured to allow on site modifications with the minimum of disruption using the PC based software to facilitate future changes or alterations to the buildings.

APPLICABLE STANDARD:

EVAC Compliant with IEC/EN60849

Loudspeakers -Rated power IEC 60286-Part 5

Tested in accordance with BSEN60268-5

Acoustic models ready for CATT, ULYSSES & EASE

Compliant with BS5839 Part 8

Battery backup/charger compliant with EN54 part 4

23.2. Scope of Work

The scope of work under this head shall include designing, supplying, installation and commissioning of Public Address System.

The PA system is designed to serve the dual purpose of making general announcement and Voice Evacuation at the time of Fire alarm activation.

23.3. System Design

The PAVA system shall be connected on the same Fire Alarm loop with in-built isolators to protect the system in case of any cable faults. The system shall be de-centralized in nature, each distributed rack DAU (Distributed Amplifier Unit) shall have all the DSP (Digital Signal Processing), messages, amplifiers, monitoring in such a way that can work in a stand-alone mode in case the master rack is faulty or down.

The Man Machine Interface (MMI) shall be connected back to the control room, to monitor and control the entire PAVA system. The MMI shall be fully BS5839 part 8 and EN60849 compliant and TUV approved. The DAU shall play background / Foreground music and in case of Fire Alarm / Paging announcement, the system shall go to full power as programmed to provide the enough SPL (Sound Pressure Level) levels to comply with BS5839 part8, with minimum of 10dB above the noise levels.

All system components shall be digitally monitored including and not limited to, Messages, Amplifiers, Speaker Circuits, Audio Matrix units, Paging Microphone, Battery Charger and the 230VAC line. Each amplifier / line circuit shall be monitored individually and shall report any faults back to the Master Audio Matrix Unit as well as the Paging Microphone.

The Battery Back up shall provide 24 hours of back up and 30 min of alarm operation. The power supply / charger must comply with EN54 part 4 and shall be 19” rack mounted. Battery calculation must strictly comply with BS5839 part 8 and shall be based on the amplifier size and not the speaker circuit load.

The PAVA system shall be properly integrated with the fire alarm system. The integrated PAVA system shall cover all normally accessible areas including the car parks.

In addition, a FIRE DRILL, BOMB ALERT, EARTHQUAKE ALERT and an ALL CLEAR message shall be incorporated into the operation. A fire alarm broadcast signal shall cancel any public-address operation and shall override it. When a fireman’s microphone is operated, this shall override any automatic voice alarm signal being transmitted to the zone selected.

All amplifier gain shall be monitored and measured for open, short or earth faults. The Entertainment Rack shall be located in the Control/Security Room enabling the operator to select music from the CD player, FM tuner or the double cassette deck to transmit music to selected zones or all the zones in the building from the touch screen paging microphone. A public-address announcement shall override the music transmission to selected zones or all zones. The Speakers shall be distributed in the entire floor and shall be configured in different zones. The announcement can have made in zone wise or to all the speakers simultaneously in ALL CALL mode. Fire Alarm shall be announced immediately on receipt of Fire signal from the panel to all zones or group of Zones.

23.4. System shall have following functions:

Voice Evacuation and Public Address system integration includes paging system and background music system.

Monitoring of microphone, controller, amplifier, fireman microphone, and source modular, AC&DC power Supply, and Volume Control.

The Amplifier shall be used only Class-D with Digital switching power technology

23.5. Remote Paging Microphone

The Remote Paging Microphone should be fully digital connected via CAT6 Cable with Controller. The Microphone should have capability to make announcement in 8 Zones and have all call facility. The Microphone shall have ability to control music and should be able to route the music in zones. Microphone should have maximum zones capacity up to 120 Zones. The Microphone should have LED indication for the different faults, the unit shall be able to indicate AC, DC, Fault, Mic and Test status through LED. The Microphone shall have 6 input & Mic/line Selection buttons. The unit shall have 12 Selection buttons with three coloured indicators. The Microphone have reset/channel, All call & Call buttons. The Unit shall have 2 RJ45 ports for Microphone so that the other microphone shall be able to link with the unit. The Microphone shall have Ability to Communication limit up to 600 Meters

The Microphone shall have following features:

1. AC 230V and DC24V battery inputs.
2. Built-in monitor speaker.
3. Paging mode: PTT & Normal paging
4. Phantom Power: 20V – 27.5V
5. Power Consumption: < 2.4A
6. Line input Sensitivity: 775 mV
7. Microphone input Sensitivity: 5 mV
8. S/N ratio: >70dB
9. Humidity: <95%

23.6. Loudspeakers:

23.6.1 6W Wall mounted speaker

The 6W wall mounted speakers shall be installed as depicted in the drawing. The speakers support EASE, CATT or ULYSSES models for acoustic studies. This mean the acoustic model can be designed to simulate the sound quality and distortion prior to installation. The Speaker should be EN54 approved, rated power output 6W/3W/1.5W. 6” full range paper woofer, line input 100V or 70V with transformer. Metal enclosure, Metal grille in white/Red.

Technical Specifications

- Rated power 6 W
- Effective frequency range 150 ~ 17kHz
- Sensitivity 88dB
- Power Handling 6W/3W
- Peak SPL 95dB
- Component 5”
- Material ABS
- Grille Metal.
- Certification EN54

23.6.2 6W Ceiling Mounted Speaker:

The 6” ceiling mounted 6 W speakers shall be installed as depicted in the drawing. The speakers support EASE, CATT or ULYSSES models for acoustic studies. This mean the acoustic model can be designed to simulate the sound quality and distortion prior to installation. The Speaker should be EN54 approved, rated power output 6W/3W/1.5W. 6” full range paper woofer, line input 100V or 70V with transformer. Metal enclosure, Metal grille in white.

Technical Specifications

➢ Rated power	6 W
➢ Tapings 100V line	6/3/1.5W
➢ Operation Voltage	100V or 70V
➢ Effective frequency range	90 ~ 18kHz
➢ SPL @ 1W/m	87dB
➢ Speaker Drive	5”
➢ Peak SPL	95 dB
➢ Certification	EN54

23.7. Voice Alarm Controller (VCA)

The network controller shall be a control unit for a public address and emergency sound system. It shall control and route audio channels on a CAT6/fiber network, with audio signals comprising e.g. announcements made via call stations or background music from a connected CD-player. The network controller shall have an RJ-45 Ethernet connection for connecting a configuration PC, directly or via an Ethernet network. After the configuration, the network controller shall be able to run stand-alone without PC, although it shall be possible to keep the network controller connected to the network or PC for additional functions, such as logging of call and fault events or remote control. The network controller shall provide power to connected equipment on the network. It shall provide 6 analog audio input channel.

The controller shall have a supervision system to monitor its operation conditions. Network connectivity status and fault conditions of the network controller itself and all network-connected units shall be stored inside the network controller. The network controller shall have 8 control inputs for activation switches, with configurable for open and short circuits. The control inputs shall have configurable functionality, such as automatically starting an emergency alarm in case of activation by a fire alarm. The network controller shall have relay outputs, that can be configured for integration with the third party. The Network controller should have 2 Separate players for alert and EVAC and should have SD Card to store the prerecorded messages. The Controller shall have message recording in following format MP3 or WMA format, two separate players of SD card with protection cover, programmable voice message up to 255.

The unit shall be able to operate at a maximum operating temperature of 55°C to accommodate high density rack mounting. The network controller shall be as per the international standard IEC 60849 for emergency sound systems. The unit can be free-standing on a tabletop or mounted in a 19" rack.

The following features shall be available or supported by Network controller.

1. The Controller shall have Class-D 500W Digital amplifier
2. EN54 Approval for the controller
3. The controller shall comply standards of BS EN54-32 & EN608409.
4. 8 zone AB speaker line low impedance supervision.
5. Red button EVAC message push to activate with priority except fireman mic.
6. 8 zone speaker outputs with separate zone volume control.

7. 8 zone separate indicator for EVAC, fault, music/paging & select.
8. System indicators of AC, DC, fault and indicators for EVAC, alert & fireman mic.
9. Zone capacity of 120 zones by cascaded routers.
10. Priority level: fireman mic, EVAC, input 1, remote microphone, timer & BGM.
11. Two RJ45 for cascade router, two RJ45 for remote microphone input and two RJ45 for LAN/WAN/Internet network.

    AC 230V and DC24V battery input. Auto switch into the battery backup when AC fails.

Technical Specification:

- Power Supply AC 220V – 250V/24VDC, 50/60Hz
- Power Consumption 650W
- Max Current <3A
- Impedance 600Ohm
- Fireman Microphone: 5mV, 600 Ohm
- Line 1 – 2 input: 385mV
- Frequency Response: 80Hz – 20kHz
- Line 3 – 6 input: 350mV
- THD <0.1%
- S/N Ratio >70dB
- Relative Humidity 95%

23.8. Class-D Digital Amplifier

All amplifiers shall be power amplifier with High quality speech and Music broadcast. The power amplifiers shall have adequate continuous (RMS) power output to meet the requirement of the configuration. The unit shall can deliver the rated output power with less than 0.1% harmonic distortion in the design bandwidth. The amplifier shall have a broad band frequency response of 40 Hz to 20 KHz. The output voltage and impedance shall meet with the system requirements. Amplifiers shall be protected against over loads and output shorts and a special thermal overload on the heat sink.

The Amplifier shall be Class –D Amplifier have one channel, Two Channel, Three Channel and four channels' each channel have rated power 120/240or 500W. The Amplifier shall have switch power technology for power electricity saving, sleep mode is automatically enabled when no signal input is detected.

Amplifier shall have AC 115V or 230V power supply and DC 24V input, having separate fuse for each channel. The Amplifier shall be connected through balanced audio input and shall work on 100V Speaker Line.

Technical Specifications

- Rated Output Voltage(RMS) 4X 500W
- No. of Channel 4
- Amplification Class-D
- Battery Voltage 24VDC
- Frequency Response 20Hz to 20KHz
- S/N Ratio >80 dB
- Total Harmonic Distortion <0.1% @ 1kHz

- Power Efficiency >85%
- Impedance 10k ohm

23.9. 19" Rack

The equipment shall be housed in a standard rack of suitable height, with Plexiglas door or metal mesh and lock. Ventilation panels of 1U height shall be provided between each item of equipment.

Details of the proposed equipment shall be forwarded to the Consultant with performance specifications, dimensions, construction and finish for approval.

Rack should comply with ANSI/EIA RS-310-D; DIN41491; DIN41494; IEC297-2; and GB/T3047.2-92.

The Rack should have DIN Rail Mounted Terminal Blocks for termination of Speaker Zone cables on the rear.

All cables coming from Speaker zones, Call Stations, Power supply should enter from Bottom.

Rack should be installed at location which has minimum 600mm space from front & back for accessing it easily.

Rack should be installed in well-ventilated room preferable Air conditioned. The unit should have Fans from top.

The unit should have Lockable Glass door at front

Dimensions

- Height as per the Quantity of PA Processor & Amplifiers
- Depth 600mm Deep
- Width 19"

23.10. Speaker Cables

All cables associated with PA System shall be of following specifications:

The 2-core speaker cable will be connected to the speakers by screw terminals before which it shall be crimped using 1.5 sq. mm. bootlace lugs. Care must be taken for avoiding any single strand of wire shall not come out of Lug & screw terminals to avoid noise & leakage.

Speaker cables used should be Multi-Conductor Stranded type

Flexible Copper Conductor of cross section 1.5 Sq. mm / 2.5 Sq. mm insulated, PVCFRLS sheathed control Cable as per IS 694.

These Cables shall be laid in G.I. Conduits concealed/surface.

23.11. Call Station Cables

Call station cables should be 4pair CAT6 STP (Shielded Twisted Pair) type,

It should be crimped by RJ45 Shielded Male Connectors.

23.12. PAVA Testing

Sr. No.	Description	Visual	Test Readings	Documentation
	OEM Authorization Should be Provided before Any Delivery of Material			

1	All cables are tested for continuity, insulation, resistance etc.			√
2	System installation proper as per drawing	√		
3	Carry out visual checks on all speakers & Processors are free from any mechanical damage, cables, inter phase modules etc.to ensure they are properly installed.	√		
4	Check for proper termination of bootlace lugs & feruling	√		
5	Check Input A/C Supply Voltage		√	
6	Check location / spacing of loudspeakers as in drawing.	√		√
7	Check Distribution of Zones as per Drawing.	√		√
8	Check full load speaker sound quality & measure Sound pressure level (SPL) in dB.	√	√	
9	Check if local loudspeakers overrides by voice messages in case of emergency evacuation.	√		√
10	If power fails, whether Voice evacuation system is working on battery supply if yes for what time		√	
11	Check if recorder messages are CLEAR, free from any noise distortion & easy to understand with Room acoustic speech transmission Index (RaSTI) value >0.5.	√	√	
12	Processor LED's and all keys are working properly	√		
13	Check for Microphone locations & the sensitivity by paging	√		√
14	Play a soft music & check sound quality	√		

23.13. Commissioning

At final commissioning of each system, the Contractor shall confirm that: All devices, control panels are tested and operate correctly.

Commissioning shall be fully documented, and the documentation submitted to the Engineer.

The Contractor shall demonstrate each zone and main panel to the satisfaction of the Engineer by conducting a series of witnessed acceptance tests as directed by the Engineer. This shall take place after the above final commissioning and following receipt of the commissioning documentation by the Engineer.

Both the installation and the commissioning activities shall be undertaken as a single continuous operation.

Upon completion of the installation activity, the contractor shall Test, Start-up, Commission and Handover the system to the customer.

The contractor shall make use of the following documents to record test results and details of commissioning tests:

Cable Test Sheets

Installation Check Report

System Layout Drawing(s)

System Schematic Diagram(s)

The contractor shall be responsible for inspecting and testing the complete system.

The contractor shall present an Acceptance Certificate for signature by the customer.

23.14. Documentation

The contractor, upon completion of the commissioning activity, shall hand over the system to the customer.

At the time of hand over, the contractor shall provide the customer with the following documentation:

1. Copy of detailed report
2. Component and equipment list
3. Product description sheets
4. System design drawing(s)
6. System schematic diagram(s)
7. System operating manuals

23.15. Handover

Prior to final acceptance, the installing contractor shall provide complete operation and maintenance instruction manuals to the owner. All aspects of system operation and maintenance shall be detailed, including wiring diagrams of all circuits, a written description of the system design, sequence of operation and drawing(s), illustrating control logic and equipment used in the system. Checklists and procedures for emergency situations, maintenance operations and procedures shall be included in the manual.

23.16. Training

The contractor shall provide the customer with details of the training required by personnel to operate and maintain the PA system.

The Contractor and the customer shall jointly agree the number of staff to attend the training courses.

24. SAFETY EQUIPMENTS

24.1. DANGER NOTICE

Danger notices shall be affixed permanently in a conspicuous position in Hindi or English and the local language of the district with sign of skull and bones on HV and MV equipments.

- Danger notices shall conform to the requirements of:
  - IS: 8923; 1978: Warning symbol for dangerous voltages.
  - IS: 2551: 1982: Specification for danger notice plates for MV danger notice plate.
- Danger notices shall be 200 mm x 150 mm, made of mild steel at-least 2 mm thick, vitreous enameled white on both sides and with the descriptions in signal red color on front side as required.
- Notice plates of other suitable materials such as stainless steel, brass or such other permanent nature material shall also be accepted with the description engraved in signal red color.

24.2. FIRST AID BOX

Standard first aid box with all standard contents shall be supplied. Standard first aid box prescribed under I. E. rules, containing materials as prescribed by 'St. John Ambulance brigade' or 'Indian Red Cross' should be provided in each sub-station.

24.3. FIRE BUCKETS

The fire bucket unit shall consist of four galvanized iron buckets with round bottom and of 13 liters capacity as per fire brigade design, supported on hanging bracket, chained and locked, initially filled with fine river sand, water.

- The fire bucket unit shall conform to I S: 2546: 1974.
- They shall be filled with dry sand.
- Arrangement shall be made to hang them on GI pipe stand comprising of at least 2 vertical and one horizontal members of 50 mm diameter G I pipe. The stand shall have hooks welded on the horizontal portion of the pipe to hang the buckets and chain locking arrangement.
- The buckets and stand shall be painted with epoxy red paint.

24.4. FIRE EXTINGUISHER

Fire extinguishers of specified type, capacity and quantity of approved make shall be provided.

- Fire extinguisher conforming to:
  - I S: 2878: 1976 : CO2 gas / Foam type and
  - I S: 15683, 2006 : ABC Powder type Pressurized by dry Nitrogen up to 15kgf/cm² as per TAC approved specific requirement for the type of fire to be extinguished.
- Extinguishers shall be fixed on walls / columns with necessary clamps made out of MS flat and coated with synthetic enamel paint/Powder coated and hardware as required.
- The hardware shall be treated for anti-rusting coat such as passivation or galvanization.

24.5. RUBBER MAT

The 1000mm wide 3.3KV, 11KV or 33KV grade Insulated Synthetic elastomer mat of tested quality rubber mat shall:

- Conform to the I S: 15683, 2006 with latest amendments.
- Have a thickness and surface finish provided as per the voltage withstand requirement.
- Be of 1Meter width and the length of matting shall be along the full length of the equipment.
- Be used in front of HT / LT panels, power & motor control centers, push button stations and distribution board in control room.

It shall be ISI marked with following technical requirements:

S. N.	SPECIFICATIOND	CLASS-A	CLASS-B	CLASS-C
1.	Composition	Synthetic elastomer	Synthetic elastomer	Synthetic elastomer
2.	Maximum use voltage (KV)	3.3	11	33
3.	Thickness (mm)	2.0	2.5	3.0
4.	Length (m)	(Refer BOQ)	(Refer BOQ)	(Refer BOQ)
5.	Width (m)	1	1	1
6.	Color	Black/Grey	Black/Grey	Black/Grey
7.	Tensile Strength (N/MM²)	15	15	15
8.	Minimum elongation (%)	250	250	250
9.	Insulation resistance (by 5000V megger) (MΩ)	1,00,000	1,00,000	1,00,000
10.	Maximum leakage current (mA)	10	10	10
11.	AC Dielectric Strength (KV)	30	45	65
12.	AC Proof voltage (KV)	10	22	36
13.	Flame Retardance (Seconds)	5	5	5
14.	Minimum retention in tensile and elongation from original value on ageing at 70 ± 1°C for 168 hrs.	TS (min): 75% EL (min): 75%	TS (min): 75% EL (min): 75%	TS (min): 75% EL (min): 75%
15.	Minimum retention in tensile and elongation from original value when immersed in acid, alkali, diesel & Transformer oil for 48 hrs.	TS (min): 80% EL (min): 80%	TS (min): 80% EL (min): 80%	TS (min): 80% EL (min): 80%
16.	Low temperature resistance	Yes	Yes	Yes

24.6. INSTRUCTION CHART

- Printed instruction chart shall be both; in English and Hindi and duly framed with front glass.
- It shall display methods of giving artificial respiration and preliminary medical assistance to a recipient of electrical shock.
- It shall be prominently displayed at appropriate place in the Sub-Station / HT / LT distribution rooms/Control Rooms.
- The chart shall conform to SP 31; 1986: Method of treatment of electric shock.

24.7. HAND GLOVES

Two pairs of 33KV, ISI marked hand gloves, conforming to IS: 4770, 1981 made of rubber; shall be provided where 33KV equipment are installed.

25. FIRE STOP SPECIFICATIONS

25.1. GENERAL

1. All openings (provisions for MEP) & Joints (provision to accommodate movement) in rated wall & floor shall be closed with tested & listed firestop systems.
2. Firestop system for all MEP application should have 2 hours fire rating when tested in accordance with ASTM E 814/UL 1479 standards and IS 12458. If equivalent test standards are followed then equivalency can be arrived by comparing parameters like movement, Hose Stream test, L-rating, Sound insulation, mold and mildew resistance etc.
3. The system shall be UL listed & classified and product shall bear the UL & FM approval logo on the packing. If none of UL test certificate comply with actual application, an EJ document prepared by qualified personnel and based on nearest third party tested & approved systems like UL test certificates & in accordance with IFC guidelines shall be produced by manufacturer. A firestop submittal shall be produced by manufacturer, in accordance with approved passive fire protection method statement, for technical approval. Firestop installation shall be done by Company Accredited Firestop Specialty Contractor (CAFSC) and in accordance with Company guidelines and UL system test certificates or approved EJ document. Firestop Specialty Contractor needs to submit work completion certificate along with installation report through documentation manager for periodic inspection & maintenance purpose.

25.2. SCOPE

1. This method statement describes a proper work procedure that shall be followed for firestopping applications as per site requirement, specification(s) and contract drawing(s). The scope of work covers:
   - Penetrations for the passage of duct, cable, cable tray, conduit, piping, electrical busways and raceways through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions
   - Openings and penetrations in fire-rated partitions or walls containing fire doors
   - Openings around structural members which penetrate floors or walls
2. The aspects covered in the scope of work are as follows: -
   - Identification of breaches in fire rated walls/floors that need to be fire stopped as per fire plan or site requirement.
   - Identification and procurement of appropriate firestop assembly as per requirement of site, fire plan, specification(s) and/or contract drawing(s).
   - Inspection and documentation of firestop assembly

25.3. Codes, Standards & References

The following codes, standards and documents have been referred to:-

- NBC 2016, “National Building Coe 2016”
- ASTM E 814, "Standard Method of Fire Tests of Through Penetration Firestops"
- UL 1479, “Fire Tests of Through Penetration Firestops”
- IS 12458:2019, “Method of test of Through Penetration firestop”
- International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments.
- ASTM E3037, “Standard Test Method for Measuring Relative Movement Capabilities of Through-Penetration Firestop Systems”

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TECHNICAL SPECIFICATIONS

Our ref.: **Document No. W.004717-Z-10930-005**

Imputation: Project No. W.004717

RESTRICTED

Client: **Development Commissioner, SEEPZ-SEZ, Mumbai**

Project : **Preparation of Detailed Master Plan for 30 years & Detailed Architectural model building for SEEPZ-SEZ, Mumbai**

Subject: **PACKAGE 2, KD 1: HVAC Works Technical Specifications of Model Building NEST-3**

Comments:

Revision No.	Date	Prepared / Revision By	Description
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REV.	YY/MM/DD	STAT.	WRITTEN	VERIFIED	APPROVED	VALIDATED
R2	2026.09.21		Project Team	Amit Sarkar	Mona Srivastava	Rahul Jotshi

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1. SECTION 1

1.1. SYSTEM DESIGN DATA

This section covers the requirement of HVAC system & Scope of work to be provided as per specifications laid down below in subsequent sections.

1.2. INTRODUCTION

The section outlines HVAC system design parameters, system selections and extent of provisions for the project. The air conditioning and ventilation system for the development should be able to maintain the desired air quality & indoor comfort. The air conditioning shall be designed to maintain specified temperature, humidity and supply of outdoor air within occupied spaces. Individual's temperature controls for each area.

The Basement ventilation system shall be designed and developed according to contaminant removal requirements of the parking spaces.

The scope of work also include staircase, lift well, lift lobby pressurization system to limit smoke movement in case of fire emergency & Smoke Extraction of upper floors, services/ utility rooms, toilet ventilation etc.

All Ventilation and air conditioning systems shall be in conformity with the NBC-2016, CPWD-2017, ISHRAE/ ASHRAE & ECBC-2024.

1.3. DESIGN INTENT

i) To create a comfortable and safe HVAC environment for the development Prime objective.

ii) To maintain good indoor environment in terms of temperature, humidity and air movement.

iii) To create a relatively quiet and low vibration control AC system.

iv) To make the HVAC system energy efficient eco-friendly & easily maintainable, Automatic and Monitoring Control

v) IBMS system to integrate the HVAC on/off operation, Monitoring and optimizing. The IBMS shall be state of the Art and with the latest features.

1.4. APPLICABLE CODES & STANDARDS (las per latest amendements)

i) American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Standards.

ii) Indian Society of Heating, Refrigeration and Air Conditioning Engineers (ISHRAE) Standards.

iii) National Building Code of India 2016.

iv) Associated Air Balancing Bureau (NEBB) Standards.

v) National Fire Protection Association (NFPA)

vi) Indian Standard Codes.

vii) Underwriters Laboratories, Inc. (UL)

viii) ECBC Norms-2024

ix) SMACNA

x) Relevant Bureau of Indian Standards (BIS) Codes.

xi) AHRI – Air-conditioning, Heating and Refrigerant institute

xii) CPWD_HVAC-2017

1.5. AIR CONDITIONING SYSTEM

Basis of Design

Table 1-1 Basis of Design for AC System

Outdoor Design Conditions: (MUMBAI)		As per NBC-2016 & ISHRAE weather data book
Summer		
Dry Bulb Temp.	31.4 deg.C (88.5 deg F)	
Wet Bulb Temp.	28.1 deg.C (82.5deg F)	
Monsoon		
Dry Bulb Temp.	30.5 deg.C (87 deg F)	
Wet Bulb Temp.	29 deg.C (84 deg F)	
Inside Design Conditions :		
All areas	Summer & Monsoon:- 23±1 deg C (73.4 ±2 deg F) (RH 55% (Design Value – No Control)	
Lighting Load	As per ECBC-2024	
Equipment Load	As per uses of Area	
Occupancy	**As per Architectural plan or NBC**	
Fresh Air	**As per NBC-2026**	
Ventilation	**As per NBC-2026**	
Building Envelope	**U value as per Technical specification of material specified in civil/ Architectural section or ECBC-2024 Note: - Under deck/ over deck insulation to be provide roof above air-conditioned area exposed to sun.**	

Estimated HVAC Requirement

The contractor shall make final calculation as per prevailing local by-laws & NBC whichever is more stringent and get it approved from client. The capacities indicated in DBR are **Minimum Capacities** and any rating/ capacities required over and above the indicated capacity shall be provided by the contractor, nothing shall be paid extra on this account.

1.6. MECHANICAL VENTILATION & PRESSURIZATION SYSTEM & SMOKE EXTRACTION

Mechanical ventilation, smoke exhaust and pressurization system has to be provided as per NBC 2016 (latest upto amended) and as required by the local Fire Authority Maharashtra By laws.

Table 1-2 Ventilation Rate

Area Description	Min. Air Change Per Hour (ACPH)
Toilets	12
Pressurization	**As per NBC-2016, Vol. 1, part IV-Table-6**
Lift Well Pressurization	Mechanically pressurized for maintaining 50 Pa.

2. SECTION II

2.1. SCOPE OF WORK

The general character and the scope of work to be carried out under this contract is illustrated in Drawings, Specifications and Schedule of Quantities. The Contractor shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the Owner's site representative.

The contractor shall furnish all labour, materials and equipment (except those to be supplied by the owner) as listed under Schedule of Quantities and specified otherwise, transportation and incidental necessary for supply, installation, testing and commissioning of the complete HVAC system as described in the Specifications and as shown on the drawings.

This also includes any material, equipment, appliances and incidental work not specifically mentioned herein or noted on the Drawings/Documents as being furnished or installed, but which are necessary and customary to be performed under this contract. The HVAC system shall comprise of (but not limited to) the project.

The system includes:

a) VRV equipment, all refrigerant piping works including insulation, pressure testing, protection, hanging and support works for all the above-mentioned buildings.

b) All duct works including insulation, pressure testing, protection, hanging and support works for all the above-mentioned buildings.

c) Control cabling from outdoor to indoor units. Electrical wiring of indoor units.

d) SITC of all equipment that includes

   i) VRV outdoor Units.

   ii) Indoor Units.

   iii) Air Handling Units.

   iv) All type fans smoke exhaust, pressurization and ventilation as per bill of quantity.

e) Foundations for equipment including foundation bolts and vibration isolation spring/pads,

f) Suspenders, brackets and floor/wall supports for suspending/supporting ducts and pipes.

g) Suspenders and/or cable trays for laying the cables,

h) Sealing of all floor slab/ wall openings provided by the lead contractor or contractor for pipes and cables, from fire safety point of view, after laying of the same.

i) Painting of all exposed metal surfaces of equipment and components with appropriate colour.

j) Making openings in the Walls/Floors/Slabs or modification in the existing openings wherever provided for carrying refrigerant pipeline, ducts etc.

k) Providing wooden/ metallic frames for fixing grills/diffusers.

l) Making good all damages caused to the structure during installation and restoring the same to their original finish.

m) All electrical associated works as per BOQ and drawings, specifications.

RELATED DOCUMENTS

These Specifications shall be read in conjunction with the General conditions of contract, schedule of work, drawings and other documents connected with the work.

TERMINOLOGY

The definition of terms used in these specifications shall be in accordance with IS: 3615-"Glossary of terms used in refrigeration and air-conditioning". Some of the commonly used terms are defined in last chapter of the specification.

Bi-Polar ionization System along with Monitoring

The Bi-Polar ionization system should consist of Supply, Installation, Testing and commissioning of Bipolar Ionization System. The Bipolar Ionization System must be a combination of Needle Point Model for Air Handlers (Needle Point should have Nitinol (nickel titanium) Needles and Carbon Fibber Brush Model for CS-AHU. The System should produce positive and negative ions for creating a Bio Climate rich in ions and hence neutralizing harmful pollutants including pathogens, Volatile Organic Compounds and Particulate Matter.

The Carbon Brush and Self-Cleaning nickel titanium-based Needle Point Bipolar Ionizer must be UL 2043 certified for Fire and Smoke Safety.

The Carbon Brush and Self-Cleaning nickel titanium-based Needle Point Bipolar Ionizer must have UL-2998 Certification for Safety against Zero Ozone Emission as per recommendation by ASHRAE.

The Carbon Brush and Self-Cleaning nickel titanium-based Needle Point Bipolar Ionizer and should be tested on UL or Intertek/ETL, to prove conformance to UL 867 for electronic devices.

The Technology should have ISO 16000 , CARB and , CSA C22.2# 187 Certifications.

Manufacturers shall provide Test report from Internationally/Nationally recognized Lab for proven efficacy on below pathogens with minimum kill rates for the following pathogens given the allotted time and in a space condition:

- SARS-CoV-2 (COVID-19) Human Strain
- MS2 Bacteriophage (Surrogates COVID-19)
- Omicron Variant of SARS-CoV-2
- H1N1
- Total Bacterial Count Reduction rate of more than 90% from NABL Accredited Lab
- Yeast & Mold/Total fungal count Reduction rate of more than 90% from NABL Accredited Lab

Indoor Air Quality Monitoring System

Supply, Installation, Testing & commissioning of IAQ Monitor to remotely measure the levels of PM 2.5, VOCs, CO2, Temperature, Humidity on a real time basis. The IAQ Monitor shall be capable of getting connected with Wi-Fi.

The Monitor should be capable of sending the indoor air quality information on display Screen/Mobile/Workstation as per Client's requirement.

The Monitor should indicate the quality of air through changing the colours on the display screen as per the NAAQS standards and should meet the WELL building standards.

The monitor should be a 3-tier architecture including sensor Hardware, secure cloud infrastructure, monitoring apps including dashboard, android/IOS. Quoted price shall be inclusive of all necessary arrangement as required to make the unit proper functional.

The Dashboard should have capability to download historic reports.

2.2. APPLICATION CODES AND STANDARDS

Supply, erection, testing and commissioning of all equipment’s shall comply with the requirements of Indian Standards and code of practice given below as amended up to the date of submission of Tender. All equipment and material being supplied shall meet the requirements of relevant standard and codes.

General

Table 2-1 Applicable Codes & Standards

ASHRAE-2008	Systems and Equipment's
ASTM D 3350, ASTM D 3035	High Density Polyethylene
IS: 2379-1963	Color code for Identification of pipes
IS 3615	Glossary of terms used in refrigeration & air-conditioning
IS : 3696	Safety code for scaffolding and ladders,
IS: 3696	Code for practice for safety and health Requirements in electrical and gas welding & cutting operations
IS: 325	Three phase induction Motors
IS: 655 (Latest Rev.)/ BIS Code	Ducting Fabrication

SHEET METAL WORK

Table 2-2 Standards for Metal Work

IS: 277-1977	Galvanized Sheets/Wires
IS: 655 (Latest Rev.)/ BIS Code	Ducting Fabrication

NOISE & VIBRATION

Table 2-3 Standards for Noise & Vibration

IS: 2264	Preferred frequencies for acoustical measurement.
IS: 3483	Code of practice for noise reduction in industrial buildings.
IS: 8418	Specification for horizontal centrifugal self-priming pumps.

EARTHING

Table 2-4 Codes for Earthling

IS: 3043 : 1966	Code of practice for earthling
IS : 3151 : 1965	Earthling transformer
IS: 12776 : 1989	Galvanized stand for earthling

FUSES

Table 2-5 Codes for Fuse Networks

IS: 2208 : 1966	HRC fuses links up to 650 V
IS : 2086 : 1963	Carrier and bases used in rewire able type electric fuses up to 650 V
IS: 3106 : 1966	Code of practice for maintenance of Fuses

MOTOR

Table 2-6 Details of Motors

IS: 325	3 Phase induction motor
IS : 996	Specs for single phase small AC and universal motor
IS: 3106 : 1966	Code of practice for maintenance of Fuses

SAFETY CODES

Table 2-7 Safety Codes

IS: 660	Safety code for mechanical refrigeration
IS : 659	Safety code for air conditioning
IS: 3016	Safety code for precaution for precaution in welding and cutting operation
IS: 5216	Code for safety procedure and practice in electrical work
IS: 3696	Code for scaffolds and ladders.

2.3. HEATING VENTILATION & AIR-CONDITIONING SYSTEM

General

- The scope of this section comprises of the design, supply erection, testing and commissioning of inverter technology-based D.C Twin Rotary / Scroll Type VRV/VRF type system of air

conditioning conforming to this specification and in accordance with the requirements of Drawing and Schedule of Quantities.

- The prices quoted shall include all the equipment ancillary material as specified and all such items whatsoever and which may be required to fulfill the intent and purpose as laid down in the specification and the approved drawings.
- The contractor shall calculate equipment capacity based upon design parameters specified for the system design & verify all the quantities and sizes of refrigerant pipe, fitting, cables, control cable, pipes, insulation, indoor units, and outdoor units etc. before installation to avoid any shortfall or surplus.
- The tenderer shall also include all necessary minor civil work & MS framework required for installation of outdoor and indoor units in VRF based air condition system.
- The cost quoted by tenderer shall also include the refrigerant R-410A & its charging for proper & specified functioning of air conditioning system.
- The scope in the tender schedule also covers detailed designing of complete air-conditioning system based on inverter technology-based D.C Twin Rotary / Scroll VRV/VRF air conditioner with air cooled outdoor units system capable of cooling and heating (reverse cycle) as per individual or season requirement suitable for operation on 415 V, 3 Phase, 50 Hz AC electric supply.
- Each indoor unit should have capability to cool or heat as per seasonal weather changes as per schedule of quantities.
- This shall also include complete capacity calculation for indoor and outdoor units complete with drawing, designing & layout of following.
    - Outdoor units.
    - Indoor units.
    - Refrigerant piping
    - Power & Control Cables between Outdoor units & Indoor units.

Outdoor Unit

Supply, Installation, testing and commissioning of Variable Refrigerant Flow /Volume (VRF/VRV) (with the latest technology/version) with All-Inverter driven Compressor, modular type air-conditioning system with step less modulation for both heating & cooling modes, complete with indoor and outdoor units, individual remote controller and centralized controller, interconnected refrigerant piping with insulation, Y joints, full charge of refrigerant gas including additional top up and oil, control cabling etc. as per detail given in specifications and having following items. The prices to be given in Indian rupees including all taxes and duties and delivered at site. Refrigerant to be used shall be - R 410 A only.

- It shall be complete as per specifications, with connectivity to automation for A/M status, RUN status & Remote start/stop command.(Bacnet/IP) with multi connection kits for each outdoor unit & First charge of refrigerant gas for the VRF/VRV Units & required MS frame work or required foundation & anti vibration pads for mounting the outdoor units. installation, testing & commissioning of air cooled VRV/VRF system shall include pipe pressure testing & flushing with nitrogen, charging of gas/oil etc. & will include all lifting/shifting etc. Supply Installation, Testing & Commissioning of modular type Variable Refrigerant Flow/Variable Refrigerant Volume air cooled Outdoor units suitable for cooling and heating, having all hermetically sealed inverter type Scroll Compressor(s), minimum two compressors for above 14 HP modules, microprocessor-based Controller, Top discharge type condensing unit(s), with R 410 A Refrigerant, vibration isolators, with suitable foundation etc. complete as required. The unit shall deliver the rated capacity at AHRI Conditions and work even at50°Cambient temperature

without tripping. The unit shall be suitable to work on 400V +/- 10%, 3 Phase, 50Hz AC power supply. The unit shall be filled with first charge of the refrigerant and ready for use as required. The COP at AHRI conditions shall not be less than 3.1 and IEER not less than 6.5 .

A TOP-discharge ODU (Outdoor Unit), you can use the following technical specification wording in the equipment schedule/submittal:

Side-Discharge ODU –	Technical Specification
Parameter	Specification
Unit Type	Outdoor Unit – Top Discharge Type
Air Discharge	Side discharge
Air Intake	Through coil surface, typically from front/rear/side as per Manufacturer design
Refrigerant	As per approved VRF/VRV system, e.g. R-410A/R-32
Compressor	Hermetically sealed inverter-driven scroll/compressor

Compressor Control	Inverter variable-speed control
Condenser Coil	Copper tubes with aluminum fins, corrosion-Protected as required.
Condenser Fan control	Axial-flow propeller fan with inverter/variable-speed
Fan Discharge Velocity	To be stated by manufacturer based on selected model.
Sound Pressure Level	To be stated by manufacturer at specified test conditions.
Casing	Powder-coated galvanized steel sheet, weather Proof and corrosion resistant
Operating Ambient Temperature	As per manufacturer's certified operating Range and project design conditions
Power Supply	As per approved equipment selection and Manufacturer requirements
Refrigerant Connections	Liquid and gas piping connections, Complete with service valves
Controls	Microprocessor-based control with Protection, fault indication and communication interface
Protection	High/low refrigerant pressure, overload, Over current, phase protection and compressor protection as applicable
Mounting	Factory-approved vibration isolators/ Support arrangement on suitable structural support!
Installation Clearance	Minimum clearances shall be maintained. Around air intake and side discharge in accordance with manufacturer's recommendations
Certification number	AHRI certified, where applicable, with certification /details submitted
Accessories	Refrigerant branch joints/headers, communication Wiring accessories, vibration isolators, supports and other things. Accessories as required for complete installation

Indoor Unit

- Supply, installation testing and commissioning of Ceiling Suspended Type Air Handling Units double skin type complete with 20mm thick ESP insulated panels, DIDW forward curved centrifugal fan, 6 row cooling coil section, filter section with MERV-8 filters, fan motor, drive set, thermostat, Power cabling, mounting base damper etc.as per specifications and drawings.
- All AHU's shall be forward curved type fan and fans selection should be highest efficiency model. Final Static pressure calculation to be rechecked by contractor and accordingly select

the motor rating.

(CS)-AHU

Supply, installation testing and commissioning of Ceiling Suspended DX Type Air Handling Units double skin type complete with 20mm thick ESP insulated panels, DIDW forward curved centrifugal fan, 6 row cooling coil section, filter section with MERV-8 filters, fan motor, drive set, thermostat, Power cabling, mounting base damper etc.as per specifications and drawings .All AHU's shall be forward curved type fan and fans selection should be highest efficiency model. Final Static pressure calculation to be rechecked by contractor and accordingly select the motor rating

Table 2-8 AHU Item Descriptions

Item	Description
Casing	Double skin construction with 25 mm thick PUF insulated panels, injected density 40 ± 2 kg/m³. Inner & outer skin 0.8 mm GI/PPGI sheet.
Framework	Heavy-duty extruded aluminum profile with nylon/glass-filled corner joints. Thermal break profile optional.
Base Frame	Heavy-duty MS channel (100–150 mm), epoxy painted or hot-dip galvanized with lifting provisions.
Fan Section .	DIDW backward curved centrifugal fan, statically and dynamically balanced to ISO 1940 standards
Motor	IE3 Energy Efficient, TEFC, IP55, Class F insulation, 415V, 3 Phase, 50 Hz.
Drive	Belt driven with taper lock pulleys and adjustable motor base.
Bearings	Self-aligning pillow block bearings, grease lubricated.
Filters	10 Micron G4 washable pre-filter in aluminum/GI frame. Fine filter optional.
Mixing Box	Fresh air and return air chamber with opposed blade GI dampers and manual volume control.
Access Doors	Double skin insulated access doors with neoprene gasket and lockable handles.
Drain Pan	SS-304 drain pans with proper slope (if coil section is provided).
Vibration Isolation	Neoprene/Spring anti-vibration isolators under fan-motor assembly
Fasteners	Zinc-plated or SS fasteners with airtight sealing gasket.
Finish	Powder-coated aluminum frame and pre-coated GI panels.
Leakage Class	Designed to comply with EN 1886 (or equivalent) for low air leakage.

The CS-AHU shall be of draw-through type and shall be selected for optimum airflow distribution and low-noise operation. The face velocity across the cooling coil shall not exceed 2.5 m/s at design airflow, with a preferred design value of approximately 2.0–2.3 m/s. The air velocity at the supply blower/fan discharge shall preferably be limited to 12 m/s and shall not exceed 15 m/s unless specifically justified by the manufacturer's selection and acoustic requirements. The complete CS-AHU, including fan, motor and casing, shall be selected to achieve a maximum sound pressure level of 65 dB(A) at 1 m under normal operating conditions. The unit shall be dynamically balanced and provided with suitable vibration isolation and flexible connections. The manufacturer shall submit certified fan performance, sound power/sound pressure data and coil selection data for approval.

The DX cooling coil and complete CS-AHU assembly, wherever covered by an applicable AHRI certification program, shall be AHRI Certified/Listed or rated in accordance with the applicable current AHRI Standard. The manufacturer shall submit a valid AHRI certificate/listing and certified selection data for the offered equipment. The certified selection shall demonstrate compliance with the specified airflow, total cooling capacity, sensible cooling capacity, entering and leaving air conditions, refrigerant conditions and air-side pressure drop. AHRI certification shall be from the actual manufacturer/model offered and shall not be based solely on an equivalent or similar model."

Power & Control Cables between Outdoor units & Indoor units.

Supply, laying, testing and commissioning of control cabling for CS-AHU equipment, including all necessary end terminations, cable glands, lugs, ferrules, identification tags and accessories. Cabling shall be 1.1 kV grade, XLPE insulated, PVC sheathed, armoured, stranded copper conductor cable, suitable for installation on existing cable trays, complete in all respects. Cable size: 3C × 1.5 sq.mm Cu.

Flanges and support description

"The CS-AHU shall be complete with factory-fitted rigid flanges/frame connections at all duct openings. Flanges shall be fabricated from galvanized steel or other approved corrosion-resistant material and shall be rigidly secured to the AHU casing. All duct connections shall be airtight and shall incorporate continuous suitable gaskets/sealants and flexible connections to prevent air leakage and transmission of vibration. Supply and return Ductwork shall be independently supported from the building structure and shall not be supported from the AHU casing. The AHU shall be installed on a rigid, level structural support frame/base with suitable spring or neoprene vibration isolators. Fan/motor assembly shall be adequately isolated to limit vibration transmission. DX refrigerant piping and condensate drain piping shall be independently supported, properly aligned and installed with suitable clamps, hangers and accessories. All supports shall be adequately sized for the operating weight and shall be corrosion protected. Adequate service clearance shall be provided around the AHU and ODU for operation, inspection and maintenance."

Outdoor DX condensing unit shall be installed on a properly designed structural support frame or concrete foundation, complete with anti-vibration pads/isolators. The support shall be capable of safely carrying the operating weight of the ODU under all design conditions. The top discharge shall remain unobstructed, and the minimum vertical clearance above the condenser fan shall be maintained in accordance with the manufacturer's certified installation requirements."

3. DUCTING

3.1. RECTANGULAR DUCT

Supplying, installation, balancing and commissioning of fabricated at site GSS sheet metal rectangular/ round ducting complete with neoprene rubber gaskets, elbows, splitter dampers, vanes, hangers, supports, bends, transitions, reducers, end caps, collars etc as required complete in all respect in confirmation with IS : 655 and approved drawings and specifications of following sheet thickness complete as required.

3.2. FABRICATION

All ducts irrespective of size shall be fabricated and installed in workman like manner, generally conforming to relevant latest IS code.

a) Ducts so identified on the drawings shall be acoustically lined with thermal insulation as described in the section `Insulation' and as indicated in schedule of quantities. Duct dimensions shown on drawings are overall sheet metal dimensions inclusive of the acoustic lining, where required and indicated in schedule of quantities.

b) Ducts shall be straight and smooth on the inside with neatly finished joints. All joints shall be made airtight.

c) Changes in dimensions and shape of ducts shall be gradual. Curved elbows, unless otherwise indicated, shall have a centre line radius equal to one and a half times the width of the duct. Air turns shall be installed in all vanes, arranged to permit the air to make the turn without appreciable turbulence. Suitable vanes shall be provided in duct collar to have uniform/ proper air distribution.

d) Ducts shall be fabricated as per details shown on drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles of sample size to keep the ducts true to shape and to prevent bulking, vibration, breathing or oil canning.

e) All sheet metal connections, partitions and plenums required to confine the flow of air to and through 18g GI/16-gauge aluminium, thoroughly stiffened with 25mm x 25mm x 3mm angle iron braces and fitted with all necessary doors as required to give access to all parts of the apparatus. Access Doors shall be not less than 45cm x 45cm in size

3.3. VOLUME CONTROL DAMPERS

Supplying, Fixing, installation, testing and commissioning of supply air diffuser of powder

coated aluminium with aluminium volume control dampers with anti-smudge ring & removable core in confirmation to SMACNA/IS and as per specifications complete etc. as required.

3.4. AIR OUTLET AND INLETS (SUPPLY AND RETURN)

Supplying, Fixing, installation, testing and commissioning of supply air diff users of powder coated aluminium with aluminium volume control dampers with anti-smudge ring & removable core in confirmation to SMACNA/IS and as per specifications complete etc.

Supplying, Fixing, installation, testing and commissioning of Return air diffuser of powder coated aluminium without volume control dampers with anti-smudge ring & removable core in confirmation to SMACNA/IS and as per specifications complete etc.

3.5. MEASUREMENT FOR DUCTING AND GRILLES/DIFFUSERS

Special Items for Air Distribution shall be measured by the cross-section area perpendicular to air flow, as identified herewith:

a. Diffuser - cross section area for air flow at discharge area excluding flanges. Volume control dampers shall form part of unit rate for supply air diffuser and shall not be separately accounted. Supplying, Fixing, installation, testing and commissioning of supply air diffuser of

powder coated aluminium with aluminium volume control dampers with anti-smudge ring & removable core in confirmation to SMACNA/IS and as per specifications complete etc. as required.

b. Linear Grilles - shall be measured by cross-sectional areas and shall exclude flanges for mounting of linear Grilles. The supply air plenum for linear Grilles shall be measured with ducting as described earlier.

c. Flexible connection - shall be measured by their cross-sectional area perpendicular to the direction of air flow.

d. Fire Damper-shall be measured by their cross-sectional area perpendicular to the direction of air flow and actuators shall be on counting basis.

Supplying, Fixing, installation, testing and commissioning of thermal insulated flexible duct of following sizes duly supported at regular interval as per site requirement etc. in confirmation to SMACNA/IS and as per specifications complete etc. as required

4. MECHANICAL VENTILATION SYSTEM

4.1. SCOPE

This chapter includes supply air fans, exhaust air fans and fans used in any equipment like AHUs, FCUs etc.

4.2. INLINE FANS

SCOPE

The scope of comprises of supply, erection, testing and commissioning of inline fans conforming to these specifications and in accordance with the Schedule of Quantities and drawings.

TYPE

a) Supply, installation, testing and commissioning of factory fabricated Single Skinned cabinet type fans section made out of extruded aluminium section with 1.0 mm pre-plasticized / pre-coated Galvanised steel sheet with DIDW blower, blower section and blower motor TEFC type suitable for operation on 415 volts ± 10%, 50 Hz ± 5% AC supply with motor and belt drive package. The fan Motor shall be of efficiency class IE3 or EFF1 whichever is more efficient. The blower should be AMCA Certified for air performance and should be selected for maximum efficiency. The motor & blower assembly shall be mounted on Aluminium extruded section only. The complete fan section shall conform to standard specification. The fan outlet velocity shall be limited to 9.5 MPS maximum. The unit shall be compatible with BMS System and complete in all respect.

b) Fans casing shall be manufactured from galvanized steel sheets.

c) All other metal parts shall be hot dip galvanized.

MOTOR

a) The fan motor shall be equipped with motor with speed regulator giving volume control from 0 to 100% of output.

b) Motors shall be with class ‘F’ insulation wired to an externally mounted weather proofed terminal box.

c) Motor name plate horsepower shall exceed brake horsepower by minimum of 10%. Motor shall be designed especially for quiet operation, and motor speed shall not exceed 1500 RPM.

INSTALLATION

a) Fan shall have rigid supports and fitted to both ends of the casing.

b) Wherever the fans are to be suspended from ceiling or mounted on the wall, the contractor

shall include supply and fixing of all the material that may be required to complete the installation in all respect.

c) Fan inlet and outlet connections shall be by means of flexible canvas connections.

TESTING

Fan after installation shall be tested for capacities, power consumption, noise level and vibration and results shall confirm to the approved data furnished by the contractor.

ELECTRIC POWER CONSUMPTION

Single phase, 220 V, 50 Hz power supply point within 2 meters from the fan shall be available. All further wiring shall be in the scope of the HVAC contractor.

4.3. AXIAL FLOW FANS

Supply, Installation, Testing & Commissioning (SITC) of Tube Axial Flow Fan for Lift Well Pressurization complete with adjustable pitch cast aluminium alloy impeller, heavy duty MS/GI long casing, TEFC squirrel cage induction motor, supports, vibration isolation arrangement, flexible canvas connections, bird screens, and all accessories required for complete operation as per approved drawings and specifications. The fan casing shall be fabricated from minimum 2 mm thick MS/GI sheet for fan diameter up to 800 mm, 3 mm thick for fan diameter from 900 mm to 1250 mm, and 4 mm thick for fan diameter above 1300 mm. The fan shall be complete with IE-3 efficiency class TEFC motor suitable for operation on 415V ±10%, 3 Phase, 50 Hz ±3% AC supply. The complete fan assembly including motor shall be suitable for smoke extraction/lift well pressurization duty and certified for continuous operation at 250°C for 2 hours with Class 'H' insulation. Fan outlet velocity shall not exceed 16 m/sec under operating conditions. Fan RPM shall be low speed type and shall not exceed 1000 RPM. The scope shall include fire retardant flexible canvas connectors minimum 150 mm deep at inlet and outlet, bird screens at inlet/outlet wherever required, mounting frame, ant vibration isolators, foundation/support arrangement, and all accessories required for vibration free installation Axial fans shall be AMCA certified for air and sound performance in accordance with AMCA 210 and AMCA 300 standards. Complete fan assembly shall be tested and certified by CE/UL/EN approved agencies in accordance with standards for "Power Ventilators for Smoke Control Systems" rated for 250°C for 2 hours. Manufacturer shall furnish valid AMCA air and sound performance certificates along with UL/EN fire test certificates sourced from the respective manufacturing facility. Noise level of the fan shall not exceed 80 dB(A) measured at 3 metre distance from the fan under operating conditions. Fan diameter and motor rating indicated in schedule are indicative only; actual fan selection including diameter, RPM, airflow, static pressure, and motor kW shall be finalized by manufacturer while maintaining all specified performance criteria. The work shall include complete installation, isolate & starter panel, alignment, balancing, testing, commissioning, trial operation, and handing over complete in all respects as per approved drawings, specifications, and directions of Engineer-in-Charge.

- Axial Fans Must Be Amca Certified For Air & Sound Performance.
- Fan shall be complete with motor, motor mount, direct driven and vibration isolation type, suspension arrangement as per approved for construction shop drawings.

CASING

The casing shall be constructed of continuously welded galvanized steel (or steel duly hot dip galvanized, or powder coated) and include integral punched inlet and outlet flanges to prevent air leakage. The motor shall be supported in the center of the casing by an inner tube (in case of flange mounted motors), or through motor mounting brackets (for foot mounted motors) made out of heavy-duty steel plate of minimum 20 mm thickness.

Support brackets for ceiling suspension shall either be welded or bolted to the casing for connection to hanger bolts. All fans shall have straightening vanes for better efficiency. The straightening vanes shall be aerodynamically designed for maximum efficiency.

ROTOR

Hub and blades shall be fabricated aluminium OR cast aluminium. Blades shall be airfoil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. The entire propeller assembly should be statically & dynamically balanced.

MOTOR

Motor shall be energy efficient IE3 squirrel-cage, totally enclosed, fan cooled standard round frame, constant speed, continuous duty, single winding, suitable for 415+10% volts, 50 cycles, 3 phase AC power supply, provided with class 'H' insulation. Motor shall be specially designed for quiet operation. Fans should be selected for maximum efficiency, lowest sound power and minimum horsepower. Motor conduit box shall be mounted on exterior of fan casing and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible conduit. For HT motors, the flexible conduit should be able to withstand the high air stream temperature.

FAN PERFORMANCE

Fan performance shall be based on tests conducted in accordance with AMCA 210 for air performance and AMCA 300 for Inlet sound power levels. These fans shall be licensed to bear the AMCA seal for air and sound performance.

All the High temperature Fans should either be EN-12103-3 or UL certified for High temperature (UL Power & smoke Ventilation listed) for a minimum of 250 Deg C for a minimum of 2 Hrs. All fans shall be vibration run tested before dispatch and vibration report to be submitted to the customer.

VIBRATION ISOLATION

The assembly of fan and motor shall be suspended from the slab by vibration isolation suspension of rubber-in-shear type.

ACCESSORIES

The following accessories shall be provided with all fans:

- Outlet cone for static pressure regain.
- Inlet Bell for non- ducted fans.

SILENCERS

Fan silencers may be provided where specifically called for in schedule of Quantities. Fans shall be factory assembled and shipped with all accessories factory mounted.

SILENCERS

These specifications are typical for commercial car park ventilation jet fans and may vary with manufacturer and project requirements

- Jet Fan Technical Specification Type Axial Impulse Jet Fan Application Car park ventilation and smoke extraction
- Diameter 315–400 mm Airflow Up to 12,000 CMH (depending on model)Thrust: 50–100 N Motor Type: TEFC, IE3 efficiency,
- squirrel cage induction motor Power Supply: 415 V ±10%, 3 Phase, 50 Hz
- Protection: IP55 minimum Insulation Class: Class F with Class B temperature rise
- Housing: Heavy-gauge galvanized steel Impeller: Aluminium or galvanized steel, dynamically balanced

- Mounting: Ceiling suspended with anti-vibration mountings Noise Level: ≤ 65 dB(A) at 3 m (with silencers)
- Fire Rating: F300 (300°C/2 h) or F400 (400°C/2 h) for smoke extraction Direction: Unidirectional or reversible
- Accessories: Inlet/outlet silencers, bird guard, mounting brackets, flexible connections Compliance: EN 12101-3,
- ISO 13350, IEC 60034 Finish: Corrosion-resistant galvanized or epoxy-coated steel

4.4. REFRIGERANT PIPING WORK

SCOPE

Supply, installation, testing and commissioning of interconnecting high pressure copper refrigerant piping work including vaccumiazation and Nitrogen testing suitable for refrigerant R 410A duly insulated with FACTORY PREFORMED TUBULAR EPDM RUBBER FOAM SECTIONS with completely closed cell structure as per specifications - Density 40-60 kg /cum , Class A as per ASTM E 84 , Class V-0 as per UL 94 and Mu value > 7000 between indoor & outdoor units as per specifications. External refrigerant piping shall be laid on 16 G GI covered perforated cable trays. Piping inside occupied area & vertical shaft inside the AHU Room shall be supported using 16 G GI hangers. All exposed pipes shall have UV coating on insulation & cost to be included in the piping. Cable tray is quantified separately.

VRV INDOOR UNIT DRAIN PIPING

Condensate from the Indoor unit shall be drained through properly installed drain piping designed to prevent any accumulation of condensate in the drain pan. Drain piping shall be made of rigid PVC pipe of 6 Kg/cm sq. pressure rating with watertight threaded connections. Leading from the Indoor unit to a suitable drain point as per the drawings. Complete drain piping shall be made leak proof and watertight by means of precise installation and the use of leak proof sealant / adhesives.

Drain lines shall be provided at all the lowest points in the system, as well as at equipment, where leakage of water is likely to occur, or to remove condensate and water from pump glands.

PIPE INSULATION

Drainpipe Insulation

Drainpipes carrying condensate water shall be insulated with 6 mm thick elastomeric nitrile rubber insulation. For proper drainage of condensate, U Trap shall be provided in the drain piping (wherever required). All pipe supports shall be of prefabricated & pre painted slotted angle supports, properly installed with clamps etc.

STRUCTURAL SUPPORTS

Structural supports including supports fabricated from pipe lengths for pipes shall be measured as part of pipeline and hence no separate payment will be made. Rates shall be inclusive of hoisting, cutting, jointing, welding, cutting of holes and chases in walls, slabs or floors, painting supports and other items as described in specifications, drawings and schedule of quantities or as required at site by Project Coordinator.

EXPANSION OR CONTRACTION

The contractor shall provide for expansion and contraction of all piping installed by the use of swing connections and expansion loops.

4.5. INSULATION WORK

SCOPE

This chapter covers the requirements of thermal insulation for duct work, Refrigerant piping and acoustic lining in duct work and weather maker rooms. This does not cover exposed roof insulation and under deck insulation work.

APPLICATION OF INSULATION (THERMAL) ON DUCT

For thermal insulation of ducts:

- Material Minimum Density(Kg / cum) Resin bonded glass wool 24 Polyvinyl Nitrile foam 40
- Fibre Glass Insulation used for duct insulation shall be factory faced with aluminium foil on one side reinforced with kraft paper & fused to the insulation material. Polyvinyl Nitrile foam Insulation used for duct insulation shall be factory faced with aluminium foil on one side

APPLICATION OF DUCT LINING (ACOUSTIC INSULATION)

The specification for resin bonded glass wool insulation & resin bonded mineral wool insulation shall conform to IS 8183 as amended upto date.

The specification for expanded polystyrene shall conform to IS-4671 as amended upto date.

FOR ASSOCIATED WORKS AT SITE

i) Inspection of raw materials to be used for fabrication and assembly and inspection of Manufacturer's Certificates.

ii) Inspection of welding including welders qualification as desired by inspection Engineers. Inspection of fabricated items.

iii) Pressure testing of pipe fittings used for the refrigerant and water services.

iv) Vacuum missing and gas/oil charging for refrigeration system.

v) Checking of electrical circuits (power & controls) and checking functioning of controls of refrigerant systems and other circuits of air conditioning plant.

vi) Checking of calibration of controls and instrumentation

vii) Performances testing of complete

The above inspection procedure is given for general guidance and information of vendors and inspection of Purchaser/Consultant is strictly not limited to these and Inspection Engineer of Purchaser/Consultant will have full right to have detailed inspection at any stage right from placement of order to completion of project as desired by Inspection Engineer, Co-ordination of Inspection Agency of Purchaser/Consultant with his Factory/Sub-vendor's Factory/Erection Site will be the sole responsibility of successful vendor after placement of order for complete

FINAL INSPECTION

After completion of entire installation as per specifications in all respects, the AC contractor shall demonstrate trouble free operation of the entire installation simultaneously. The test readings shall be recorded in a mutually acceptable format. All tests shall be carried out by the AC contractor at his own expenses. However necessary utilities such as power and water shall be provided by the owner free of cost.

The tests shall include but will not be limited to the following:

i. To check satisfactory functioning of all equipment installed

ii. Clean all equipment to remove foreign material and construction dirt and dust with Vacuum cleaner.

iii. Verify that the equipment is secure on mounting and supporting devices and that connection for piping, Duct work and electrical are complete.

iv. Verify proper thermal overload protection is installed in motors, starters, and disconnects.

v. Perform cleaning and adjusting specified as per OEM.

vi. Check proper motor `rotation direction and verify fan wheel / pump free rotation and smooth bearing operations.

vii. Reconnect drive system and align belts.

viii. Lubricate bearings, pulleys, belts, and other moving parts with factory recommended lubricants.

ix. Set outside-air / supply air dampers to minimum outside-air setting.

x. Install temporary throw away filters for initial run and finally install clean filters.

xi. Verify manual and automatic volume control, and fire dampers in connected ductwork system are in the full-open position.

xii. Replace fan and motor pulleys as required to achieve design conditions.

xiii. Measure and record motor electrical values for voltage and amperage.

xiv. Shut unit down and reconnect automatic temperature control operators.

xv. Cooling / heating capacity of various Indoor units shall be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements shall be by a calibrated rotating vane anemometer and temperature measurements by accurately calibrated mercury-in-glass thermometers. Computed ratings shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current, whereas noise level at various locations within the conditioned spaces shall be measured by a sound pressure level meter.

NOTE:

i. All measuring instruments such as thermometer, Psychometric, Pressure gauges, anemometers, Flow meter, dB Meter, Tong tester, etc. or any other necessary instrument shall be arranged by the AC contractor at his own expense.

ii. The instruments shall be new and shall have a valid calibration certificate from a renowned test lab.

iii. The plant will be run initially, and all equipment's shall be adjusted to give desired results as per contract. Thereafter, the plant shall be testing for 96 hours as described above and the readings shall be demonstrated in the required format. The test shall be witnessed by the owners and engineer in charges representative. In case the conditions are not achieved during the initial run test the plant shall be readjusted and the new dates for tests shall be determined. The entire test shall be repeated, and satisfactory results shall have to be obtained. Only after satisfactory test shall the installation be taken over by the customer and warranty period for one year shall commence.

iv. The test readings shall be suitably adjusted for the absence of Peak ambient conditions, fouling factor, and available load.

v. The snag list prepared jointly after initial test shall be attended to by the vendor for a maximum of 30 days from the start of warranty period. Failure to do so shall result in corresponding increase in the warranty period.

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Project : **Preparation of Detailed Master Plan for 30 years & Detailed Architectural model building for SEEPZ-SEZ, Mumbai**

Subject: **PACKAGE 2, KD 1: Plumbing and Fire Fighting Technical Specifications of Model Building NEST-3**

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TECHNICAL SPECIFICATIONS – PLUMBING AND FIRE FIGHTING

SPECIAL CONDITION OF CONTRACT

1. SCOPE OF WORK

Work under this contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely furnish all the Plumbing and other specialized services as described hereinafter and as specified in Plumbing/Firefighting System Drawings.

Without restricting to the generally of the foregoing shall include the following:-

a) Supplying & Fixing of Sanitary Fixtures.

b) Soil, Waste, Rain Water and Vent Pipes.

c) Water supply including Hot & Cold (Internal & External).

d) Pumps, water treatment & allied works.

e) External Sewerage system.

f) Storm Water Drainage System.

g) Effluent Treatment Plan (ETP)

h) Fire Fighting System.

The Contractor must get acquainted with the proposed site for the works and study Specifications and Conditions carefully before Tendering. The work shall be executed as per programme approved by the Engineer-in- Charge. If part of site is not available for any reason or there is some unavoidable delay in supply of materials stipulated by the Owner, the programme of construction shall be modified accordingly and the Contractor shall have no claim for any extras or compensation on this account.

Works area shall be the area shown in the drawing.

2. SPECIFICATIONS

Work under this contract shall be carried out strictly in accordance with Specifications attached with the Tender & as per C.P.W.D. specifications latest version Volumes I to VI.

Items not covered under these Specifications due to any ambiguity or misprints, or additional works, the work shall be carried out as per Specifications of the latest Central Public Works Department with latest amendments as applicable in the contract.

Works not covered as mentioned above shall be carried out as per relevant Indian Standards Specifications or Codes of Practice.

The work shall be carried out strictly as specified in Drawings & Technical Specifications. In case of any ambiguity, the details of particular item as given in specification shall supersede the details in Drawings.

3. EXECUTION OF WORK

The work shall be carried out in conformity with the individual services drawings and within the requirements of Architectural, HVAC, Electrical, Structural and Other specialized services drawings.

The Contractor shall cooperate with all trades and agencies working on the site. He shall make provision for hangers, sleeves, structural openings and other requirements well in advance to prevent hold up of progress of the construction programmed.

On award of the work, Contractor shall submit a programmed of construction in the form of a PERT Chart or Bar Chart for approval of the Engineer-in- Charge All dates and time schedule agreed upon should be strictly adhered to, within the stipulated time of completion/commissioning along with the specified phasing, if any.

4. DRAWINGS

All the drawings are diagrammatic but shall be followed as closely as actual construction permits. Any deviations made shall be in conformity with the Architectural and other services drawings.

Architectural drawings shall take precedence over Plumbing or other services drawings as to all dimensions.

Contractor shall verify all dimensions at site and bring to the notice of the Architects or Engineer-in-Charge all discrepancies or deviations noticed. Architects decision shall be final.

Large size details and manufacturers dimensions for materials to be incorporated shall take precedence over small-scale drawings.

All drawings supplied with the Tender shall be returned in good conditions along with the Tender.

All drawings/sketches issued by the Architects/Consultant for the works are the property of the Architects/Consultant and shall not be lent, reproduced or used on any works other than intended without the written permission of the Architects/Consultant.

5. INSPECTION AND TESTING OF MATERIALS

Contractor shall be required, if requested, to produce manufacturers Test Certificate for the particular batch of materials supplied to him. The tests carried out shall be as per the relevant Indian Standards.

For examination and testing of materials and works at the site Contractor shall provide all Testing and Gauging Equipment necessary but not limited to the followings:-

a) Theodolite

b) Dumpy level

c) Steel tapes

d) Weighing machine

e) Plumb bobs, Spirit levels, Hammers

f) Micrometres

g) Thermometers, Stoves

h) Hydraulic test machine

i) Smoke test machine

All such equipment shall be tested for calibration at any approved laboratory, if required by the Engineer-in-Charge.

All Testing Equipment shall be preferably located in special room meant for the purpose.

6. METRIC CONVERSION

All dimensions and sizes of materials and equipment given in the Tender document are commercial metric sizes.

Any weights, or sizes given in the Tender having changed due to metric conversion, the nearest equivalent sizes accepted by Indian Standards shall be acceptable without any additional cost.

7. REFERENCE POINTS

Contractor shall provide permanent Bench Marks, Flag Tops and other reference points for the proper execution of work and these shall be preserved till the end of the work.

All such reference points shall be in relation to the levels and locations given in the Architectural and Plumbing drawings.

8. SHOP DRAWINGS

The Contractor shall submit to the Engineer-in-Charge six copies of the shop drawings.

Shop drawings shall be submitted under following conditions:-

- Contractor shall prepare shop drawings of plumbing / Firefighting etc, for the entire hospital within four weeks of the award of work. These drawings shall be submitted to the Engineer-in-Charge for approval and the work shall be executed at site on the basis of these approved drawings.
- Large scale drawings showing typical details for Toilets & Fixtures.
- Equipment layout, piping and wiring diagram.
- Structural supports/hanging/laying and jointing details for all types of pipes as required.
- Layout plans as required and for any changes in the layout of Plumbing / Architectural Drawings.

9. AS BUILT DRAWINGS

The Contractor shall maintain one as built copy of all Drawings, Specifications, Addenda variations, approved submittals, correspondence, and transmittals at the site in good order and readily available to the Owner and the Engineer-in-Charge. The As built Drawings shall be clearly and correctly marked and as built specifications annotated by the Contractor to show all changes made during the construction process at the time the changed Work is installed. No such changes shall be made in the Work unless previously authorized by the change order or by specific approval of deviations or revisions in submittals.

The Contractor shall prepare and furnish to the Architect / services consultant accurate as built drawings. Architect / Services consultant shall approve these drawings after due verification at site. After approval, the contractor shall submit to Engineer-in-Charge, A1 size three (3) black line white paper prints as well as soft copy in form of CD of each drawing as part of close out documents. Project manager shall forward the same to the owner for their records and for maintenance and operation.

The as built drawings must have the following information:

- The works as executed complete with :
- Run of all piping & diameters on all floors and vertical stacks.
- Ground and invert levels of all drainage pipes together with location of all manholes and connections up to our fall.
- Run of all water supply lines with diameters, locations, of Control Valves, Access Panels.
- Location of all Mechanical equipment with whole plant layout, piping connections and panels as erected.
- Details of supports left in place and locations of all services encountered.
- Complete schematic diagram of the installation, as installed.
- ETP System layout and Schematic of the system

10. CONTRACTORS RATES

Rates quoted in this Tender shall be inclusive of cost of materials, labour, supervision, erection, tools, plant, scaffolding, service connections, transport to site, taxes, breakage, wastage, sales tax on works contract and all such expenses as may be necessary and required to completely do all the items of work and put them in a working condition.

Rates quoted are for all heights and depths required for this work.

All rates quoted are inclusive of cutting holes and chases in walls and floors and making good the same with cement mortar/concrete of appropriate mix and strength as directed by Engineer-in-Charge. Contractor shall provide holes, sleeves and recesses in the concrete and masonry work as the work proceeds.

Rates quoted shall be inclusive of cost incurred in testing, commissioning of works and materials.

11. TESTING

Piping and drainage works shall be tested as specified under the relevant clauses of the specifications.

Tests shall be performed in the presence of the Engineer-in-Charge / Consultant.

All materials and equipment found defective shall be replaced and whole work tested to meet the requirements of the specifications.

Contractor shall perform all such tests as may be necessary and required by the local authorities to meet Municipal or other bye-laws in force.

Contractor shall provide all labour, equipment and materials for the performance of the tests.

Contractor shall afford all the expenses for the offsite testing of material and equipment

12. SITE CLEARANCE AND CLEANUP

The Contractor shall, from time to time clear away all debris and excess materials accumulated at the site.

After the Fixtures, equipment and appliances have been installed and commissioned, Contractor shall clean-up the same and remove all plaster, paints stains, stickers and other foreign matter of discoloration leaving the same in a ready to use condition.

On completion of all works, Contractor shall demolish all stores, remove all surplus materials and leave the site in a broom clean condition, failing which the same shall be done at Contractors risk and cost.

13. LICENSE AND PERMITS

Contractor must hold a valid Plumbing license issued by the Municipal Authority or other competent authority under whose jurisdiction the work falls.

Contractor must keep constant liaison with all relevant authorities and shall be responsible for obtaining all approvals relating to water supply, sewerage, drainage and firefighting system. He shall also be responsible for co-ordination for getting the approval , with other agencies working on the project relating to their scope of work.

Contractor shall obtain No Objection Certificate before commencement of work, from the local authorities all related to his work as required for the building.

Contractor shall obtain, from the local authorities all related completion certificates with respect to his work as required for occupation of the building.

All inspection fees or submission fees paid by the Contractor shall be reimbursed by the Owner on production of valid official receipts.

14. CUTTING & MAKING GOOD

No structural member shall be chased or cut without the written permission of the Engineer-in-Charge.

15. MATERIALS

All materials used in the works shall conform to the Tender specifications.

As far as possible materials bearing I.S. certification marks shall be used with the approval of the Engineer-in-Charge.

Unless otherwise specified and expressly approved in writing by the Engineer- in-charge, materials of makes and specifications mentioned with Tender shall be used.

TECHNICAL CONDITION OF CONTRACT

SECTION – I SANITARY FIXTURES & FITTINGS

16. SCOPE OF WORK

- Work under this section shall consist of furnishing all labor as necessary and required to completely install all Sanitary Fixtures, Brass and Chromium plated fittings and accessories as required by the drawings and specified hereinafter.
- Without restricting to the generally of the foregoing the Sanitary Fixtures shall include all Sanitary Fixtures, C.P. fittings and Accessories etc. necessary and required for the Building.
- Whether specifically mentioned or not all Fixtures and appliances shall be provided with all fixing devices, nuts, bolts, screws, hangers as required.
- Testing of all fixture and fittings.

17. GENERAL REQUIREMENTS

- All Fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Drawing, Specifications and Drawings.
- All Fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per Architectural/Interior designer's requirements. Wherever necessary the fittings shall be centered to dimensions and pattern desired.
- Fixing screws shall be half round head Chromium Plated brass with C.P. washers wherever required as per directions of Engineer-in-Charge.
- All Fittings and Fixtures shall be fixed in a neat workmanlike manner true to Levels and Heights shows on the drawings and in accordance with the manufacturer's recommendations. Care shall be taken to fix all Inlet and Outlet Pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling or terrace shall be made good at Contractors cost.
- When directed, Contractor shall install Fixtures and accessories in a mock-up room for the approval of the Engineer-in-Charge Sample room Fixtures may be reused on the works if undamaged, but no additional payment for fixing or dismantling shall be admissible.

17.1. Supporting and Fixing Devices

The contractor shall provide all supporting and fixing devices necessary to install the sanitary fixtures and fittings securely in position. The fixing devices shall be rigidly anchored into the building structure. The devices shall be rust resistant and shall be so fixed that they do not present an unsightly look in the final assembly. Where the location demands, the Architects may instruct the contractor to provide chromium plated or other similarly finished fixing devices. In such circumstances the contractor shall arrange to supply fixing devices and install them complete with appropriate vibration isolating pads, washers and gaskets.

17.2. Final Installation

The contractor shall install all sanitary fixtures and fittings in their final position in accordance with approved trial assemblies and as shown on drawings. The installation shall be complete with all supply and waste connections. The connection between building piping system and the sanitary fixtures shall be through proper unions and flanged to facilitate removal/replacement of sanitary fixtures without disturbing the built in piping system. All unions and flanges shall match in appearance with other exposed fittings.

Fixtures shall be mounted rigid, plumb and true to alignment. The outlets of water closet pans and similar appliances shall be examined to ensure that outlet ends are butting on the receiving pipes before making the joints. It shall be ensured that the receiving pipes are clear of obstruction. When fixtures are being mounted, attention shall be paid to the possibility of movement and settlement by other causes. Overflows shall be arranged as to give visible warning and discharge. A check shall be made to ensure that necessary anchoring devices have been provided for supporting water closets, wash basins, sinks and other appliances.

Joints/gaps between all sanitary appliances/fixtures and the floor/walls shall be caulked with an approved mildew resistant sealant, having antifungal properties, of color and shade to match that of the appliances/fixture and the floor/wall to the extent possible.

17.3. Protection against Damage

The contractor shall take every precaution to protect all sanitary fixtures against damage, misuse, crazing, staining breakage and pilferage by providing proper wrapping and locking arrangement till the completion of the installation. At the time of handing over, the contractor shall clean, disinfect and polish all fixtures and fittings. Any fixtures and fittings found damaged, cracked chipped, stained or scratched shall be removed and new fixtures and fittings free from defects shall be installed at his own cost to complete the work.

18. EUROPEAN W.C.

European W.C. shall be wash down, single or double siphonic type, wall mounted set, flushed by means of exposed cistern, as specified in Drawing. Flush pipe/bend shall be connected to the W.C. by means of suitable rubber adapter. Wall hung W.C. shall be supported by C.I. floor mounted chair.

Each W.C. seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C.

Each W.C. shall be provided with 110mm dia (OD) PVC connector connecting the ceramic outlet of W.C.

19. URINALS

- Urinals shall be flat back large white glazed Vitreous China as per approved size.
- Flat back Urinals shall be provided with 15 mm dia C.P. spreader, 32 mm dia C.P. domical waste and C.P. cast brass bottle trap with pipe and wall flange, and shall be fixed to wall by one uPVC bracket and two uPVC. wall clips as recommended by manufacturers complete and as directed by Engineer-in-Charge.
- Flat back urinals shall be fixed with C.P. Brass screws and shall be provided with 32 mm dia Domical Waste leading to Urinal trap.
- Urinals shall be flushed by means of sensor operated flush system.

Waste pipes for urinals shall be of the following:

19.1. uPVC Pipes

Waste pipes may be exposed on wall or concealed in chase as directed by the Engineer-in-Charge. Specifications for waste pipes shall be same as given in Sub Section.

20. FLUSHING CISTERN

Flushing cistern shall be concealed or Exposed type design for low volume dual flushes 3 Litres & 6 Litres as directed by Engineer-in-Charge or mentioned in the drawing.

21. LAVATORY BASIN

- Lavatory Basins shall be white glazed vitreous china of size, shape and type as indicated in architectural drawings.
- Each Basin shall be provided with MS. or uPVC Pipe. brackets and clips and the basin securely fixed to wall. Placing of Basins over the brackets without proper securing and fixing shall not be accepted.

- Each Basin shall be provided with 32mm dia C.P. waste with overflow, pop-up waste or rubber plug and chain, 32mm dia C.P. Brass Bottle Trap with C.P. pipe to wall and flange.
- Each basin shall be provided with CP brass push type self-closing pillar tap or Single hole Mixing Fitting as mentioned in the drawing.
- Basins shall be fixed at proper heights as shown on architecture drawings. If height is not specified, the rim level shall be 79 cms above the floor or as directed by Engineer-in-Charge.

22. SINKS

Sinks shall be of precast Terrazzo marble or White Glazed fire clay or vitreous china or stainless steel or any other material as specified in the architectural drawing.

Hand Wash Sinks and Process Sinks shall be of stainless steel.

Each sink shall be provided with M.S. or C.I. brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable angle iron clips or brackets as recommended by the manufacturer. Each sink shall be provided with 40 mm dia C.P. waste with chain and plug or P.V.C. waste. Fixing shall be done as directed by Engineer-in-Charge.

Fittings for sinks shall be mixing fittings or as specified in the architectural drawing.

23. ACCESSORIES

Accessories shall be of any of the following types:

a) Towel rails

Towel rail shall be C.P brass of size 610mm longer as per approved and 20mm dia, and fixing with C.P brass brackets fixed to wooden cleats with C.P. brass screws.

b) Towel rings

Towel rail shall be C.P brass of size 150mm dia, and fixing with C.P brass brackets fixed to wooden cleats with C.P. brass screws.

c) Toilet paper holder

Toilet paper holder shall be of Satin finish stainless steel AISI 316 grade wall mounted type fixed to wooden cleats with C.P. brass screws.

d) Hand Dryer

Hand dryer shall be of best quality, to be operated with 230 volts, single phase, with fully hygienic condition, with all accessories and fixing in the wall as mention in the Architectural drawing or as directed by Engineer-in-Charge.

e) Coat hooks

Coat hooks shall be of satin finish stainless steel AISI 316 grade wall mounted coat hooks fixed to wooden cleats with C.P. brass screws or as directed by Engineer-in-Charge.

f) Soap dispensers

Soap dispensers shall be of satin finish stainless steel AISI 316 grade wall mounted liquid soap dispenser with indicator having bottom trough of soap fixed to wooden cleats with C.P. brass screws or as directed by Engineer-in-Charge.

Accessories shall be fixed with stainless steel half round head screws and cup washers in wall with Rawl plugs or nylon sleeves and shall include cutting and making good.

Porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement : 2 coarse sand) and fixed in relation to the tiling work. The flange of the recessed fixture shall cover the recess in the wall fully.

Contractor shall install all Chromium Plated and porcelain accessories as shown on the drawings or directed by Engineer-in-Charge.

All C.P. Accessories shall be fixed with C.P. brass half round head screws and cup washers in wall with Rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by Engineer-in-Charge.

Porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work.

24. URINAL PARTITIONS

Urinal partitions shall be white glazed vitreous china or 25mm/40 mm thick marble of size of 690x325mm or as per approved sample.

Porcelain partitions shall be fixed at proper heights with C.P. brass bolts, anchor fasteners and M.S. clips as recommended by the manufacturer and directed by Engineer-in-Charge.

25. TOILET FOR THE DISABLED

Where specified, in washroom facilities designed to accommodate physically disabled , accessories shall be provided as per the NBC Norms for Disable Persons architectural drawing or as directed by the Engineer-in-Charge.

Stainless steel grab bars of 600mm long suitable for expose mounting and penned non-slip gripping surface shall be provided in washroom for disabled persons. The flushing cistern shall be provided with chromium plated long handles.

26. TESTING AND ACCEPTANCE

Testing is done as per BS-5572 of Make & Model of Sanitary fixture & fittings.

SECTION – II INTERNAL DRAINAGE SOIL, WASTE & VENT PIPES

27. SCOPE OF WORK

Work under this section shall consist of furnishing all labor, materials, equipment's and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes as required by the drawings, specified hereinafter and as directed by the Engineer-in-Charge.

Without restricting to the generally of the foregoing, the soil, waste, vent and rainwater pipes system shall include the followings:-

- Vertical and horizontal Soil, Waste and Vent Pipes, Rainwater Pipes and Fittings, Joints Clamps and connections to Fixtures.
- Connection of pipes to Gully Traps & Manholes etc.
- Floor and urinal traps, cleanout plugs, inlet fittings and rainwater heads as specified.
- Waste pipes connections from all Fixtures e.g. wash basins, sinks, urinals and kitchen equipment.
- Testing of all pipes.

28. GENERAL REQUIREMENTS

- All materials shall be new of the best quality conforming to specifications and subject to the approval of Engineer-in-Charge.
- Soil, waste and vent pipes in shafts, ducts and in concealed areas i.e. (false ceiling) shall consist of uPVC, SWR Pipe.
- Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified. Pipes shall as far as possible be kept 50mm clear of wall.
- Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.
- Every waste pipes shall discharge above the grating of properly trapped gully. Contractor will ensure that this requirement is adequately met with. Wherever floor traps are provided it shall be ensured that at-least one washbasin/washing trough is connected to such floor traps to avoid drying of water seal in the trap.
- All traps on branch soil and waste pipes shall also be ventilated at a point not less than 75mm or more than 300mm from their highest part and on the side nearest to the soil pipe or waste pipe.
- All works shall be executed as directed by Engineer-in-Charge.

28.1. Soil, Waste & Vent Pipes

a) The Soil & Waste pipe system above ground has been planned as a "two pipe system" as defined in IS: 5329, having separate pipes for waste from kitchen sinks, showers, washbasins, AHU's condensate drains and floor drains . Waste stacks have been provided with a “P” trap at basement ceiling.

b) All waste water from AHU's, A.C. plant and pump rooms, floor channels in basements will be provided with a deep seal trap before connecting to the main drain or vertical stack.

c) Vertical soil & waste stacks shall be connected to a common horizontal drain pipe at basement ceiling or to an external manhole directly wherever feasible as shown on the drawings.

d) All soil and waste from areas below general ground level (Basements) will be collected in sumps and pumped into sewer lines.

e) Anti-siphonage pipe (ASP) shall be provided for soil fittings on vertical stacks. It may also be provided for waste lines where shown on the drawings.

f) Vent pipes shall be provided at all sewer lines at the starting manholes.

g) Waste pipe used in kitchen area shall be Cast Iron Pipes. All pipes shall be straight and smooth and inside free from irregular bore, blowholes, cracks and other manufacturing defects. Pipes shall be centrifugally cast (spun) iron pipes conforming to I.S:3989.

28.2. Rainwater Pipes

a) All terraces shall be drained by providing down-takes rainwater pipes.

b) A separate piped drainage system for slopping roof with leaders shall be provided.

c) Rainwater pipes are separate and independent connected to the external storm water drainage system as shown on the drawings.

d) Rainwater in enclosed courtyards shall be collected in catch-basins and connected to storm water drains.

e) Any dry weather flow from waste appliances, AHU's pump rooms, shall be connected to the sewerage system only.

28.3. Balcony/Planter drainage

Open balconies, terraces, planters and formal landscape areas will be drained by a separate pipe connected to external storm water drainage system.

28.4. Polypropelene pipe for Soil, waste & uPVC pipes rain water

Pipes

a) All pipes shall be straight and smooth and inside free from cracks and other manufacturing defects. Pipes shall be conforming to I.S. 13952 type A for rain water & I.S. 13952 type B for soil and waste.

b) Pipes shall be joined by approved type of socket and 'O' rubber ring (confirms to I.S. 5382) joints with rubber lubricant.

Fittings

a) Fittings shall conform to the Indian Standard recommended for the pipes. Pipes and fittings must be of matching I.S. Specification. Interchange of pipes of one standard with fittings on the other standard will not be permitted.

b) Fittings shall be of the required degree of curvature with or without access door.

c) Connection from a vertical stack or position to a horizontal line shall be made only by a "Y" junction.

Fixing

All vertical pipes shall be fixed truly vertical to walls with approved type of uPVC saddle clamp. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard). However shaft where more vertical pipes run, the pipes may be fixed to the slotted angle/channel supports fixed to walls at intervals specified here under:-

a) Horizontal pipes running along ceiling shall be fixed on galvanized structural adjustable clamps (Clevis clamps) of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.

b) Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the Engineer-in-charge for making such provisions in the

c) structure as necessary. All damages shall be made good to restore the surfaces at no extra cost.

Clamps

a) Holder bat clamps shall be of standard design and fabricated from galvanized M.S. standard flats 40x3 mm thick and 12 mm dia M.S. Rod and 6 mm nuts and bolts. Holder bat clamps shall be fixed in cement concrete 1:2:4 mix blocks 10x10x10 cms deep.

b) Where holder bat clamps are to be fixed in RCC column or slotted angles, walls or beam they shall be fixed with galvanized 40x3 mm flat iron "U" type clamps with anchor fasteners of approved design or 6 mm nuts and bolts.

c) For SWR pipes conforming to IS 13592 shall be clamped to wall with approved type of uPVC saddle clamp/ U-clamp or as given in the Bill of quantities.

d) Structural clamps shall be fabricated by electro-welding from M.S. structural members e.g. rods, angles, channels flats as per detailed drawing. Contractor shall provide all nuts & bolts, welding material. All fabricated clamps, nuts, bolts and washers shall be not dipped galvanized.

e) Galvanized slotted angle/channel supports on walls shall be provided wherever shown on drawings. Angles/channels shall be of sizes shown on drawings or specified in schedule of quantities. Angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with suitable anchor fasteners. The spacing of support bolts horizontally shall not exceed 1 m.

f) Wherever M.S. clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement and making good with cement concrete 1:2:4 mix (1 cement :2 coarse sand :4 mm stone aggregate 20 mm nominal size) as directed by the Engineer-in-Charge.

For sleeves, anchor fasteners and clamp spacing chart shall be as follows:

Table 28-1Clamp and Pipe Support Spacing

S.No.	Type of Pipes & Position	15/20	20/25	32/40	50	75/80	100/110	150/160
1	**Vertical Pipes**							
1.1	**GI /MS Pipes**	**2.4**	**2.4**	**3**		**3.6**	**4.5**	**5.4**
1.2	uPVC Pipes							
	SWR Pipes	x	x	<---------- 1 m ---------->				
	IS 13592							
1.3	uPVC /cPVC Pipes							
	IS 4985 for Water Supply	x	x	x		<----------1 m---------->		
	IS 13585 for SWR	x	x	0.5		0.7	0.9	0.9
2	**Horizontal Pipes**							
2.1	GI /MS Pipes	<------2.0 m ------>		2.4 m	3	3.6	4	4.5
2.2	uPVC pipes							
	SWR Pipes			<---------- 1.0 m ---------->				
	IS							
	Water Supply Pipes uPVC					<----------1 m---------->		
	IS 4985							
2.3	Fittings	All traps and tees and fittings runing below ceiling shall be supported on both sides						

Urinal traps

Urinal traps/horn shall be cast iron P or S traps with or without vent shall be fixed as specified for floor traps.

Floor trap inlet

- Bath room traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a special type inlet fitting fabricated from uPVC pipe without, with one, two or three inlet sockets fixed on side to connect the waste pipe.
- Joint between waste and hopper inlet socket of the trap shall be joined with solvent cement recommended by the manufacturer. Inlet shall be connected to a uPVC. P or S trap.
- Floor trap inlet hoppers and the traps if set in cement concrete blocks as specified in para above without extra charge. uPVC multi-inlet trap can be used where ever possible to be decided by the Engineer-in-Charge.

Trap & Seals

All traps shall be self-cleaning design and the seal depth shall be as specified below wherever the traps are not integral with the appliances:

Table 28-2 Seal Depth Details

Appliance or ware	Material	Trap Type	Seal depth(mm)
Lavatory /wash basin	C.P. cast brass	32 mm dia Bottle	75 mm
Sink	C.P. cast brass	40 mm dia Bottle	75 mm
Kitchen floor drain of fabricated drain boxes	uPVC	75/100 mm dia 'P' or 'S'	50 mm
Urinals	uPVC	100 mm dia 'P' or 'S'	50 mm
AHU's	uPVC	75 mm dia 'P' or 'S'	50 mm

Floor Gratings

Floor and urinal traps shall be provided with 100-150mm square or round C.P./ Stainless steel grating, with rim of approved design and shape. Minimum thickness shall be 4 mm.

Jointing

Pipe to pipe and pipe to fitting (SWR) joint shall be with 'O' rubber ring as recommended by the manufacturer. Jointing with solvent cement shall be applied to uPVC waste pipes (confirming to I.S. 4985) and fittings or as recommended by the manufacturer's.

28.5. Cleanout Plugs (on soil pipes)

uPVC Clean out pipe for Soil, Waste or Rainwater pipes laid under floors shall be provided near pipe junctions bends, tees, "Ys" and on straight runs at such intervals as required as per site conditions. Cleanout pipe shall terminate flush with the floor levels.

Cleanout on Drainage Pipes

- Cleanout pipe shall be provided on starting point of each drain and in between at locations indicated on plans or directed by the Engineer-in-Charge Cleanout pipe shall be of size matching the full bore of the pipe but not exceeding 160 mm OD.
- Cleanouts at ceiling level pipe shall be provided with a bend terminating at floor level above. The cap of the cleanout pipe shall have a cap flush with floor.

28.6. Waste pipe from appliances

General

- Waste pipe from appliances e.g. wash basins, sinks and urinals shall be of uPVC pipes 40, 50 or 63 mm OD conforming to IS:4985 class II (6 kg/cm2)shown on the drawings.

- All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required pipes may be run at ceiling level in suitable gradient and supported on galvanized structural clamps. Spacing for clamps for such pipes shall be as per the pipe spacing chart given in section 1.

28.7. Encasing Pipe in Cement Concrete

uPVC soil and waste pipes and drainage under floor in sunken slabs and in wall chases (when cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement :2 coarse sand : 4 stone aggregate 12 mm size) 75 mm in bed and all-round. When pipes are running well above the structural slab, the encased pipes shall be supported with suitable cement concrete pillars of required height at intervals of one meter.

28.8. Testing

- Testing procedure specified below apply to all soil, waste and vent pipes above ground including pipes laid along basement ceiling.
- Entire drainage system shall be tested for water tightness during and after completion of the installation. No portion of the system shall remain untested. Contractor must have adequate number of expandable rubber/bellow plugs, manometers, smoke testing machines, pipe and fitting work test benches and any other equipment necessary and required to conduct the tests. All testing equipment/motors etc. shall be certified for its calibration by an approved laboratory.
- All materials obtained and used on site must have manufacturer's Hydraulic Test Certificate for each batch of materials used on the site.

28.9. Testing Soil, Waste and Rainwater Pipes

- Apart from factory test all pipes and fittings shall be hydraulically tested for a head of 3 m preferably on a specially set up work bench. After applying pressure, strike the pipe with a wooden pallet and inspect for blow holes and cracks. Pressure may be applied for about 2 minutes. Reject and remove all defective pipes.
- After installation all connections from fixtures, vertical stacks and horizontal drains including pipes along ceiling shall be tested to a hydraulic pressure not exceeding 3 m. Such tests shall be conducted for each floor separately by suitable plugs.
- After the installation is fully complete, it should be tested by flushing the toilets, running at least 20% of all taps simultaneously and ensuring that the entire system is self-draining, has no leakages, blockages etc. Rectify and replace where required.
- Contractor shall maintain a test register identifying date and time of each area. All tests shall be conducted in presence of Engineer-in-Charge and signed by both.

SECTION – III EXCAVATION FOR PIPE LINE

29. EXCAVATION

The excavation for pipe works shall be open cutting unless the permission of the Engineer-in-Charge for the ground to be tunnelled is obtained in writing. Where sewers have to be constructed along narrow passages, the Engineer-in-Charge may order the excavation to be made partly in tunnel and in such cases the excavated soil shall be brought back later on for refilling the trenches or tunnel.

29.1. Opening out Trenches

In excavation the trenches, etc. the solid road metal ling, pavement, curbing etc. and turf is to be placed on one side and preserved for reinstatement when the trenches or other excavation shall be filled up. Before any road metal is replaced, it shall be carefully shifted. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the Engineer-in-Charge and of the Owners of the roads or other property traversed and the Contractor shall not cut out or break down any live fence of trees in the line of the proposed works but shall tunnel under them, unless the Engineer-in-Charge shall order to the contrary.

The Contractor shall grub up and clear the surface over the trenches and other excavations of all trees, stumps roots and all other encumbrances affecting execution of the work and shall remove them from the site to the approval of the Engineer-in-Charge.

29.2. Obstruction of Roads

The Contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street and sufficient space shall then be left for public and private transit, he shall remove the materials excavated and bring them back again when the trench is required to be refilled. The Contractor shall obtain the consent of the Engineer-in-Charge in writing before closing any road to vehicular traffic and the foot walks must be clear at all times.

29.3. Removal of Filth

All night soil, filth or any other offensive matter met with during the execution of the works, immediately after it is taken out of any trench, sewer or cess pool, shall not be deposited on to the surface of any street or where it is likely to be a nuisance or passed into any sewer or drain but shall be at once put into the carts and removed to a suitable place to be provided by the Contractor.

29.4. Excavation to be taken to Proper Depths

The trenches shall be excavated to such a depth that the pipes shall rest on concrete or on firm bedding as described in the several clauses relating to these so that the inverts may be at the levels given in the sections. In bad ground, the Engineer-in-Charge may order the Contractor to excavate to a greater depth than that shown on the drawings and to fill up the excavation to the level of the sewers with concrete, broken stone, gravel or other materials. For such extra excavation and concrete, broken stone, gravel or other materials, the Contractor shall be paid extra at rates laid down for such works in the schedule, if the extra work was ordered by the Engineer-in-Charge in writing, but if the Contractor should excavate the trench to a greater depth than is required without a specific order to that effect in writing of the Engineer-in-Charge the extra depth shall have to be filled up with concrete 1:5:10 mix (1 cement: 5 fine sand: 10 stone aggregate 40mm nominal size) at the Contractor's own costs and charges to the requirements and satisfactions of the Engineer-in-Charge.

29.5. Refilling

After the pipes or other work has been laid and proved to be water tight, the trench or other excavations shall be refilled. Utmost care shall be taken in doing this, so that no damage shall be caused to the sewer and other permanent work. The filling in the haunches and up to 75 cms above the crown of the sewer shall consist of the finest selected materials placed carefully in 15 cms layers and flooded and consolidated. After this has been laid, the trench and other excavation shall be refilled carefully in 15 cms layers with materials taken from the excavation, each layer being watered to assist in the consolidation unless the Engineer-in-Charge shall otherwise direct.

29.6. Contractor to Restore Settlement and Damages

The Contractor shall, at his own costs and charges, make good promptly during the whole period the works are in hand, any settlement that may occur in the surfaces of roads, beams, footpaths, gardens, open spaces etc. Whether public or private caused by his trenches or by his other excavations and he shall be liable for any accidents caused thereby. He shall also, at his own expenses and charges, repair and make good and damage done to buildings and other property. If in the opinion of the Engineer-in-Charge he fails to make good such works with all practicable dispatch, the Engineer-in-Charge shall be at liberty to get the work done by the Contractor or deducted from any money that may be or become due to him or recovered from him in any other manner according to the law of the land.

29.7. Disposal of Surplus Soil

The Contractor shall at his own costs and charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled the surplus soil shall be immediately removed, the surface properly restored and roadways and sides left clear.

29.8. Timbering of Sewer and Trenches

The Contractor shall at all times support efficiently and effectively the sides of the sewer trenches and other excavations by suitable timbering, piling and sheeting and they shall be close, timbered in loose or sandy strata and below the surface of the sub soil water level.

All timbering, sheeting and piling with their waling and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse or subsidence of the walls of the trench shall take place.

The Contractor shall be held responsible and will be accountable for the sufficiency of all timbering, branches, sheeting and piling used as also for all damage to persons and property resulting from improper quality, strength, placing, maintaining or removing of the same.

29.9. Shoring of Buildings

The Contractor shall shore up all buildings, walls and other structures, the stability of which is liable to be endangered by the execution of the work and shall be fully responsible for all damages to persons or property resulting from any accident.

29.10. Removal of Water from Sewer, Trench etc.

The Contractor shall at all times during the progress of the work keep the trenches and excavations free from water which shall be disposed off by him in a manner as will neither cause injury to the public health nor to the public or private property nor to the work completed or in progress nor to the surface of any roads or streets, nor cause any interference with the use of the same by the public.

29.11. Width and Depth of Trench

The Engineer-in-Charge shall have power by giving an order in writing to the Contractor to increase the maximum width in respect of which payment will be allowed for excavation in trenches for various classes of sewer, manholes, and other works in certain lengths to be specifically laid down by him, where on account of bad ground or other unusual conditions, he considers that such increased widths are necessary in view of the site conditions.

SECTION – IV WATER SUPPLY SYSTEM (COLD & HOT)

30. SCOPE OF WORK

- Work under this section consists of furnishing all labor, materials equipment and appliances necessary and required to completely install the water supply system as required by the drawings & specified hereinafter.
- Without restricting to the generality of the foregoing, the water supply system shall include the following:-
  - i) Municipal water connection including water meter up to U.G. water tanks.
  - ii) Piping from tube well to raw water tank
  - iii) Domestic & Flushing water transfer to OHT.
  - iv) Distribution system from overhead tank to single toilet in the building.
  - v) Excavation and refilling of pipes trenches.
  - vi) Control valves, masonry chambers and other appurtenances.
- All water lines to different parts of building and making connection from source etc.
- Pipe protection and painting.
- Providing Hot water supply and return lines and insulation of hot water pipe lines.
- Control valves, masonry chambers and other appurtenances.
- Connections to all toilets kitchen equipment's, tanks and appliances.
- Excavation and refilling of pipe trenches, wherever necessary.
- Trenches for taking pipe lines for these services if required.

31. GENERAL REQUIREMENTS

- All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Engineer-in-Charge.
- Pipes and Fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- Short or Long bends shall be used on all main pipe lines as far as possible. Use of Elbows shall be restricted for short connections.
- As far as possible all Bends shall be formed by means of a hydraulic pipe bending machine for pipes up to 65mm dia.
- Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.
- As far as possible, all piping inside the buildings shall run either concealed or embedded. Outside the buildings the piping shall be installed at-least 60cms below finished grade. All galvanized steel piping embedded either in trenches or in concrete and masonry work shall be tightly wrapped 1mm thick fiberglass tissue laid in bitumen.
- Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

Water Supply System

- Contractor should study the site plan and water supply system diagram for an overview of the system.

Source

a. Water supply will be acquired from Municipal water mains through a service connection

b. Additional water supply will be obtained from captive tube-wells within the site. The rising mains will be connected to the main fire static tank and then overflow into the main domestic water tank.

Water supply piping for garden hydrant and sprinkler and irrigation system will be separate and independently connected to a different pumping system.

32. CLAMPS

G.I. pipes in shafts and other locations shall be supported by galvanized clamps of design approved by Engineer-in-Charge Pipe in wall chases shall be anchored by iron hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from galvanized structural as described in the sub section. Pipes in typical shafts shall be supported on Slotted Angles/Channels as specified elsewhere.

Pipe hangers shall be provided at the following maximum spacing:

Table 32-1 Spacing between the Pipe Hangers

S. No.	Pipe Dia (mm)	Hanger Rod Dia (mm)	Spacing between Supports (Mtr)
1	Up to 25	6	2
2	32 to 50	10	2
3	65 to 100	12	2.4
4	125 to 150	16	3.6
5	200 to 300	19	5.3

33. UNIONS

Contractor shall provide adequate number of unions on all pipes to enable dismantling later. Unions shall be provided near each Gunmetal Valve, Stop Cocks, or Check Valves and on straight runs as necessary at appropriate locations as required and/or directed by Engineer-in-Charge.

34. FLANGES

Flanged connections shall be provided on pipes where shown on the drawings, all equipment connections as necessary and required or as directed by Engineer-in-Charge Connections shall be made by the correct number and size of the bolts and made with 3 mm thick insertion rubber washer. Where hot water or steam connections are made insertion gasket shall be of suitable high temperature grade and quality approved by Engineer-in-Charge Bolt hole dia for flanges shall conform to match the specification for C.I. Sluice Valve to I.S. 780.

35. TRENCHES

The galvanized iron pipes and fittings shall be laid in trenches. The width and depth of the trenches for the different diameters of the pipes shall be as follows:

Table 35-1Dimensions of Trenches

Dia of Pipe	Width of Trench	Depth of Trench
15mm to 50mm	30 cms	60 cms
65mm to 100mm	45 cms	75 cms

At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earth work in trenches.

When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.

36. PAINTING

All pipes above ground shall be painted with one coat of Red Lead and two coats of Synthetic Enamel paint of approved shade and quality. Pipes shall be painted to standard color code specified by Engineer-in-Charge.

All pipes in chases and below floor shall be provided with Anti-corrosive treatment.

37. PIPE PROTECTION

Where specified in the Drawing all pipes below ground shall be protected against corrosion by wrapping 100mm wide and 4mm thick layer of PYPKOTE/MAKPOLYKOTE over the pipe.

37.1. Sand Filling

All G. I. pipes in trenches shall be protected with fine sand 150 mm all around before filling in the trenches.

38. GUNMETAL VALVES

Valves 65mm dia and below shall be heavy Gunmetal Full way Valves or Globe Valves or Ball valves conforming to IS: 778-1971 of 20 Kg/cm2 class. Valves shall be tested at manufacturer's works and the same stamped on it.

All Valves shall be approved by the Engineer-in-Charge before they are allowed to be used on work.

39. SLUICE VALVES

All valves 80mm dia and above shall be C.I. Double Flanged Sluice Valves. Sluice valves shall be Cast Iron double flanged, with rising spindle. Each sluice valve shall be provided with wheel for valves in exposed positions and Cap Top for underground valves. Contractor shall provide suitable operating keys for Sluice Valves with Cap Tops.

Sluice valves shall be of best quality conforming to IS: 780-1969 of class specified.

- Joints for double flanged sluice valves shall be made with suitable tail/socket pieces on the pipeline and flanges joints made with 3 mm thick insertion rubber gasket with appropriate number of bolts, nuts and washers.
- Sluice valves shall be installed at all branches and as shown on the drawings.

39.1. Scour Valves

Scour valves shall be C.I. sluice valves as specified above. They shall be installed at the lowest level or tail end of the system as shown on drawings and directed by Engineer-in-Charge.

39.2. Air Release Valves

- Air release valves shall be single acting type air valves with Gunmetal body and bronze/gunmetal internal parts and plastic float.
- Each air release valve shall be provided with a cast iron isolating sluice valve of specification given above.

39.3. Pressure Release Valves

- pressure relief valves are designed to limit the upstream pressure by opening at a preset value and discharging the medium. Range includes pressure relief valves in different mounting styles and for a application areas: toilets, for the use in hydraulic and pneumatic systems body of PRV shall be SS.

40. INSULATION

40.1. For Chased Internal Pipes

- Hot water pipes fixed in chase shall be thermal insulation over hot water pipes with 9mm thick nitrile or approved equivalent thermal insulation tubing, a elastomeric flexible material having hermetic blister closed cell structure of expanded synthetic rubber having a thermal conductivity not exceeding
- 0.040w/m°k @ 40deg C over pipes.

40.2. For Exposed Piping

Exposed hot water line laid in trenches, exposed in shafts, on terrace and along ceiling level shall be thermal insulation over hot water pipes with 9mm thick nitrile/ polyolefin or approved equivalent thermal insulation tubing, a electrometric flexible material having hermetic blister closed cell structure of expanded synthetic rubber having a thermal conductivity not exceeding 0.040w/m°k @ 40 deg Cover pipes. With Aluminium Cladding/ protective coating of resin hardener paint with fibre cloth (FRP)

Table 40-1 Details of Insulation

S.No	Pipe Size (MM)	Thickness of Nitrile Rubber Insulation (MM)
1	15 to 25	9
2	32 to 80	13
3	100 & above	19

40.3. Anchor Block

Suitable anchor blocks shall be provided at all bends and tees to encounter the excessive thrust developed due to water hammer.

41. CPVC PIPES

All pipes inside the buildings and where specified, outside the building shall be CPVC pipes tubes conforming to IS 15778:1996 .Specific Gravity ASTM D 792 at 230C should be 1.55 as specified. With Tensile Strength as per ASTM D 638 at 230C should be 55N/mm2.

41.1. Joining Pipe & Fittings

Cutting

- Pipes shall be cut either with a wheel type plastic pipe cutting or hacksaw blade and care shall be taken to make a square cut which provides optimal bonding area within a joint.

Deburing / Bevelling

- Burrs and fittings should be removed from the outside and inside of pipe with a pocket knife or file otherwise burrs and fittings may prevent proper contact between pipe and fitting during assembly.

Fitting Preparation

- A clean dry rag/cloth should be used to wipe dirt and moisture on the fitting sockets and tubing end. The tubing should make contact with the socket wall 1/3 or 2/3 of the way into the fitting socket.

Solvent Cement Application

- Only CPVC solvent cement confirming to ASTM-F493 should be used for joining pipe with fittings. CPVC schedule 40 & 80 heavy bodied CPVC solvent cement only should be used confirming to ASTM-F493.

Assembly

- After applying the solvent cement on both pipe and fitting socket, pipes should be inserting into the fitting socket within 30 seconds, and rotating the pipe ¼ to ½ turn while inserting so as to ensure even distribution of solvent cement with the joint. The assembled system should be held for 10 seconds (approx.) in order to allow the joint to set up.
- An even bead of cement should be evident around the joint and if this bead is not continuous, remake the joint to avoid potential leaks.

Set & Cure times

- Solvent cement set & cure times shall be strictly adhered to as per the below mentioned table:
- Minimum Core prior to pressure testing at 150 PSI

Table 41-1 Time for Curing

S.No.	Ambient Temperature during Core period	Pipe Size	
		½" to 1"	1.1/4" to 2"
1	Above 15 deg C	1 Hr	2 Hrs
2	4 – 15 deg C	2 Hrs	4 Hrs
3	Below 4 deg C	4 Hrs	8 Hrs

- Once an installation is completed and cored as per above mentioned recommendations, the system should be hydrostatically pressure tested at 150 PSI (10 Bar) for minimum 24hrs.During pressure testing the system should be filled with water and if a leak is found, the joint should be cut out and replacing the same with new one by using coupler.

Transition of CPVC to Metals

- When making a transition connection to metal threads, special brass/plastic transition fitting (Male & Female adopters) should be used. Plastic threaded connection should not be over torque hard tight plugs one half turn should be adequate.

Threaded Sealants

- Teflon tapes shall be used to make threaded connection leak proof.

Hangers & Supports

- For horizontal runs, support should be given at 3 ft (90 cms) intervals for diameter of 1" and below and at 4 ft (1.20 mtr) intervals for larger size.
- Hangers should not have thrown or sharp edges which come in contact with the tubing and shall be of GI.
- Support should be as per the below mentioned table:

Table 41-2 Hangers & Supports

S. No	Size of Pipe Inch	210C Ft	490C Ft	710C Ft	820 C Ft
1	½"	5.5	4.5	3.0	2.5
2	¾"	5.5	5.0	3.0	2.5
3	1"	6.0	5.5	3.5	3.0
4	11/4"	6.5	6.0	3.5	3.5

S. No	Size of Pipe Inch	210C Ft	490C Ft	710C Ft	820 C Ft
5	11/2”	7.0	6.0	3.5	3.5
6	2”	7.0	6.5	4.0	3.5

- All special fittings and accessories like internally or externally threaded brass adaptors, ball valves, globe valves, unions, diaphragm valves, butterfly valves, etc shall be made of CPVC by licensee.
- The CPVC solvent cement used for installing CPVC piping systems shall conform to ASTM F493. Pipes from ½” up to 2” pipes and fittings, single step medium bodied CPVC solvent cement should be used. For CPVC pipes and fittings upwards of 2”, a primer shall be used followed by heavy bodied solvent cement conforming to ASTM F493.
- ***PVC solvent cement should not be used.***

41.2. Concealed Plumbing

All internal concealed plumbing for water supply shall be done with CPVC pipes. The pipes & fittings shall conform to CTS (Copper Tube Size) SDR-11 as per ASTM D2846. All pipes and fittings from ½” up to 2” shall come under this category. Medium body CPVC solvent cement conforming to ASTM F493 should be used for joining pipes to fittings.

41.3. Installation procedure

All parameters pertaining to the installation of CPVC plumbing system such as cutting, joining, support spacing, expansion loops, insulation, type of support, special connections, etc. shall be as per the manufacturer’s specifications.

42. VALVE CHAMBERS

Contractor shall provide suitable brick masonry chambers in cement mortar 1:5 (1 cement: 5 coarse sand) on cement concrete foundations 150 mm thick 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) 12 mm thick cement plaster inside and outside finished with a floating coat of neat cement inside with cast iron surface box as approved or as specified in Drawing and in drawings including excavation, back filling complete.

43. WATER METERS

- Water meters of approved make and design shall be supplied for installation at locations as shown in drawing The water meters shall meet with the approval of the local municipal authorities. Suitable valves and chambers to house the meters shall also be provided along-with the meters.
- All meters shall conform to Indian Standard IS: 779-1978 (Water meters-domestic type) and IS: 2373-1981 (water meters-bulk type). Where called for water meters shall be located in masonry chambers of appropriated size

44. PIPE HANGERS BRACKETS ETC.

- Sturdy hangers, brackets and saddles of approved design shall be installed to support all pipe lengths which are not embedded over their entire run. The hangers and brackets shall be of adjustable heights and primer coated with red-oxide primer clamps. Collars and saddles to hold pipes shall be provided with suitable gaskets. The brackets and hangers shall be of Mild Steel designed to carry the weight of pipes safely and without excessive deflections.
- All pipes and fittings shall be supported near every joint and half-way through every pipe length unless otherwise specified. Where called for, pipe hangers shall also be supplied with proper sound and vibration dampening devices to minimize noise and vibration transmission.

45. TESTING

- All pipes, fittings and valves shall be tested by hydrostatic pressure of min. 1.5 times, the working pressure and subject to minimum of 7 kg/cm2 in any case and with the consent of Engineer-in-Charge.
- Pressure shall be maintained for a period of at least TWELVE hours without appreciable drop in the pressure after fixing at site. (+10 %). A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and Engineer.
- In addition to the sectional testing carried out during the construction, Contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages, and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes or failure of fittings, to the building, furniture and Fixtures shall be made good during the defects liability period without any extra cost.
- After completion of the water supply system, Plumbing Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones at no extra cost and the same shall be tested as above.

46. CONNECTIONS TO WATER TANKS

- The contractor shall provide all inlets, outlets, washouts, vents, ball cocks, overflow, control valves and all such other piping connections including level indicator to water storage tanks as called for.
- Suitable float controls of an approved make, securely fixed to the tank independent of the inlet pipe and set in a position so that water inlet into the tank is cut off when filled up to the water line. The water level in the tanks shall be adjusted to 25mm below the lip of the overflow pipe. Full way gate/ball valves of approved make shall be provided as near the tank as practicable on every outlet pipe from the storage tank except the overflow pipe.
- The overflow pipe shall be so placed as to allow the discharge of water being readily seen. The overflow pipe shall be of size indicated. A stop valve shall also be provided on the inlet water connection to the tank. The outlet pipes shall be fixed approximately 75mm above the bottom of the tank towards which the floor of the tank is sloping to enable the tank to be emptied for cleaning. The ball valves shall conform to Indian Standard IS:1703-1968

47. CONNECTIONS TO MECHANICAL EQUIPMENT SUPPLIED BY OTHER AGENCIES

All inlets, outlets, valves, piping and other incidental work connected with installation of all mechanical equipment supplied by other agencies shall be carried out by the Plumbing contractor in accordance with the drawings, requirements for proper performance of equipment, manufacturer's instructions and the directions of the Engineer-in-Charge The equipment to be supplied by other agencies consists mainly of Kitchen, Laundry, Air-conditioning, Water Treatment and other similar equipment. The connections to the various equipment shall be effected through proper unions and isolating valves. The work of effecting connections shall be executed in consultation with and according to the requirements of equipment suppliers, under the directions of the Engineer-in-Charge. The various aspects of connection work shall be executed in a manner similar to the work of respective trades mentioned elsewhere in these specifications.

48. DISINFECTION

- After completion of the work Contractor shall flush clean the entire system with the city's filtered water after connection has been made.
- After the first flushing, commercial bleaching powder is to be added to achieve a dosage of 2 to 3 mg/l of water in the system added and flushed. This operation should be performed twice to ensure that the system is fully disinfected and usable. The Commissioning would not be considered complete without performing the Disinfection.

49. PRE COMMISSIONING

- Ensure that all pipes are free from debris and obstructions.
- Check all valves and fire hydrant for effective opening and closing action. Defects should be rectified or valves replaced.
- Ensure that all Connections to Branches has been made.
- Ensure that mains have been connected to the respective pumps, underground and Overhead tanks.
- Water supply should be available at main Underground tank.
- All main line Valves should be closed.

50. COMMISSIONING

- Fill Underground tank with water. Add 1kg fresh bleaching powder after making a solution to be added near inlet.
- Start Water Supply Pump and allow water to fill main Underground tank. Water will first fill the fire tank and then overflow to the Raw Water tanks.
- After filling Overhead Reservoir drain the same to its one forth capacity through tank scour valve. (This is to ensure removal of all mud, debris etc. from the tank).
- Fill Overhead tank to full.
- Release water in the main lines by opening Valves in each circuit. Drain out water in the system through scour valves or fire hydrant in lower regions. Ensure clean water is now coming out of the system.
- Open valves for individual clusters. Observe for leakages or malfunctions, check pressure & flow at end of line by opening Hydrants etc. Remove and rectify defects noticed.
- Check all outlet points for proper operation by opening each valve and allowing water to flow for a few minutes. Also check for effective closure of valve.
- The entire water supply system should be disinfected with bleaching powder and system flush cleaned.
- Send four samples of water drawn from four extreme locations for testing for bacteriological test in sterilized bottles obtained from the concerned laboratory. (Laboratory personal may collect the samples themselves).

51. RESPONSIBILITY

Responsibility for various activities in pre-commissioning and commissioning procedures will rest with the Contractor.

SECTION –V GARDEN HYDRANT SYSTEM

52. SCOPE OF WORK

- The scope of this section comprise of the supply, installation testing and commissioning of piping network for garden hydrant & irrigation system.
- Work under this section consists of furnishing all labor, materials equipment and appliances necessary and required to completely install the garden irrigation system as required by the drawings, specified hereinafter and given in the Drawing.
- Without restricting to the generality of the foregoing, the garden hydrant system shall include the following:-
- All irrigation lines to different parts of site and making connection from source i.e. from existing irrigation line etc.
- Pipe protection.
- Control valves, masonry chambers and other appurtenances.
- Connections to all hydrant point.
- Excavation and refilling of pipe trenches, wherever necessary.
- Trenches for taking pipe lines for these services if required.

53. GENERAL REQUIREMENTS

- All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Engineer-in-Charge.
- Pipes and Fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.
- Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- As far as possible shall be installed at-least 60cms below finished grade.
- Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

54. FLANGES

Flanged connections shall be provided on pipes where ever required or as directed by Engineer-in-Charge. Connections shall be made by the correct number and size of the bolts and made with 3 mm thick insertion rubber washer.

55. TRENCHES

The cPVC (Schedule 80) pipes and fittings shall be laid in trenches. The width and depth of the trenches for the different diameters of the pipes shall be as follows:

Dia of Pipe	Width of Trench	Depth of Trench
15mm to 50mm	30 cms	60 cms
65mm to 100mm	45 cms	75 cms

- At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earth work in trenches.
- When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.

56. PIPE PROTECTION

Where specified in the Drawing all pipes below ground shall be in trenches and protected with fine sand 150 mm all around before filling in the trenches.

SECTION – VI SEWERAGE/DRAINAGE SYSTEM

57. SCOPE OF WORK

- Work under this section shall consist of furnishing all Labor, Materials, Equipment and Appliances necessary and required to completely finish Sewerage/Drainage system as specified hereinafter or given in the Drawing.
- Without restricting to the generality of the foregoing, the sewerage system shall include:
- Internal/External sewer line.
- Excavations including refilling etc.
- Construction of Collection Chambers, Manholes and Drop Connections.
- Construction of Grease Trap etc.
- Connection to existing effluence manholes
- Storm Water Drainage and Disposal.
- Construction of Desalting chamber & Rain water Harvesting tank
- Testing of pipe lines

58. GENERAL REQUIREMENTS

- All materials shall be new of the best quality conforming to specifications and subject to the approval of the Engineer-in-Charge.
- Drainage lines shall be laid to the required gradients and profiles.
- All piping shall be installed at depth greater than 80cms below finished ground level.
- The piping system shall be vented suitably at the starting point of all branch drains, main drains, and the highest/lowest point of drain and at intervals as shown. All venting arrangement shall be un-obstructive and concealed.
- All drainage work shall be done in accordance with the local Municipal bye-laws.
- Wherever the sewerage pipes run above water supply lines, same shall be completely encased in cement concrete 1:2:4 all round with the prior approval of the Engineer-in-Charge.
- Location of all manholes, catch basins etc., shall be got confirmed by the Contractor from the Engineer-in-Charge before the actual execution of work at site.
- All works shall be executed as directed by Engineer-in-Charge.

59. ALIGNMENT AND GRADE

The sewer pipes shall be laid to alignment and gradient shown on the drawings but subject to such modifications as shall be ordered by the Engineer-in-Charge from time to time to meet the requirements of the works. No deviations from the lines, depths of cutting or gradients of sewers shown on the plans and sections shall be permitted except by the express direction in writing of the Engineer-in-Charge.

60. REINFORCED CEMENT CONCRETE NP2 CLASS PIPES

All underground storm water drainage pipes and sewer lines where specified (other than those specified cast iron) shall be centrifugally spun RCC NP2 Class pipes of specified class. Pipes shall be true and straight with uniform bore. Throughout cracked, warped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the Contractor shall produce, when directed a certificate to that effect from the manufacturer.

60.1. Laying

R.C.C. spun pipes shall be laid on cement concrete bed or cradles as specified and shown on the detailed drawings the cradles may be precast and sufficiently cured to prevent cracks and breakage in handling. The invert of the cradles shall be left 12mm below the invert level of the pipe properly placed on the soil to prevent any disturbance. The pipe shall than be placed on the bed concrete or cradles and set for the line and gradient by means of sight rails and bonding rods etc. cradles or concrete bed may be omitted, if directed by the Engineer-in-Charge

Encasing

(all pipes have to be encased)

The sewer pipes shall be completely encased or surrounded with concrete where:

- The maximum water table level is likely to rise above the top of the barrel.
- The top (overt) of pipe is less than 200 cms under the road surface.

60.2. Jointing

After setting out the pipes the collars shall be centered over the joint and filled in with tarred gaskin, so that sufficient space is left on either side of the collar to receive the mortar. The space shall then be filled with cement mortar 1:2 (1 cement: 2 fine sand) and caulked by means of proper tools all joints shall be finished at an angle of 45 degree to the longitudinal axis of the pipe on both side of the collars neatly semi flexible type collar joint.

Curing

The joint shall be cured for at least 7 days. Refilling at joints will be permitted only on satisfactory completion of curing period.

61. CEMENT CONCRETE AND MASONRY WORKS FOR MANHOLES AND CHAMBERS ETC.

61.1. Materials

Water

Water used for all the construction purposes shall be clear and free from Oil, Acid, Alkali, Organic and other harmful matters, which shall deteriorate the strength and/or durability of the structure. In general, the water suitable for drinking purposes shall be considered well enough for construction purpose.

Aggregate for Concrete

The aggregate for concrete shall be in accordance with I S: 383 and I S: 515 in general, these shall be free from all impurities that may cause corrosion of the reinforcement. Before actual use these shall be washed in water, if required as per the direction of Engineer-in-Charge. The size of the coarse aggregate shall be done as per I S: 383.

Sand

Sand for various constructional purposes shall comply in all respects with I S: 650 and I S: 2116. It shall be clean, coarse hard and strong, sharp, durable, uncoated, free from any mixture of clay, dust, vegetable matters, mica, iron impurities soft or flaky and elongated particles, alkali, organic matters, salt, loam and other impurities which may be considered by the Engineer-in-Charge as harmful for the construction.

Cement

The cement used for all the constructional purposes shall be ordinary Portland cement or rapid hardening Portland cement conforming to I S: 269.

Mild Steel Reinforcement

The mild steel for the reinforcement bars shall be in the form of round bars conforming to all requirements of I S: 432 (Grade I).

Bricks

Bricks shall have uniform color, thoroughly burnt but not over burnt, shall have plan rectangular faces with parallel sides and sharp right angled edges. They should give ringing sound when struck. Brick shall not absorb more than 20% to 22% of water, when immersed in water for 24 hours. Bricks to be used shall be approved by the Engineer-in-Charge.

Other Materials

Other materials not fully specified in these specifications and which may be required in the work shall conform to the IS code. All such materials shall be approved by the Engineer-in-Charge before use.

61.2. Cement Concrete (Plain or Reinforced)

- Cement concrete pipes bedding, cradles, foundations and RCC slabs for all works shall be mixed by a Mechanical Mixer where quantities of the concrete poured at one time permit. Hand mixing on properly constructed platforms may be allowed for small quantities by the Engineer-in-Charge. Rate for cement concrete shall be inclusive of all shuttering and centering at all depth and heights.
- All concrete work shall be cured for a period of at least 7 days. Such work shall be kept moist by means of gunny bass at all times. All pipe trenches and foundations shall be kept dry during the curing period.

61.3. Masonry Work

Masonry work for manholes, chambers, brick masonry pipe trench and such other works as required shall be constructed from 1st class bricks or 2nd class as specified in the Drawing in cement mortar 1:5 mix (1 cement: 5 coarse sand). All joints shall be properly raked to receive plaster.

61.4. Cement Concrete for Pipe Support

Wherever specified or shown on the drawings, all pipes shall be supported in concrete bed all round or in haunches. The thickness and mix of the concrete shall be given in the Drawing. Type of the bedding is as described as follows:

- Unless otherwise directed by the Engineer-in-Charge cement concrete for bed, all round or in haunches shall be laid as follows:-

Table 61-1 Cement Concrete Specifications

Description	**Up to 3 M depth**
Pipes in open ground (No sub soil water)	All round (1:4:8)
Pipes (all) in sub soil water condition	All round (1:4:8)
Pipes under the building or at road crossing or under public places	All round (1:3:6)

(1=1 cement, 3-5=coarse sand, 6-10 stone aggregate 40mm nominal size)

- R.C.C. pipes or C.I. pipes ,may be supported on brick masonry or precast R.C.C or Cast insitu cradles. Cradles shall be as shown on the drawings.
- Pipes in loose soil or above ground shall be supported on brick or RCC anchor blocks as shown on the drawings.

62. MANHOLES AND CHAMBERS

- All manholes, chambers and other such works as specified shall be constructed in brick masonry in cement mortar 1:5 (1 cement: 5 coarse sand) or as specified in the Drawing.

- All Manholes, Chambers, etc., shall be supported on base of cement concrete of such thickness and mix or shown on the drawings.
- Where not specified, Manholes will be constructed as follows:-

Table 62-1 Sewer Manholes Details

(All dimensions internal clear in cms)

Size of Manhole Type	**90x80 Rect.**	**120x90 Rect.**	**910 dia Circular**	**1220 dia Circular**	**1520 dia Circular**
Maximum depth	100	245	170	230	Any depth beyond 230
Average thickness of R.C.C slab	15	15	--	--	--
Size of cover and frame (Internal dia)	61x45.5	50 dia	56 dia	56 dia	56 dia
Weight of cover and frame	38 Kg.	116 Kg.	116 Kg.	116 Kg.	116 Kg.
Type of Cover & Frame	SFRC	SFRC	SFRC	SFRC	SFRC

- All manholes shall be provided with cement concrete benching in 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20mm nominal size). The benching shall have a slope of 10cm towards the channel. The depth of the channel shall be full diameter of the pipe. Benching shall be finished with a floating coast of neat cement.
- All manholes shall be plastered with 12/15mm thick cement mortar 1:3 (1 cement: 3 coarse sand) and finished with a floating coat of neat cement inside. Manhole shall be plastered outside as above but with rough plaster.
- All manholes with depths greater than 1 M. shall be provided with plastic encapsulated 20mm square or 25mm round rods foot rungs set in cement concrete blocks 25 x 10 x 10cms in 1:2:4 mix 30cms vertically and staggered. Foot rests shall be coated with coal tar before embedding.
- All manholes shall be provided with cast iron covers and frames and embedded in reinforced cement concrete slab or SFRC precast concrete covers as per instructions of the Engineer-in-Charge. Weight of cover, frame and thickness of slab as given above.
- All Rainwater Collection Chamber shall be of the size 50x45x60cm (internal) with horizontal C.I. grating or SFRC precast Gully Grating as per instructions of Engineer-in-Charge. The grating along with frame shall be of size 500x450mm grating having total Wt. of app. 38 Kg and of approved design and quality as per instruction of Engineer-in-Charge. The remaining details of construction shall be same as stated above for the construction of the Manholes etc.

63. MAKING CONNECTIONS

Contractor shall connect the new sewer line to the existing manhole by cutting the walls, benching and restoring them to the original condition. A new channel shall be cut in the benching of the existing manhole for the new connection. Contractor shall remove all sewage and water if encountered in making the connection without additional cost.

64. COMMISSIONING

- After successful testing of the different sewerage and drainage pipes in parts, the Contractor shall provide all facilities including necessary piping's, labors, tools and equipment's etc. for carrying out testing and commissioning of the entire external sewerage and drainage system complete as per requirement in the presence of Client representative/Consultant, wherever and as may be required. Generally, the following test/inspection has to be carried out:-
- For any Leakages/seepages in the external sewerage and drainage pipes.
- For checking the functioning of the entire external sewerage and drainage system including rainwater harvesting system and to ensure that the waste water is continuously flowing towards outfall without any intermediate stagnation.
- For the functioning of the valves and accessories etc. by putting ON/OFF the controlling valves of the various diversions in the sewerage and drainage and rain water harvesting system.

65. DESALTING CHAMBER & RAIN WATER PIPING & GRAVEL

- All Rainwater Collection Chamber shall be of the size 200x100x60cm (internal) complete as per drawing or as instructions of Engineer-in-Charge.
- Rain water harvesting pit is constructed preferably 5 to 10m from the permanent structure. The bore will be excavated manually or drilled by reverse direct rotary method up to the water level or as per instruction of Engineer-in-Charge.
- Bore shall be 250mm dia and pipe shall be 160 OD uPVC 6 kg /cm2. The pipe placed in the center of the shaft touching the lowest portion of the pit. The overflow pipe from the desalting chamber is directly connected to the rain water harvesting pit so that the rain water freely enters the pit for recharging. In addition to the inlet pipe from desalting chamber an overflow pipe at the ground level so that any excess water that enters the pit is automatically drained away without damaging the pit.

SECTION – VII HANDING OVER PROCEDURE

66. DOCUMENTS SUBMISSION

The Contractor shall before finally handing over the completed work in his scope to the Owner, submit the documents as per the Contract and as directed by the Engineer-in-Charge. Given below the checklist for the reference of the Engineer-in-Charge.

Table 66-1 Work Compliance Checklist

Packages/	Sanitary Fixtures	Soil, waste & vent pipes	Water supply system	Sewerage/ drainage system	Water tanks
Final cleaning					
List of inventory					
Training Conducted on					
Operation Manual					
Main. Manual					
As built P&I Diag/ SLD					
Defects Liability Period/ Warranty					
Commissioning report					
Test reports/ Certificates					
List of essential spares					
Address/ Contact nos. of Vendors					
Remarks					

SECTION – VIII FIRE FIGHTING SYSTEM

67. TECHNICAL SPECIFICATION

- Work under this sub-head consists of furnishing all Labor, Materials, equipment and accessories necessary and required to completely install the Fire Fighting equipment etc., specified hereinafter and given in the
- Without restricting to the generality of the foregoing the work of Fire Fighting System shall include the followings:
- Providing M.S. black steel (Class C) pressure pipe line main including Valves, Fire Hydrants, Excavation for Pipe, Laying of pipe, Painting of pipe and Making Connection to supply system.
- Black Steel Pipe, Mains Laterals, Branches, Valves, Hangers and Appurtenances.
- Hose Reels, Rubberized fabric lined hose pipes, Hose cabinets, Sprinkler heads and Landing Valves.
- Portable Fire Extinguishers
- Fire Fighting Pumps, diesel operated pumps, panels and all connected accessories including suction & delivery pipes.
- Testing Commissioning and giving live demonstrations to the various Inspection Authorities and Obtain their “No Objection Certificate” (NOC) for occupation of the building.

68. GENERAL REQUIREMENTS

- All materials shall be of the best quality conforming to the Specifications and subject to the approval of the Engineer-in-Charge.
- Pipes and Fittings shall be fixed truly Vertical, Horizontal or in slopes as required in a neat workman like manner.
- Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause any obstruction in shaft, passage etc.
- Pipes shall be securely fixed to walls and ceiling by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceilings.
- Valves and other appurtenance shall be so located that they are easily accessible for operation, repairs and maintenance.

69. PIPES

- All pipes within and outside the building in exposed locations and shafts including connections buried under floor shall be M.S. Pipes as follows:
- Pipes 150 mm dia and below IS: 1239 (Class C) Heavy Class
- Pipe 200 mm dia and above IS 3589 of thickness specified.

70. PIPE FITTINGS

- Pipes and fittings means tees, elbows, couplings, flanges, reducers etc. And all such connecting devices that are needed to complete the piping work in its totality.
- Fabricated fittings shall not be permitted for pipe diameters 50 mm and below.
- When used, they shall be fabricated, welded and inspected in workshops under supervision of Engineer-in-Charge whose welding procedures have been approved by the TAC as per TAC rule 4102 for sprinkler system and applicable to hydrant and sprinkler system. For "T" connections, pipes shall be drilled and reamed. Cutting by gas or electrical welding will not be accepted.

71. JOINTING

71.1. Screwed (50 mm dia pipes and below)

Joint for black steel pipes and fittings shall be metal-to-metal thread joints. A small amount of red lead may be used for lubrication and rust prevention. Joints shall not be welded or caulked. (With screwed MS forged fittings)

71.2. Welding (65 mm dia and above)

Joints between MS pipes and fittings shall be made with the pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. Buried pipes will be subject to X Ray test from an approved agency as per the TAC norms at the cost of contractor. (With welded M.S. fittings heavy class with V-Groove). The welding machine shall be 3 Phase rectifier of required current and capacity. The vendor for welding will be approved by Engineer-in-Charge.

71.3. Flanges

Flanged joints shall be provided on:

a) Straight runs not exceeding 30 m on pipelines 80 mm dia and above.

b) Both ends of any fabricated fittings e.g. bends, tees etc. of 65 mm dia or larger diameter.

c) For jointing all types of valves, appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and required as good for engineering practice.

d) Flanges shall be as per IS 6392-1971, Table 17/18 with appropriate number of G.I. nuts and bolts, half threaded of with 3 mm insertion neoprene gasket complete.

71.4. Unions

Provide Approved type of dismountable unions on pipes lines 65 mm and below in similar places as specified for flanges shall be provided.

72. PIPE PROTECTION

- All pipes above ground and in exposed locations shall be painted with one coat of Red Oxide Primer and two or more coats of Synthetic Enamel Paint of approved shade.
- All black steel pipes under floors or below ground shall be provided with protection against corrosion by application of 100mm wide and 4mm thick layer of PYPKOTE/ MAKPOLYKOTE over the pipe, as per manufacturers specifications.

73. PIPE SUPPORTS

- All pipes shall be adequately supported from ceiling or walls from existing/new inserts by Structural clamps fabricated from M.S. Structural e.g. Rods, Channels, Angles and Flats as per details given in drawings and specifications. All clamps shall be painted with one coat of red lead and two coats of black Enamel paint.
- Where inserts are not provided, the Contractor shall provide anchor fasteners. Anchor fastener shall be fixed to walls and ceilings by drilling holes with Electrical drill in an approved manner as recommended by the manufacturer of the fasteners.

74. TESTING

- All pipes in the system shall be tested to a hydraulic pressure of 1.5 times of the working pressure or minimum of 15 kg/cm2 without drop in the pressure for at least 2 hours.
- Rectify all leakages, make adjustment and retest as required.

75. ANCHOR BLOCK

Contractor shall provide suitable cement concrete, anchor blocks of ample dimensions at all bends, tee connection and other places required and necessary for overcoming pressure thrusts in pipes. Anchor blocks shall be of cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size).

76. VALVES

76.1. Valves, Gauge and Orifice Plates

- Sluice Valves above 65 mm shall be of Cast Iron body and Bronze/Gunmetal seat. They shall conform to type PN 1.6 of IS:780-1980, valves up to 65mm shall be of Gunmetal Full way Valve with wheel tested to 20 kg/cm2 class-II as per I.S: 778-1971. Valve wheels shall be of right hand type and have an arrow head engraved or cast thereon showing the direction for turning open and closing.
- Non-return valves shall be of Cast Iron body and Bronze/Gunmetal seat. They shall conform to class of IS: 5312 and have flanged ends. They shall be swing check type in horizontal runs and lift check type in vertical runs of piping. They shall not be spring-loaded type.

77. EXTERNAL YARD HYDRANTS

- The Contractor shall provide External Fire Hydrant in the Ring or on External Fire Line, as per specifications and as shown in drawings. The spacing of the hydrants and the distance from the building shall be maintained as per relevant requirements of latest relevant codes, unless specified herewith.
- Each External Fire Hydrant shall be provided with an External Fire Hose Cabinet of M.S of size 76.8 x 61.44 x 25.80 cm, as approved by the Architect to equip 2 nos. of 63 mm dia controlled percolating hose and accessories as required. The cabinet shall be installed near the Hydrant as per details, approved by the Engineer-in-Charge / Architect.

78. INTERNAL HYDRANTS

- The Internal Hydrant outlet shall comprise “Single Headed Single Outlet Stainless steel Landing Valve” conforming to type ‘A’ of IS: 5290-1977. Separate valve on the head shall form part of the landing valve construction.
- A cap with chain is provided on one head of the outlet. The hydrant will have an instantaneous pattern female coupling for connecting to Hose Pipe.
- The Landing Valve shall be fitted to a Tee connection on the wet riser at the landing.

79. FIRST-AID HOSE REEL EQUIPMENT

- First aid hose reel equipment shall comprise reel, hose guide fixing bracket hose tubing globe valve, stopcock and nozzle. This shall conform to IS:884 - 1969. The hose tubing shall confirm to IS:1532-1969.
- The hose tubing shall be 20 mm dia and 36.5m long. The SS 304 nozzle 5mm and globe valve shall be of 20 mm size.
- The fixing bracket shall be of swinging type. Operating instructions shall be engraved on the assembly. This heavy duty mild steel and cast iron brackets shall be conforming to IS: 884 - 1969. The first-aid hose reel shall be connected directly to the MS pipe riser taken independently from ring.

80. HOSE PIPES, BRANCH PIPES AND NOZZLES

80.1. Hose Pipes

- Two numbers Hose Pipes shall be rubber lined woven jacketed and 63mm in dia. 15m long. They shall confirm to type A (Reinforced rubber lined) of IS:636 - 1979. The hose shall be sufficiently flexible and capable of being rolled.
- Each run of hose shall be complete with necessary coupling at the ends to match with the landing valve or with another run of hose pipe or with branch pipe. The couplings shall be of instantaneous spring lock type. This shall be conforming to IS: 903.

80.2. Branch Pipes

Branch pipe shall be of Gunmetal 63 mm dia and be complete with male instantaneous spring lock type coupling for connection to the hose pipe. The branch pipe shall be externally threaded to receive the nozzle.

80.3. Nozzle

- The nozzle shall be of Gunmetal 20 mm in (internal) diameter. The screw threads at the inlet connection shall match with the threading on the branch pipe. The inlet end shall have a hexagonal head to facilitate screwing of the nozzle on to the branch pipe with nozzle spanner.
- End Couplings, Branch pipe, and Nozzles shall conform to IS:903 - 1985.
- Two C.P hoses of 15m length with couplings shall be provided with each External (Yard) Hydrant. Two RRL hoses of 15m length, as specified, with couplings shall be provided with each Internal Hydrant. One nozzle and one branch pipe with coupling shall be provided with each Yard Hydrant and Internal Hydrant.

81. HOSE CABINET

- The internal hose cabinet shall accommodate the Hose pipes, branch pipe, Nozzle First aid Hose Reel and Hydrant Outlets and shall be fabricated from 2 mm thick or 14 mm gauge MS/aluminum sheet. The overall size shall be 2100x900x715 mm, or as specified in the Architectural details. This shall have lockable centre opening glazed doors as per the requirement and as per Architectural details. Where the niche for wet riser is provided with shutters, separate hose cabinet as above may be dispensed with.
- The hose cabinet shall be painted red and stove enamelled and woods FIRE written in front glazed portion.

82. FIRE BRIGADE INLET CONNECTION

Fire Brigade Inlet connection shall be provided near the pump house and to the wet riser system as specified, for the following purposes:

- Fire Brigade suction connection for fire static tank with provision of foot valve.
- Fire brigade inlet connection to fire static tank.
- Fire brigade inlet connection to the wet riser system. Each connection shall be provided with similar dia of Sluice valve and Non return valve.

The locations of this Fire brigade connection shall be suitably decided with the approval of Consultant/Landscape Architect and with a view that these are easily accessible to the fire brigade, without any possible Hindrance.

83. HYDRAULIC SIREN

A siren shall be provided in the system, to indicate the flow of water in the wet riser system. Alternative arrangements may also be adopted. This shall be turbine type.

84. VALVE CHAMBERS

- Contractor shall provide suitable Brick Masonry Chamber in cement mortar 1:5 (1 cement: 5 coarse sand) on cement concrete foundations 150 mm thick in 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) 15 mm thick plaster inside and outside finished with a floating coat of neat cement inside with cast iron surface box approved by fire brigade including excavation, back filling complete.
- Valve chambers shall be of following size:
- For depths 100 cm and beyond 90x90x100 cm

85. PORTABLE FIRE EXTINGUISHER

Portable fire extinguishers shall be provided as per the drawing and shall confirm to IS:2190-1979.

- Two 9 lit. water CO2 type for every 600 m2 area with minimum of 1 extinguishers per floor as per IS:15683
- Dry Chemical powder type of 6 Kg. Capacity as per IS:15683
- CO2 type of 4.5 kg capacity as per IS:15683.

NOVEC/ FK-5112 gas based Fire suppression system for HT Panel, Main LT Panel, capacitor Panels, Main Ventilation Panels, Fire pump panel, AC main Panel and any other LV Panel having incoming rating of 200A or above and critical locations as per direction of Engineer-in-Charge, shall be provided as per CPWD specifications and Fire officer's requirements.

86. SPRINKLER HEADS

- Sprinkler heads shall be provided at approximate spacing to cover 9 to 12 m2 per Sprinkler head. The spacing shall however, be in conformity with the drawings and properly coordinated with Electrical Fixtures, Ventilation Ducts and Grills and other services along the ceiling.
- Sprinkler heads shall be chrome finished Brass/Gunmetal with quartz bulb with a temperature rating of 68°C. Sprinkler heads shall be of type and quality approved by the local fire brigade authority. The inlet shall be screwed. Sprinkler heads shall be pendent, recessed or special application side wall Sprinkler types as shown in drawings. All Sprinklers should have the Specifications.
- Contractor shall supply spare Sprinkler Heads of each type as per requirement and one Spanner for each type of sprinkler neatly installed in a steel box with glass shutters at locations approved by the Engineer-in-Charge.

87. WATER CURTAIN SYSTEM.

- Water curtains are an array of nozzles that are installed parallel to each other along and around the sidewalls / protected zones in car parking basement floor. With a water curtain, the heat radiation around burner booms can be decreased sufficiently to prevent thermal damages by creating significant spray water cooling systems. The idea is to make water continuously flow toward burner booms so that the heat can never escape out of the water curtains.
- The system proposed to operate through deluge valve. The water is directly connected to a water supply and when the system is activated, a deluge valve will release the water-to-water curtain nozzles. The valve is opened when activated by a heat or smoke detection system

88. SHOP DRAWINGS & SPECIFICATIONS

- The Contractor shall submit to the Consultant two copies of Shop Drawings for Fire Fighting works as an Advance Copy to the Engineer-in-Charge for approval before start of work. Subsequent to the approval of the shop drawings, the Contractor shall submit six copies of Shop Drawings for execution to the Engineer-in-Charge. Also the Contractor shall submit four copies of the Technical Specifications and Catalogues.
- Shop drawings shall be submitted for the following conditions:
- Structural supports/hanging/laying and jointing details for all types of pipes as required.
- Fire Fighting layout plans as required and for any changes in the layout of Fire Fighting/Architectural drawings.
- The Contractor can only commence the work after the approval of above documents by Consultant.

SECTION – IX WATER SUPPLY PUMPS & EQUIPMENTS AND WATER TREATMENT UNITS ETC.

89. PUMPS AND WATER TREATMENT EQUIPMENT

- Work under this sub-head consists of furnishing all labor, materials, equipment and accessories necessary and required to completely install pumping system for various water supply services and water treatment as per drawings, specified hereinafter.
- Without restricting to the generality of the foregoing, the work of pumps and water treatment equipment shall include as per BOQ.

90. PUMP SET

90.1. Water Supply Pumps

- Water supply pumps shall be suitable for clean water. Pumps shall be multistage, monoblock vertical centrifugal pumps with Cast Iron body and Cast Iron impeller, stainless steel shaft and coupled to a TEFC electric motor by means of a flexible coupling. Each pump should operate a curve 10m below specified head.
- Pump and motor shall be mounted on a common M.S. structural base plate or as required as per site conditions.
- Each pump shall be provided with a totally enclosed fan cooled induction motor.
- Each pumping set shall be provided with a 150mm dia or of suitable size gunmetal “Burden” type pressure gauge with gunmetal isolation cock and connecting piping.
- Provide vibration-eliminating pads appropriate for each pump.
- Provide rate of flow measuring meter with bypass arrangement with every set of pumps.
- All water supply pumps shall be provided with mechanical seals.

91. SUMP PUMP

- Sump pumps shall be submersible type for lifting domestic sewage or muddy water/drainage. Pump with impeller of approved material shall be mounted on waterproof motor. The impeller shall be suitable for handling solids up to 46-100mm dia.
- The pump shall automatically operate with high water level and stop at low water level in the sump by means of “Electronic Level Controller”, of the approved make.
- The sump pumps shall be complete in all respect and shall be installed as per manufacturer’s requirement as shown in the drawing. All accessories shall be In-Built as per manufacturer’s specification.
- Sump pumps are compact monoblock dry motor submersible pumps for suitable rating, with non-clog free flow open impeller, minimum solid handling capacity up to 100mm for sewer & 40 for storm water . Suitable for operation on 415 volts + 5% -15%, 50 C/s A.C 3 phase supply, speed 960/1440R&M including oil chamber, guide wire for lifting & lowering of pump, M.S. galvanized lifting chain, duck foot bend.
- The above pump sets must be supplied complete with following accessories :
- Complete piping 100mm dia common delivery up to 1.5m as shone in the drawing. (The pipe should be preferably heavy duty GI)
- Necessary valve i.e Butterfly valve on delivery/suction side and Non return valves are on delivery side.
- Necessary cable from pumps set to control panel.
- Electrical switch panel having all necessary accessories & safety devices of standard specifications. (Panels with sump pumps near each sump as per site conditions)
- Automatic built-up water level controller with necessary length of cable up to control panel.

92. FIRE FIGHTING PUMPS

92.1. Electrical Operated Main Fire, Sprinkler and Jockey Pumps

- Pumping sets shall be single stage horizontal centrifugal single outlet with cast iron body and dynamically balanced bronze impellers. Connecting shaft shall be of stainless steel with bronze sleeve and grease-lubricated bearings.
- Pumps shall be connected to the drive by means of spacer type love-joy coupling which shall be individually balanced dynamically and statically.
- The coupling joining the prime mover with the pump shall be provided with a sheet metal guard.
- Pumps shall be provided with approved type of mechanical seals.
- Pumps shall be capable of delivering not less than 150% of the rated discharge at a head of not less than 65% of the rated head. The shut-off head shall not exceed 120% of the rated head.
- The System shall meet the requirements of the National building Code 2016 (NBC).
- Necessary 'Y' strainer on the suction side and pressure gauge with GM cocks on the delivery side including bypass arrangement (with 50 valve and up to 5M G.I. Medium pipes) for periodical testing of the working of the pumping set shall be provided.
- Pump shall be mounted on common base frame fabricated from MS channel as per manufacturer’s specification.
- Suitable RCC Pump-foundations as per manufacturer's design and 4 nos. Dunlop (cushy foot) heavy duty Antivibration mounting pads shall be provided.

92.2. Motors for Electric Driven Pumps

- Electrically driven pumps shall be provided with totally enclosed fan cooled induction motors.
- Motors for fire protection pumps shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge and shall be designed for continuous full load duty and shall be design proven in similar service.
- Motors for fire pumps shall meet all requirements and specifications of the tariff advisory committee.
- Motors shall be suitable for 415 volts, 3 Phase, 50 cycles A.C supply and shall be designed for 33OC ambient temperature. Motors shall conform to I.S: 325.
- Motors shall be designed for two start system.
- Motors shall be capable of handling the required starting torque of the pumps.
- Contractor shall provide heating arrangements for the main fire pump motor to ensure that motor windings shall remain dry.

92.3. Air Vessel for Fire Pumps

- Provide an air vessel fabricated from 10mm M.S. sheet with dished ends and suitable supporting legs, air vessel shall be provided with a 100mm dia flanged connection from pump, one 25mm dia drain with valve, one gunmetal water level gauge and 25mm sockets for pressure switches. The vessel shall be 450mm in dia and 2000 mm high and tested to 10.0Kg/cm2 pressure.
- The fire pumps shall operate on drop of 1 Kg/cm2 pressure in the mains. The pump operating sequence shall be arranged in a manner to start the pump automatically but should be stopped manually by starter push buttons only.

92.4. Operating Conditions for the Service Pumps

Table 92-1 Operating Conditions for Service Pumps

Fire Service Pump	Nos.	Cut in Pressure	Cut Out Pressure	Remarks
Jockey pump	One	8.2 kg/cm2	6.7 kg/cm2	To auto start and auto stop on pressure switch on air vessel.
Main pump	One	6.2 kg/cm2	Push button manual	To auto start on pressure switch on air vessel and manual off.
Diesel Fire Pump	One	5.7 kg/cm2	Push button manual	To auto start on pressure switch on air vessel and manual off.
Sprinkler Pump	One	6.7 kg/cm2	Push button manual	To auto start on pressure switch on air vessel and manual off.

92.5. Diesel Fire Pump

Scope

This section covers the details of requirements of the standby fire pump, operated by a diesel engine.

General

The diesel pump set shall be suitable for automatic operation, complete with necessary automatic starting gear, for starting on wet battery system and shall be complete with all accessories. Both engine and pump shall be assembled on a common bed plate, fabricated from mild steel channel.

Drive

The pump shall be only direct driven by means of a flexible coupling. Coupling guard shall also be provided. The speed shall be 1450/1800 rpm.

Fire Pump

- The fire pump shall be horizontal split casing centrifugal type. It shall have a capacity to deliver 2280 lpm as specified, developing adequate head so as to ensure a minimum pressure of 3.5 Kg. per cm2 at the highest and the farthest outlet. The delivery pressure at the pump outlet shall be not less than 8 Kg. per cm2 in any case. The pump may be single stage or multi stage as specified. The pump shall be capable of giving a discharge of not less than 150% of the Rated discharge at a head of not less than 65% of the rated head. The shut off head shall be within 120% of the rated head.
- The pump casing shall be of cast iron to grade FG 200 to I.S: 210 and parts like impeller shaft sleeve, wearing-ring etc. shall be of non-corrosive metal like bronze/brass/gunmetal. The shaft shall be of stainless steel. The pump shall be provided with mechanical seal.
- The pump casing shall be designed to withstand 1.5 times the working pressure.
- Bearings of pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water.

92.6. Diesel Engine

Environmental Conditions - The engine shall be required to operate under the conditions of environment as required as per site conditions.

Engine Rating - The engine shall be cold starting type without the necessity of preliminary hearing of the engine cylinders or combustion chamber (for example, by wicks, cartridge, heater plugs etc). The engine shall be multi cylinder/vertical 4 stroke cycle, water cooled diesel engine, developing suitable HP at the operating speed specified to drive the fire pump. Continuous capacity available for the load shall be exclusive of the power requirement of auxiliaries of the diesel engine, and after correction for altitude, ambient temperature and humidity for the specified environmental conditions as mentioned. This shall be at least 20% greater than the maximum HP required to drive the pump at its duty point. It shall also be capable of driving the pump at 150% of the rated discharge at 65% of rated head. The engine shall be capable of continuous non-stop operation for 8 hours and at least 3000 hours of operation before major overhaul. The engine shall have 10% overload capacity for one hour in any period of 12 hours continuous run.

The engine shall accept full load within 15 seconds from the receipt of signal to start. The diesel engine shall conform to B.S: 649/I.S: 1601/I.S: 10002, all amended up to date.

Engine Accessories - The engine shall be complete with the following accessories:-

a) Fly sheet dynamically balanced.

b) Direct coupling for pump and Coupling Guard.

c) Radiator with hoses, fan, water pump, drive arrangement and guard.

d) Corrosion Resister

e) Air cleaner, oil bath type/dry type

f) Fuel service tank support, semi-rotary pump and fuel oil filter with necessary pipe work.

g) Pump for lubricating oil and lub. oil filter

h) Elect. starting battery (2x12 v)

i) Exhaust silencer with necessary pipe work

j) Governor

k) Instrument panel housing all the gauges, including Tachometer, hour meter and starting switch with key (for manual staring).

l) Necessary safety controls

m) Winterization arrangement, where specified.

Cooling System - The engine cooling system shall be radiator water cooled system. The radiator assembly shall be mounted on the common bed plate. The radiator fan shall be driven off the engine as its auxiliary with a multiple fan belt. When half the belts are broken, the remaining belts shall be capable of driving the fan. Cooling water shall be circulated by means of an auxiliary pump of suitable capacity driven by the engine in a closed circuit.

Fuel System - The fuel shall be gravity fed from the engine fuel tank to the engine driven fuel pump. The engine fuel tank shall be mounted either over or adjacent to the engine itself or suitably wall mounted on brackets at a height not less than 60 cm above the fuel injection pump. The fuel filter shall be suitably located to permit easy servicing.

All fuel tubing to the engine shall be with copper, with flexible hose connections where required. Plastic tubing shall not be permitted.

The fuel tank shall be of welded steel construction (3mm thick) and of capacity sufficient to allow the engine to run on full load for at least 8 hours. The tank shall be complete with necessary floor mounted supports, level indicator (protected against mechanical injury) inlet, outlet, overflow connections and drain plug and piping to the engine fuel tank. The outlet should be so located as to avoid entry of any sediment into the fuel line to the engine.

A semi rotary hand pump for filling the daily service tank together with hose pipe 5 mtr. long with a foot valve etc. shall also form part of the scope of work.

Lubricating Oil System - Forced feed lub. oil system shall be employed for positive lubrication. Necessary lub. oil filters shall be provided, located suitably for convenient servicing.

Starting System - The starting system shall comprise necessary batteries (2x12 v), 24 volts starter motor of adequate capacity and axle type gear to match with the toothed ring on the fly wheel. By metallic relay protection to protect starting motor from excessively long cranking runs suitably integrated with engine protection system shall be included within the scope of the work.

The battery capacity shall be suitable for meeting the needs of the starting system.

The battery capacity shall be adequate for 10 consecutive starts without recharging with cold engine under full compression.

The scope shall cover all cabling, terminals, initial charging etc.

Exhaust System - The exhaust system shall be complete with silencer suitable for outdoor installation, and silencer piping including bends and accessories needed for a run of 5 meter from the engine manifold. (Adjustment rates for extra length shall also be given). The total back pressure shall not exceed the engine manufacturer's recommendation. The exhaust piping shall be suitably lagged.

Engine Shut Down Mechanism - This shall be manually operated and shall return automatically to the starting position after use.

Governing System - The engine shall be provided with an adjustable governor to control the engine speed within 5% of its rated speed under all conditions of load up to full load. The governor shall be set to maintain rated pump speed at maximum pump load.

Engine Instrumentation - Engine instrumentation shall include the following:-

a) Lubricant oil pressure gauge.

b) Lubricant oil temperature gauge.

c) Water pressure gauge.

d) Water temperature gauge.

e) Tachometer.

f) Hour meter.

The instrumentation panel shall be suitably resilient mounted on the engine.

Engine Protection Devices - Following engine protection and automatic shutdown facilities shall be provided: -

a) Low lub. oil pressure

b) High cooling water temp.

c) High lub. oil temperature

d) Over speed shut down.

Pipe Work - All pipe line with fittings and accessories required shall be provided for fuel oil, lub. oil and exhaust systems. Copper piping of adequate sizes shall be used for lub. oil and fuel oil. M.S. piping will be permitted for exhaust.

Anti Vibration Mounting - Suitable vibration mounting duly approved by Engineer-in-Charge shall be employed for mounting the unit so as to minimise transmission of vibration to the structure. The isolation efficiency achievable shall be clearly indicated.

Battery Charger - Necessary float and boost charger shall be incorporated in the control section of the power and control panel, to keep the battery under trim condition. Voltmeter to indicate the state of charge of the batteries shall be provided.

93. CABLES

- Contractor shall provide all power control cables from the motor control center to various motors, level controllers and other control devices.
- Cables shall conform to I.S: 1554 and carry ISI mark.
- Wiring cables shall conform to I.S 694.
- All power and wiring cables shall be aluminum conductor PVC insulated armoured and PVC sheathed of 1100 volts grade.
- All control cables shall be copper conductor PVC insulated armoured and PVC sheathed 1100 Volt grade.
- All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer's name.
- All cable joints shall be made in approved manner as per standard practice.

94. CABLE TRAYS

- Contractor shall provide M.S slotted cable trays at locations as shown on the drawings.
- Cable trays shall be supported from the bottom of the slab at intervals of 60cms at both ends by anchor fasteners.

95. EARTHING

There shall be an independent earthing station. The earthing shall consist of an earth tape connected to an independent plate made of copper or G.I. having a conductivity of not less than 100% international standard. All electrical apparatus, cable boxes and sheath/armour clamps shall be connected to the main bar by means of branch earth connections of appropriate size. All joints in the main bar and between main bar and branch bars shall have the lapping surface properly tinned to prevent oxidation. The joints shall be riveted and sweated.

Earth plates shall be burried in a pit of 1.20x1.20M at minimum depth of 3M below ground. The connections between main bar shall be made by means of three 10mm brass studs and fixed at 100mm centers. The pit shall be filled with coke breeze, rock salt and loose soil. A G.I. pipe of 20mm dia with perforations on the periphery shall be placed vertically over the plate to reach ground level for watering.

A brick masonry manhole 30x30x30cm size shall be provided to surround the pipe for inspection. A bolted removable link connecting main bar outside the pit portion leading to the plates shall be accommodated in this manhole for testing.

96. CONTROL PANELS / STARTERS

Switch board cubicles of approved type shall be fabricated from 16-gauge M.S. sheet with dust and vermin proof construction. It shall be painted with powder-coated finish of approved make and shade. It shall be fitted with suitable etched plastic identification plates for each motor. The cubicle shall comprise of the followings:-

a) Incoming main isolation MCCB of required capacity.

b) Fully Aluminum taped Bus Bar of required capacity.

c) Isolation MCCB one for each motor.

d) Fully automatic as specified D.O.L/Star Delta starters suitable for motor H.P. with push buttons one for each motor and on/off indicating neon lamps. (DOL up to 7.5 HP and Star Delta from more than 7.5 H.P)

e) Single phase preventer of appropriate rating for each motor.

f) Panel type ampere meters one for each motor with selector switch.

g) Panel type voltmeter on incoming main with rotary selector switch to read voltage between phase to neutral and phase-to-phase.

h) Neon phase indicating lamps for incoming main and on/off indicating lamps for each motor.

i) Rotary switch for manual or auto operation for each pump (manual/auto off).

j) Fully taped separate aluminum bus bars of required capacity and with required outlets.

k) Space for liquid level controllers as specified + 1 extra space.

l) The panel shall be pre-wired with color-coded wiring. All interconnecting wiring from incoming main to switch gear, meters and accessories within the switchboard panel.

m) Provision of main incoming cables from the top of the panel.

All switch gears and accessories shall be of approved make such as “Siemens, Larsen & Toubro” or equivalent.

Switchboard cubicles shall be floor or wall mounted type as recommended by manufacturers. All floor-mounted switchboards shall rest on minimum 225mm high platform. The contractor shall provide the shop drawings for base and panels.

97. VIBRATION ELIMINATORS

Provide on all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump. Length of the connector shall be as per manufacturer’s details.

98. ILLUMINATED FACSIMILE ANNUNCIATOR PANEL

98.1. Scope

Scope of this section comprises the supply, installation, testing and commissioning of illuminated facsimile annunciation panel.

98.2. Illuminated Facsimile Enunciator

- Illuminated facsimile enunciator shall be provided with facsimile of the building, constructed of acrylic panels of suitable dimensions, showing the Basement, Ground floor plans and section showing the location of Zonal Panels on each typical floor, entry points, various facilities shown with enamels in various colours.
- Alarm lights to indicate fire location shall be arranged within the acrylic panel and shall be either automatically lighted by operation of any automatic fire detection devices or manual station, or by control of push button incorporated in the control desk.
- Indicator of each building or facility shall include two lamps connected in parallel and so arranged that the failure of either of the lamps is readily apparent when a call or test is made.
- Power for the Enunciator shall be supplied from the power supply for the control desk.
- Representation of the various plans/Drawings on the acrylic of the Enunciator shall be by negative film processing with colored Discrimination of various zones for which the drawings shall be furnished for approval.

99. WATER FILTER

- Water filter shall be of dual filter media pressure filter downward or upward flow type suitable for a rate of filtration.
- Filter shall be vertical type of required diameter. The shell shall be fabricated from M.S. plate suitable to withstand a working pressure as given below. The minimum thickness of shell will be 8mm and dished ends shall be 10mm. The filter shall have at least one pressure tight manhole cover.
- Filter shall be provided with screwed or flanged connections for inlet, outlet, individual drain connections and all other connections necessary and required. Filter shall be painted inside with two or more coats of non-toxic corrosion resistant paint, one coat of red oxide primer outside with two or more coats of synthetic enamel paint of approved shade.

99.1. Under Drain System

Filter shall be provided with an efficient under drain system comprising of collecting pipes, gunmetal/polypropylene nozzles of manufacturer's design. The entire under drain system be provided on M.S. plate or cement concrete supports.

99.2. Face Piping

Filter shall be provided with interconnecting face piping comprising of inlet, outlet, and backwash pipe complete with pipes, valves and accessories, as per requirement. Piping shall be G.I/M.S. piping, medium duty, as per I.S: 1239 and valves shall be cast iron double flanged sluice valves on SOUNDERS pattern with C.I. body and Neoprene rubber diaphragm (Suggested make LABLINE, NKI or equivalent).

99.3. Accessories

Each filter shall be provided with following accessories:-

- Air release valve with connecting piping.
- 150mm dia dial burden type gunmetal pressure gauges with gunmetal isolation cock and connecting piping on inlet and outlet.
- Sampling cocks on raw water inlet and filtered water outlet.
- Individual drain connection with gunmetal full way valve.
- Connection with valve for air scouring.

100. WATER SOFTENER

- Softener shall be designed to give zero commercial hardness. Softener shall be with cation exchange resins.
- Softener vessel shall be of mild steel plate with dished ends and self supporting arrangement. Vessel shall be suitable for a working pressure. The shell shall have a minimum thickness of 8mm and dished ends 10mm. The vessel shall be painted internally with non-toxic bitumen paint and externally with one coat of red oxide and two or more coats of synthetic paint to give an even shade.
- The vessel shall have an internal collecting and distribution system of manufacturer's design.
- The softener shall have a set of interconnecting face piping consisting of inlet, outlet and brine injection system with valves and accessories complete as per requirement. Piping shall be M.S. medium duty, as per I.S: 1239 and valves shall be cast iron double flanged sluice valves on SOUNDERS pattern, with C.I. body and Neoprene rubber diaphragm (suggested make LABLINE, NKI or equivalent).
- One set of hydraulic injector with control valve, brine delivery pipes with adjustable indicator.
- One cylindrical salt saturator and measuring tank of M.S. rubber lined having a capacity of a minimum of two regenerations for.
- One orifice board for indicating wash and rinse rate to be fitted in drain sump.
- One charge of supporting gravel, sand and "cation" resin in requisite quantity. Resin shall be Indian 220 or approved equivalent make.
- One water testing kit with instructions for testing water samples.

101. PIPING

- Pipes for suction and delivery shall be galvanized/M.S tube (heavy duty) confirming to I.S:1239 up to 150mm dia and as per I.S:3589 for dia 200mm and above. The M.S flanges shall confirm to I.S:6392-1971.
- Gate valve and check valve above 65mm dia shall be C.I. double flanged conforming to I.S:780 manufactured by the reputed manufacturers or C.I. double flanged butterfly valves.

- Full way and check valves 65mm dia and below shall be gunmetal tested to 20Kg/cm2 pressure certified and conforming to I.S:778.
- Suction strainer or foot valves shall be C.I., confirming to I.S:4038 - 1979.

101.1. Joints

All pipes and fittings shall be provided with flanged joints, with flanges either screwed or welded complete and jointed with 1.5mm thick gasket complete with nuts, bolts and washers etc.

101.2. Testing

All G.I pipes (except fire pipe) shall be tested hydrostically for a period of 30 minutes to a pressure of 7 Kg/cm2 without drop in pressure and all G.I pipes for fire shall be tested hydrostically for a period of 30 minutes to a pressure of 10 Kg/cm2 without drop in pressure.

102. GUARANTEE

- The contractor shall submit a warranty for all equipment, materials and accessories supplied by him against manufacturing defects, malfunctioning or under capacity functioning.
- The form of warranty shall be as approved by the Engineer-in-Charge.
- The warranty shall be valid for a period of one year from the date of commissioning and handing over.
- The warranty shall expressly include replacement of all defective or under capacity equipment, Engineer-in-Charge may allow repair of certain equipment if the same is found to meet the requirement for efficient functioning of the system.
- The warranty shall include replacement of any equipment found to have capacity lesser than the rated capacity as accepted in the contract. The replacement equipment shall be approved by the Engineer-in-Charge.

103. IMPORTANT INSTRUCTION FOR QUALITY OF WATER

- The successful contractor will have to carry out a test of raw water from all the sources of water for the Hospital at their own cost from a reputed lab as approved by the Engineer-in-Charge / Consultant. On the basis of these results the contractor has to submit his shop drawings, design calculations and specifications accordingly.
- Please note that it is ultimately the responsibility of the contractor to provide treated water for different use in the hospital as per International Standard as given in the attached guidelines.

104. REQUIRED QUALITY OF TREATED WATER

Table 104-1 Parameters for Quality of Water

Sl. No.	Characteristics	Acceptable as per Indian Standard of P.H.E.
1	Turbidity (Units on J.T.U scale)	2.5
2	Colour (Units on Platinum Cobalt scale)	5.0
3	Taste and Odour	Unobjectionable
4	pH	7.0 to 8.5
5	Total dissolved solids (mg/l)	500
6	Total hardness (mg/l) (as CaCO3)	200
7	Chlorides (as Cl) (mg/l)	200

Sl. No.	Characteristics	Acceptable as per Indian Standard of P.H.E.
8	Sulphates (as SO4)	200
9	Fluorides (as F) (mg/l)	1.0
10	Nitrates (as NO3) (mg/l)	45
11	Calcium (as Ca) (mg/l)	75
12	Magnesium (as Mg) (mg/l)	> 30
13	Iron (as Fe) (mg/l)	0.1
14	Manganese (as Mn) (mg/l)	0.05
15	Copper (as Cu) (mg/l)	0.05
16	Zinc (as Zn) (mg/l)	5.0
17	Phenolic compounds (as Phenol) (mg/l)	0.001
18	Anionic detergents (mg/l) (as MBAS)	0
19	Mineral Oil (mg/l)	0.01
20	Arsenic (as As) (mg/l)	0.05
21	Cadmium (as Cd) (mg/l)	0.01
22	Chromium (as hexavalent Cr) (mg/l)	0.05
23	Cyanides (as CN) (mg/l)	0.05
24	Lead (as Pb) (mg/l)	0.1
25	Selenium (as Se) (mg/l)	0.01
26	Mercury (total as Hg) (mg/l)	0.001
27	Polynuclear Aromatic Hydrocarbons (PAH)	0.2 ug/l
28	Gross Alpha activity	3p Ci/l
	Gross Beta activity Pci = pico curie	30p Ci/l
29	Bacteriological Quality of piped water supplies	
	Treated water entering the distribution system	
29.1	Faecal coliforms number/100 ml	0

Sl. No.	Characteristics	Acceptable as per Indian Standard of P.H.E.
29.2	Coliform organisms number/ 100 ml	0

LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIALS PLUMBING SYSTEM

S. No.	Details of Materials / Equipment	Manufacturer's Name
1.	Vitreous China Sanitaryware	Aquaviva/Hindware/Vaalve Bathware
2.	Wc Pan Connector	Supreme/Prince/Mc Alpine
3.	Bath Fittings	Aquaviva/Hindware/Vaalve Bathware
4.	Stainless Steel Sink	Paryware/Nilkanth
5.	Auto Urinal Flush System	Euronics/Cmr/Roca
6.	Hand Drier	Euronics/Cmr/Kopal
7.	Cistern	Viega/Gebrit/Hindware
8.	Cp Brass Fittings	Aquaviva/Hindware/Vaalve Bathware
9.	Geyser	Racold/Bajaj/Havells
10.	Floor Drain Fixture Rain Water Outlets	Viega/Gmgr/Gebrit
11.	Cp Grating For Floor Trap	Viega/Gmgr/Neer
12.	Cast Iron Pipes & Fittings Manhole Cover & Frame	
13.	Pp Pipes	Huliot//Wavin
14.	Pp Fittings	Huliot/Astral/Wavin/
15.	C. As Per Is: 1536 (Pipes & Fittings) (Ci Class La Pipes)	Neco/ Iisco/Kesoram Calcutta
16.	D. Di Manhole Covers & Frames	Skf/ Neco
17.	Cila Fittings	Skf/ Neco
18.	Suspended Manhole & Gully Trap	Patel Pattern
19.	Drip Seal	Acqua Bond/Binod Cement Companey/Meggaseal

S. No.	Details of Materials / Equipment	Manufacturer's Name
20.	GI / MS PIPE (IS : 1239 And IS : 3589)	TATA STEEL/JINDAL
21.	Gi Pipe Fittings	Nvr/Mac/Zoloto M/Unik
22.	Gi Pipe Sealent	Henkel- Loctite 55
23.	Pipe Clamp & Support	Chilly Euro Clamp/Kanwal
24.	D.I Pipes	Electro Steel/Jindal/Lancokalahasthi
25.	Upvc Pipe	Supreme/Akg/Astral
26.	Cpvc Pipes	Ajay/Ashirwad/Astral/Akg
27.	Rcc Pipe	Om Spun Pipe/Pragati/Local Isi Approved
28.	Stoneware Pipe,Gulley Trap	Om Spun Pipe /Rajura/Perfect Potteries
29.	Gm /Forged Brass Ball Valves	Utam/Vtm/Audco/Leader
30.	Sluice Valve	Utam/Vtm/Audco/Leader
31.	Butterfly Valve	Utam/Vtm/Audco/Leader
32.	Check Valve-Wafer Type	Utam/Vtm/Audco/Leader
33.	Check Valve-Dual Plate	Utam/Vtm/Audco/Leader
34.	Check Valve-Forged Screwed	Utam/Vtm/Audco/Leader
35.	Pressure Reducing Valve	Honeywell/ Zoloto/ New /Leader
36.	Solenoid Valve	Danfos/ Honeywell
37.	Thermostatic Valve	Oventrop
38.	Air Release Valve	Advance/ Sant /Leader
39.	Ball Float Valve	Zoloto
40.	Nrv-Ball Type-Sewage Application	Danfos/Silverspark/Normex
41.	Y Strainer Ci	Emerald/Sant/Zoloto
42.	Hydropneumatic System	Grundfos/Ksb/Willo-Mather & Platt
43.	Storm Water Drainage & Sewage Sump Pumps	Grundfos/Ksb/Willo-Mather & Platt

S. No.	Details of Materials / Equipment	Manufacturer's Name
44.	Transfer Pumps	Grundfos/Xylem/Willo-Mather & Platt/Kirloskar
45.	Self-Priming Pump	Johnson/Kirloskar
46.	Mechanical Seal	Burgmann/Sealol
47.	Couplings	Love Joy
48.	Antyvibration Mounting & Flexible Connection	Dunlop/Kanwal Industries/Resistoflex
49.	Pressure Gauge	H Guru/Fiebig/Emerald
50.	Water Meter (Mechanical Type)	Kranti/Actaris/Kent/Capstan
51.	Electronic Flow Meter	Krohne/Rockwin
52.	Level Controller & Indicator Water	Eleggent Controll/Technika/Techtrol
53.	Paints	Asian Paints/Berger
54.	Mh/Water Tank Plastic Step	Kgm/Patel/Pranali Industries
55.	Insulation For Hot Water Pipe	Armacell-Armaflex/K-Flex/Thermaflex
56.	Three Way Motorised Valve	Danfoss/Honeywell/Siemens/Aip
57.	Grease Trap	Aco/Wade
58.	Welding Rods	Ador/Essab
59.	Fastener	Fisher/Hilti
60.	Fire Sealant	Birla 3m/Hilti
61.	Manhole(Prefabricated)	Ok Plat/Crescent Foundary
62.	Temperature Sensor/Gauge	Forbes Marshall/Wika
63.	Dosing Pumps	Lmi/Pulser Feeder/Toschon
64.	Flanges	Class 150 Table H
65.	U.V Sterlizer	Alfa/Eureka
66.	Flow Control Devices	Aquaplus/Jaquar/Rst
67.	Solar Pannel & Heat Pump	Greentrk/ Epl India/

LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIALS FIRE FIGHTING SYSTEM

S. No.	Details of Materials / Equipment	Manufacturer's Name
1.	C.I. Manholes Frame & Cover	Neco/ Skf /Rif
2.	Butterfly Valve	Utam/Vtm/Audco
3.	Gate Valve	Utam/Vtm/Audco/Leader
4.	Non Return Valve	Utam/Vtm/Audco/Leader
5.	Ball Valve	Utam/Vtm/Audco/Leader
6.	Di Fittings	V.S/Johnson/ Sant
7.	Dash Fasteners	Hilti/ Fisher
8.	Automatic Air Vent	Cim/Aip/Zoloto
9.	Pipe Hangers/Clamps/Support	Euro Clamp/ Chilly/Gripple
10.	Paint	Shalimar/ Berger/ Nerolac
11.	Fire Hose	Padmini/Newage/Minimax
12.	Fire Hydrant Valve	Padmini/Newage/Minimax
13.	First Aid Hose Reel Drum & Tubing	Padmini/Newage/Minimax
14.	Branch Pipe	Padmini/Newage/Minimax
15.	Double/Single Headed Landing Valves	Padmini/Newage/Minimax
16.	Fire Man Axe	Padmini/Newage/Minimax
17.	Fire Brigade Inlet Connection	Padmini/Newage/Minimax
22.	Battery Charger	Bch/Hbl/Kinetic
23.	Ms Pipe	Tata Steel/Jindal Hissar
24.	Sprinkler Head	Padmini/Newage/Minimax
25.	Alarm Control Valve	Tyco/Viking/Omex/Eversafe
26.	Flow Switch	System Sensor/Honeywell/Potter/Omex
27.	Welding Rod	Esab/ Ador/ Superon Oerlikon
28.	Pressure Switch	System Sensor/Honeywell/Potter

S. No.	Details of Materials / Equipment	Manufacturer's Name
29.	Controls	Honeywell/ Siemens/ Danfoss
30.	Vibration Eliminator	Resistoflex/ Kanwel
31.	G.I Fittings	Unik/ Zoloto
32.	Hooter	Honeywell/ Siemens/ Danfoss
33.	Sluice Valve	Leader/ Audco/ Sant
34	Y Strainer	Emeral/Sant/Zoloto
35.	Deluge Valve	Viking/Tyco/Hd
36.	Water Curtain Nozzle	Viking/Tyco/Hd
37.	Fire Extinguishers	Padmini/Newage/Minimax
38.	Flexible Drop Connection	Padmini/Newage/Minimax
39.	Electrical Pannel Dection & Supperession System	Padmini/Newage/Minimax
40.	Pipe Protection Wrapping	Pipekote/Coatek
41.	Inspector Test Assembly	Eversafe/Viking/Victaulic
42.	Fire Buckets	Padmini/Newage/Minimax
43.	Foot Valve	Kirloskar/Normex
44.	Mechanical Seal	Burgmann/Sealol
45.	Pressure Gauge	Hguru/Emerald/Fiebig
ELECTRICAL ACCESSORIES		
46.	Motor Control Center	Tricolite Electrical/Adlec Control System/Sk Power Solution
47.	Variable Speed Drives	Danfos/Abb/Siemens
48.	Moulded Case Circuit Breaker(Mcb)	L&T/Schneider Electric/Siemens
49.	Starter Contactor	Larsen & Turbo
50.	Miniature Circuit Breaker(Mcb)	Hager/ Schneider Electric/Siemens
51.	Overload Relays With Built In Single Phase Preventer	L&T/Schneider Electric/Siemens
52.	Current Transformer	Gilbert & Maxwell/Pragati/Automatic Electric

S. No.	Details of Materials / Equipment	Manufacturer's Name
53.	Rotary Switch	L&T/Schneider Electric/Siemens
54.	Timer Delay Relay	L&T/Schneider Electric/Siemens
55.	Timer	Asia Brown/L&T/ Siemens/Ge Power
56.	Selector Switch,Toggle Switch	L&T/Kaycee
57.	Change Over Switch	L&T/Hpl-Socomec
58.	Electronic Digital Meter	L&T/Schneider Electric/Siemens
59.	Indicating Lamps Led Type, Push Button	L & T / Schneider Electric/Siemens
60.	Pvc Insulated Aluminium/Copper Conductor, Aurmered Mv Cable(1100 V Grade)	Finolex/Polycab/Havells
61.	Metalic Conduit	Bec/Akg
62.	Pvc Conduit & Accessaris	Bec/Akg/Polycab
63.	Sandwitched Construction Bus Ducts	Control & Switchgear-Henikwon/ Schneider Electric
64.	Cable Tray (Factory Fabricated)	Sllotco/Neeedo/Mem
65.	Lt Jointing Kit/Termination	Birla-3m/Raychem
66.	Bimettalic Cable Lugs	Comet/Dowells(Biller India)
67.	Protection Relay	
68.	Numeric Type	Abb/Areva/L&T/ Siemens/Woodword
69.	B.Electromagnetic Type	Abb/Areva/L&T

Note: The contractor has to furnish the certificate stating that the material for firefighting system shall be supplied as per specification from the original manufacturer / authorized dealer and also he has to produce the documents in support of the statement.

TOWER A

Sr. No.	Description	Floor to Floor height (M)	Passenger Lift								Fireman's Lift	Goods Lift	
			L1	L2	L3	L4	L5	L6	L7	L8	F1	G1	G2
			GROUP 1			GROUP 2							
1	Shaft size (W X D)		2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.20 x 2.10	4.50 x 4.50 Required: 4.0 X 4.5	4.50 x 4.50 Required: 4.0 X 4.5
2	No. of Floors		13	13	13	14	14	14	14	14	13	13	13
3	No. of Stops												
	Basement	4.50	N	N	N	Y	Y	Y	Y	Y	N	N	N
	Ground	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P1	3.30	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P2	3.30	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	1st Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	2nd Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	3rd Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	4th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	5th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	6th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	7th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	8th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	9th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	10th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	MR/MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MR	MR
4	Car Size (W X DX H)		1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.5 X 1.6 X 2.7	2.50 x 3.25 X 2.4	2.5 X 3.5 X 2.4
5	Car Capacity		24 pax	24 pax	24 pax	24 pax	24 pax	24 pax	24 pax	24 pax	15Pax	5000kg	5000kg
6	Speed		1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1m/s	1m/s
7	Door size (width x height)		1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.00 x 2.40	1.7x 2.1	1.7x 2.1
8	Door Opening		Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening
9	Finish												
	Landing Door		SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline
	Car Door		SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline
	Car Cabin		SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish
	COP		2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	1 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL
10	Ceiling Type		spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)
11	Mirror		No	No	No	No	No	No	No	No	No	No	No
12	Handrail		Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside
13	Voice Announcement		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
14	PA System		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
15	Fire management System integrated with BMS		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
16	Lift Pit Height (m)		**1.6m**	**1.6m**	**1.6m**	**1.6m**	**1.6m**	**1.6m**	**1.6m**	**1.6m**	**1.6m**	**2m**	**2m**
17	Overhead Height (m)		5m	5m	5m	5m	5m	5m	5m	5m	5m	5m	5m
18	Defect Liability period (DLP)		2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs

TOWER B - WING I

Sr. No.	Description	Floor to Floor height (M)	Passenger Lift								Fireman's Lift	Goods Lift	
			L1	L2	L3	L4	L5	L6	L7	L8	F1	G1	G2
			GROUP 1			GROUP 2							
1	Shaft size (W X D)		2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.20 x 2.10	4.50 x 4.50 Required: 4.0 X 4.5	4.50 x 4.50 Required: 4.0 X 4.5
2	No. of Floors		13	13	13	14	14	14	14	14	13	13	13
3	No. of Stops												
	Basement	4.50	N	N	N	Y	Y	Y	Y	Y	N	N	N
	Ground	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P1	3.30	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P2	3.30	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	1st Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	2nd Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	3rd Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	4th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	5th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	6th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	7th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	8th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	9th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	10th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	MR/MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MR	MR
4	Car Size (W X D)		1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.5 X 1.6 X 2.7	2.50 x 3.25 X 2.4	2.5 X 3.5 X 2.4
5	Car Capacity		24 pax	24 pax	24 pax	24 pax	24 pax	24 pax	24 pax	24 pax	15Pax	5000kg	5000kg
6	Speed		1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1m/s	1m/s
7	Door size (width x height)		1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.00 x 2.40	1.7x 2.1	1.7x 2.1
8	Door Opening		Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening
9	Finish												
	Landing Door		SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline
	Car Door		SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline
	Car Cabin		SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish
	COP	0	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	1 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL
10	Ceiling Type		spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)
11	Mirror		No	No	No	No	No	No	No	No	No	No	No
12	Handrail		Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside
13	Voice Announcement		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
14	PA System		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
15	Fire management System integrated with BMS		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
16	Lift Pit Height (m)		1.6m	1.6m	1.6m	1.6m	1.6m	1.6m	1.6m	1.6m	1.6m	2m	2m
17	Overhead Height (m)		5m	5m	5m	5m	5m	5m	5m	5m	5m	5m	5m
18	Defect Liability period (DLP)		2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs

Remark Bottom of Pit to be solid filled for Group 1 , Fire and Goods Lift to avoid hanging pit requirement. This is in client scope

TOWER B - WING II

Sr. No.	Description	Floor to Floor height (M)	Passenger Lift								Fireman's Lift	Goods Lift	
			L1	L2	L3	L4	L5	L6	L7	L8	F1	G1	G2
			GROUP 1			GROUP 2							
1	Shaft size (W X D)		2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.20 x 2.10	4.50 x 4.50 Required: 4.0 X 4.5	4.50 x 4.50 Required: 4.0 X 4.5
2	No. of Floors		13	13	13	14	14	14	14	14	13	13	13
3	No. of Stops												
	Basement	4.50	N	N	N	Y	Y	Y	Y	Y	N	N	N
	Ground	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P1	3.30	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P2	3.30	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	1st Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	2nd Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	3rd Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	4th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	5th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	6th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	7th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	8th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	9th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	10th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	MR/MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MR	MR
4	Car Size (W X D)	0	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.5 X 1.6 X 2.7	2.50 x 3.25 X 2.4	2.5 X 3.5 X 2.4
5	Car Capacity		24 pax	24 pax	24 pax	24 pax	24 pax	24 pax	24 pax	24 pax	15Pax	5000kg	5000kg
6	Speed		1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1m/s	1m/s
7	Door size (width x height)		1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.00 x 2.40	1.7x 2.1	1.7x 2.1
8	Door Opening		Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening
9	Finish												

TOWER A

Sr. No.	Description	Floor to Floor height (M)	Passenger Lift								Fireman's Lift	Goods Lift	
			L1	L2	L3	L4	L5	L6	L7	L8	F1	G1	G2
			GROUP 1			GROUP 2							
	Landing Door		SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline
	Car Door		SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline
	Car Cabin		SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish
	COP	0	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	1 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL
10	Ceiling Type		spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)
11	Mirror		No	No	No	No	No	No	No	No	No	No	No
12	Handrail		Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside
13	Voice Announcement		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
14	PA System		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
15	Fire management System integrated with BMS		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
16	Lift Pit Height (m)		1.6m	1.6m	1.6m	1.6m	1.6m	1.6m	1.6m	1.6m	1.6m	2m	2m
17	Overhead Height (m)		5m	5m	5m	5m	5m	5m	5m	5m	5m	5m	5m
18	Defect Liability period (DLP)		2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs
Remark			Bottom of Pit to be solid filled for Group 1 , Fire and Goods Lift to avoid hanging pit requirement. This is in client scope										

TOWER C - WING I

Sr. No.	Description	Floor to Floor height (M)	Passenger Lift								Fireman's Lift	Goods Lift	
			L1	L2	L3	L4	L5	L6	L7	L8	F1	G1	G2
			GROUP 1			GROUP 2							
1	Shaft size (W X D)		2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.20 x 2.10	4.50 x 4.50 Required: 4.0 X 4.5	4.50 x 4.50 Required: 4.0 X 4.5
2	No. of Floors		13	13	13	13	13	13	13	13	13	13	13
3	No. of Stops												
	Ground	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P1	3.30	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P2	3.30	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	1st Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	2nd Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	3rd Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	4th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	5th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	6th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	7th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	8th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	9th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	10th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	MR/MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MR	MR
4	Car Size (W X DX H)	0	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.5 X 1.6 X 2.7	2.50 x 3.25 X 2.4	2.5 X 3.5 X 2.4
5	Car Capacity		24 pax	24 pax	24 pax	24 pax	24 pax	24 pax	24 pax	24 pax	15Pax	5000kg	5000kg
6	Speed		1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1m/s	1m/s
7	Door size (width x height)		1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.00 x 2.40	1.7x 2.1	1.7x 2.1
8	Door Opening		Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening
9	Finish												
	Landing Door		SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline
	Car Door		SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline
	Car Cabin		SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish
	COP	0	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	1 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL
10	Ceiling Type		spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)
11	Mirror		No	No	No	No	No	No	No	No	No	No	No
12	Handrail		Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside
13	Voice Announcement		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
14	PA System		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
15	Fire management System integrated with BMS		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
16	Lift Pit Height (m)		1.6m	1.6m	1.6m	1.6m	1.6m	1.6m	1.6m	1.6m	1.6m	2m	2m
17	Overhead Height (m)		5m	5m	5m	5m	5m	5m	5m	5m	5m	5m	5m
18	Defect Liability period (DLP)		2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs

TOWER C - WING II

Sr. No.	Description	Floor to Floor height (M)	Passenger Lift								Fireman's Lift	Goods Lift	
			L1	L2	L3	L4	L5	L6	L7	L8	F1	G1	G2
			GROUP 1			GROUP 2							
1	Shaft size (W X D)		2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.58 x 2.75	2.20 x 2.10	4.50 x 4.50 Required: 4.0 X 4.5	4.50 x 4.50 Required: 4.0 X 4.5
2	No. of Floors		13	13	13	13	13	13	13	13	13	13	13
3	No. of Stops												
	Ground	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P1	3.30	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	P2	3.30	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	1st Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	2nd Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	3rd Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	4th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	5th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	6th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	7th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	8th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	9th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	10th Floor	4.10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	MR/MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MRL	MR	MR
4	Car Size (W X D)	0	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.8 X 2.0 X 2.7	1.5 X 1.6 X 2.7	2.50 x 3.25 X 2.4	2.5 X 3.5 X 2.4
5	Car Capacity		24 pax	24 pax	24 pax	24 pax	24 pax	24 pax	24 pax	24 pax	15Pax	5000kg	5000kg
6	Speed		1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1.75m/s	1m/s	1m/s
7	Door size (width x height)		1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.10 x 2.40	1.00 x 2.40	1.7x 2.1	1.7x 2.1
8	Door Opening		Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening	Central Opening
9	Finish												
	Landing Door		SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline
	Car Door		SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline	SS 304 Hairline
	Car Cabin		SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish	SS Linen finish
	COP	0	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL	1 COPs- SSHL	2 COPs- SSHL	2 COPs- SSHL
10	Ceiling Type		spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)	spotlight + fan (blower)
11	Mirror		No	No	No	No	No	No	No	No	No	No	No
12	Handrail		Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside	Yes Backside
13	Voice Announcement		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
14	PA System		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
15	Fire management System integrated with BMS		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
16	Lift Pit Height (m)		1.6m	1.6m	1.6m	1.6m	1.6m	1.6m	1.6m	1.6m	1.6m	2m	2m
17	Overhead Height (m)		5m	5m	5m	5m	5m	5m	5m	5m	5m	5m	5m
18	Defect Liability period (DLP)		2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs	2 yrs

Important Note: Based on the current pricing, it is estimated that the material component is 85% and the labour component is 15% of the total contract value, as stated in Clause 1. For the material component that forms part of this Contract, we have considered 1 CNY to 14.3 INR (C). Schindler reserves the right to proportionately revise the material portion of the contract value for the material component as per the exchange rate on the date of bill of lading (D) and claim from client. Any change or variation increase/decrease in import duties, or government levies and/ or any other consequent charges after the booking of Contract shall be charged solely to the Customer and calculated on an actual basis, with payment due immediately. For clarity, the additional price arising from foreign exchange fluctuation will be calculated as follows, by way of illustration: Delta price = (Contract value * A) / (C) * (D-C) Where: A = 85% C = Exchange rate considered at order booking D = Exchange rate on the bill of lading date

Scope

OEM Scope							
Above prices are inclusive of Supply, Installation, Testing and Commissioning of Elevators.							
DLP of 2 year from Installation of Elevator							
Bamboo Scaffolding							
Barricading							
Project Management							
PWD Coordination							
SEEPZ Scope							
All Civil and Electrical works are under client scope							
Client to provide single phase and 3 Phase electricity for Installation							
Covered Storage space							
PWD Document and Fees							

GEOTECHNICAL REPORT

GEOTECHNICAL INVESTIGATION

FOR

THE CONSTRUCTION OF INDUSTRIAL BUILDING FOR SEEPZ-SEZ AUTHORITY, ANDHERI (E), MUMBAI, MAHARASHTRA

CLIENT - TRACTEBEL ENGINEERING PVT LTD

Client	Reporting Agency
TRACTEBEL ENGINEERING PVT LTD	

NAME OF DOCUMENT:

GEOTECHNICAL INVESTIGATION REPORT

REPORT NO: LCEPL/LAB/REPORT/300

22 June 2026

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ANNEXURE VII: SITE & COREBOX PHOTOGRAPHS

1. INTRODUCTION

The SEEPZ Special Economic Zone (SEZ) Authority has proposed the construction of an Industrial Building at Andheri (East), Mumbai, Maharashtra. For the planning and design of the proposed development, a geotechnical investigation was required to assess the subsurface conditions and evaluate the engineering characteristics of the underlying soil and rock strata.

M/s Tractebel Engineering Pvt. Ltd., appointed as the Engineering Consultant for the project, entrusted the geotechnical investigation work to M/s Landchester Engineers, Navi Mumbai. Accordingly, a detailed subsurface exploration programmed was carried out at the project site to obtain geotechnical data necessary for foundation design and construction planning.

1.1 PURPOSE OF GEOTECHNICAL INVESTIGATION

The purpose of the geotechnical investigation is to determine the subsurface soil and rock characteristics at the proposed construction site to facilitate safe and economical foundation design. To achieve this objective, a comprehensive geotechnical investigation program was undertaken, which included:

- Drilling of three boreholes up to 15.00 meters depth each below ground level (BGL).
- Conducting in-situ Standard Penetration Tests (SPT).
- Collection of soil and rock samples.
- Laboratory testing on selected soil and rock samples.

This report presents detailed findings of one borehole, along with engineering interpretation and foundation recommendations for the proposed residential building.

2. SCOPE OF WORK

The scope of work for the geotechnical investigation included the following:

2.1 BOREHOLE DRILLING

Drilling of three boreholes was carried out at the designated locations within the project site. The boreholes were advanced up to the specified termination depths based on the subsurface conditions encountered during drilling. The borehole depths are as follows:

- BH-01: 10.50 m below existing ground level
- BH-02: 15.00 m below existing ground level
- BH-03: 15.00 m below existing ground level

2.2 IN-SITU TESTING

- Conducting Standard Penetration Tests (SPT) at 1.5-meter intervals and at every change in soil strata.
- Recording SPT N-values.
- Collection of disturbed soil samples during SPT.

2.3 ROCK CORING

- NX-sized rock coring in rock strata encountered during drilling.
- Determination of Rock Quality Designation (RQD).
- Recording of core recovery and nature of rock.

2.4 LABORATORY TESTING

Laboratory testing was carried out on selected rock core samples to determine engineering properties, including:

- Uniaxial Compressive Strength (UCS) Test
- Point Load Index Test
- Dry Density of Rock
- Bulk Density of Rock
- Water Content of Rock
- Porosity of Rock

All laboratory test results are enclosed in **Annexure IV** of this report.

2.5 REPORT PREPARATION

Preparation of a detailed geotechnical report including:

- Subsurface soil stratification
- Laboratory test results
- Foundation recommendations

3. METHODOLOGY OF INVESTIGATION

3.1 FIELD INVESTIGATION

The subsurface investigation was carried out in accordance with the project specifications and relevant Indian Standards, including IS 1892:1979 for subsurface investigation, IS 2131:1981 for Standard Penetration Test (SPT), and IS 4464:2020 for drilling, core logging, and presentation of rock core information.

Boreholes were drilled using calyx rotary drilling rigs capable of advancing through both soil and rock formations to the required depths. The drilling equipment was maintained in good working condition to ensure stable and vertical boreholes throughout the investigation. Temporary casing was provided wherever required to prevent the collapse of borehole walls until stable strata were encountered. Drilling operations were continuously monitored, and groundwater levels, water loss, artesian conditions, cavities, seams, and other significant field observations were recorded in the borehole logs.

3.2 SOIL INVESTIGATION

Standard Penetration Tests (SPT) were carried out at every 1.5 m depth interval or at every change of soil strata, whichever occurred earlier, in accordance with IS 2131:1981. The test was performed using a split-spoon sampler of 50 mm outside diameter, driven into the soil by a 63.5 kg hammer falling freely through a height of 750 mm. After an initial seating drive of 150 mm, the number of blows required to drive the sampler through the subsequent 300 mm was recorded as the Standard Penetration Resistance (N-value).

Representative disturbed soil samples obtained during the SPT were collected, properly labelled, sealed in airtight containers, and transported to the laboratory for identification and testing. Undisturbed soil samples, wherever required and feasible, were collected using thin-walled Shelby tubes in accordance with the relevant provisions of IS 1892 for laboratory determination of engineering properties.

3.3 ROCK CORE DRILLING

On encountering SPT refusal or rock strata, drilling was continued by NX-size diamond core drilling in accordance with IS 4464 (Part 1 & Part 2):2001. Continuous rock coring was carried out using a double core barrel fitted with diamond-impregnated bits. The maximum length of

each core run was limited to 1.5 m or reduced wherever necessary to achieve maximum core recovery and preserve the in-situ condition of the rock.

The drilling rate for each core run was recorded, and all recovered cores were carefully examined and logged for lithology, colour, weathering, rock strength, degree of fracturing, joint characteristics, and other geological features. Core Recovery (CR) and Rock Quality Designation (RQD) were determined for each core run in accordance with IS 4464.

Rock Quality Designation (RQD) was calculated using the following expression:

RQD (%) = (Sum of the lengths of intact core pieces greater than 100 mm / Total length of core run) × 100

Recovered rock cores were placed sequentially in properly labelled core boxes and preserved for geological logging, laboratory testing, and future reference.

The borehole locations, depths, groundwater observations, soil strata, rock descriptions, SPT results, Core Recovery, and RQD values are presented in the borehole logs included in this report Borehole details and locations are given in Table below.

S.N	Bore Hole Designation	UTM Coordinates		Reduced Level (m)	Depth of Water Table (m)	Exploration Depth (m)
		Easting	Northing			
1	BH 01	276439.3074	2116031.374	25.3	4.10 m Below EGL	10.50m
2	BH 02	276372.5479	2116076.322	25.9	3.70 m Below EGL	15m
3	BH 03	276429.5664	2115990.954	25.3	3.90 m Below EGL	15m

4. SUBSURFACE CONDITIONS

4.1 STRATIGRAPHY AND SUBSURFACE CONDITIONS AT BOREHOLE LOCATION

Based on the boring information, the following subsoil profile was inferred up to final depth of boreholes drilled at borehole locations

Stratigraphy and Sub-Surface Conditions						
BH No.	Depth (m)		Strata Description	SPT N Value	Core Recovery (%)	RQD (%)
	From	To				
BH-01	0	1.5	Filled up soil	Refusal	-	-
	1.5	4.5	Light Brown, completely weathered Rock	-	7.33 - 8.93	Nil
	4.5	7.5	Light Brown, highly weathered Rock	-	21.33 - 25.13	Nil - 14.90
	7.5	9	Light Brown, moderately weathered Rock	-	21.33	7.33
	9	10.5	Light Brown, slightly weathered Rock	-	36.3	30.3

Stratigraphy and Sub-Surface Conditions						
BH No.	Depth (m)		Strata Description	SPT N Value	Core Recovery (%)	RQD (%)
	From	To				
BH-02	0	1.5	Filled up soil	Refusal	-	-
	1.5	4.5	Light Brown, completely weathered Rock	-	12.30-15.10	Nil - 6.60
	4.5	7.5	Light Brown, highly weathered Rock	-	18.46 - 29.13	7.13-16
	7.5	9	Light Brown, moderately weathered Rock	-	37.8	37.8
	9	12	Light Brown, highly weathered Rock	-	23.80-31.00	Nil
	12	15	Light Brown, slightly weathered Rock	-	54 - 64	54 - 64

Stratigraphy and Sub-Surface Conditions						
BH No.	Depth (m)		Strata Description	SPT N Value	Core Recovery (%)	RQD (%)
	From	To				
BH-03	0	1.5	Filled up soil	Refusal	-	-
	1.5	4.5	Light Brown, completely weathered Rock	-	4.6 - 6.60	Nil
	4.5	9	Light Brown, highly weathered Rock	-	14 -16	Nil
	9	10.5	Light Brown, moderately weathered Rock	-	35	30.2
	10.5	12	Light Brown, completely weathered Rock	-	15.3	Nil
	12	13.5	Light Brown Highly weathered Rock	-	13	6.7
	13.5	15	Light Brown, slightly weathered Rock	-	25.8	25.8

4.2 GROUNDWATER LEVEL

Groundwater was encountered during the course of drilling in all boreholes. the groundwater level was observed at depths ranging approximately between 3.70 m and 4.10 m below existing ground level (BGL) at the time of investigation. The measured groundwater levels are as follows:

- **BH-1:** ~4.10 m bgl
- **BH-2:** ~3.70 m bgl
- **BH-3:** ~3.90 m bgl

it is to be noted that the recorded groundwater level represents the condition prevailing at the time of investigation. the groundwater table may fluctuate seasonally depending upon rainfall, drainage conditions, and nearby site activities. therefore, suitable dewatering measures, if required during excavation or foundation construction, should be adopted based on actual site conditions at the time of execution.

5. GEOTECHNICAL ANALYSIS

5.1 BEARING CAPACITY OF ROCK (as per IS: 12070 – 1987)

Analysis for allowable bearing capacity on rock has been done by the following two methods.

a) Safe Bearing Capacity from the Core Strength

The safe bearing capacity has been estimated from the following equation given in IS: 12070.

$q_s = q_c * N_j$

q_s = gross safe bearing pressure (includes safety factor 3)

q_c = average uniaxial compressive strength of rock cores

N_j = empirical coefficient depending on the spacing of discontinuities.

= $\frac{3+S/B_f}{10\sqrt{(1+300\delta/S)}}$, equation includes a factor of safety 3.

= 0.10 for spacing of discontinuities 300 mm to 1000 mm

where, δ = thickness of discontinuities (cm)

S = spacing of discontinuities (cm)

B_f = width of footing (cm)

This relationship is valid for a rock mass with spacing of discontinuities greater than 0.30 m aperture of discontinuities less than 10 mm and foundation width more than 0.30 m.

b) Safe Bearing Pressure from the RMR System:

Analysis has been carried out using the RMR also known as Geo-mechanics classification by considering various parameters such as uni-axial compressive strength, RQD, spacing and condition of discontinuities and ground water condition. The correlation between the RMR value and allowable pressure has been given in Table –3, IS: 12070. This will ensure settlement of raft foundation to be less than 12 mm.

Net Safe Bearing Pressures Based on RMR:

Classification No	I	II	III	IV	V
Description of Rock	Very Good	Good	Fair	Poor	Very Poor
R M R	100-81	80-61	60-41	40-21	20-0
Q ns (T/m2)	600-448	448-288	280-141	135 - 48	45-30

The RMR for use in Table should be the average within a depth below foundation level equal to the width of foundation, provided the RMR is fairly uniform within the depth. If the upper part of the rock, within a depth of about one fourth of the width of foundation, is of lower quality the value of this part should be used or the inferior rock should be removed. Since these values are based on limiting the settlement, they should not be increased if the foundation is embedded into the rock.

5.2 ROCK MASS RATING

Rock Mass Rating (RMR) of jointed rock masses, may be worked out based on IS 13365 (part I). Rock Mass Rating parameters are reproduced from annex B of IS 13365 (part I) below for ready reference.

Strength of intact rock material (MPa)

Rock	Compressive Strength (MPa)	Rating	Basis
Exceptionally	>250	15	UCS value data of specific borehole from laboratory test is used in RMR
Very Strong	100-250	12	
Strong	50-100	7	
Average	25-50	4	
Weak	10-25	2	
Very Weak	2-10	1	
Extremely Weak	<2	0	

Rock quality designation (RQD)

Rock	RQD (%)	Rating	Basis
Excellent	90-100	20	RQD values of specific boreholes below given depth from relevant borehole is used in RMR
Good	75-90	17	
Fair	50-75	13	
Poor	25-50	8	
Very Poor	<25	3	

Spacing of discontinuities

	Spacing, (m)	Rating	Basis
Very Wide	>2	20	Spacing of discontinuities of specific borehole from field observations is used in RMR
Wide	0.6-2	15	
Moderate	0.2-0.6	10	
Close	0.06-0.2	8	
Very Close	<0.06	5	

Condition of discontinuities

Very rough and unweathered rock wall rock, tight and discontinuous, no separation	rough and slightly weathered wall rock surface, separation < 1 mm	slightly rough and moderately to highly weathered wall rock surface, separation < 1 mm	Slicken sided wall rock surface or 1- 5 mm thick gauge or 1-5 mm wide opening, continuous discontinuity	5 mm thick soft gauge 5 mm wide continuous discontinuity
30	25	20	10	0

Ground water condition

General Description	Completely Dry	Damp	Wet	Dripping	Flowing
Rating	15	10	7	4	0

Rating adjustment for discontinuities orientations

Strike and Dip Orientations of Discontinuities		Very Favourable	Favourable	Fair	Unfavourable	Very Unfavourable
Ratings	Tunnels and mines	0	-2	-5	-10	-12
	Foundations	0	-2	-7	-15	-25
	Slopes	0	-5	-25	-50	-60

6. DISCUSSION AND BEARING CAPACITY ANALYSIS

6.1 The proposed RCC industrial building comprises a G+2 podium and a 10-storey superstructure, with a basement under two towers of the three-tower building plan. The depth of the single basement is 4.5 m, and the thickness of the raft foundation/footing is 1.4 m to 1.5 m. Therefore, the minimum excavation required below the existing ground level would be approximately 6 m to 7.5 m.

6.2 As stated above, filled-up soil is encountered up to a depth of approximately 1.50 m at all borehole locations, followed by light brown, completely weathered rock, highly weathered rock, moderately weathered rock, and slightly weathered rock at varying depths. Hence, for the proposed industrial building, isolated footings or a raft foundation should be adopted, resting on or embedded in the moderately weathered to slightly weathered rock stratum at a depth of approximately 6.00 m to 7.50 m below the existing ground level, depending upon the location of the foundation.

6.3 Safe bearing capacity of rock stratum can be calculated using unconfined compression strength value of rock cores tested in the laboratory. For determining safe bearing capacity of rock stratum, it is the usual practice to consider the unconfined compression strength of rock cores determined in the laboratory as the ultimate bearing capacity of in situ rock mass. Then adopting a factor of safety value of 3 to 10, the net safe bearing capacity of rock stratum is worked out.

Foundation Details For isolated footing				
Borehole	Depth of foundation below existing ground level	Net Safe Bearing Capacity (As per Shear criteria Only) Based on (t/m2)		Recommended Net Safe Bearing Capacity (t/m2)
	(m)	UCS value	RMR value	
BH-01	3.0	103.24	66	66
	4.5	78.39	52.6	52.6
	6.0	119	98	98
	7.5	135	125	125
BH-02	3.0	57.74	52.57	52.57
	4.5	73.18	52.57	52.57
	6.0	114	52	52
	7.5	140	125	125
BH-03	3.0	77	66	66
	4.5	75	52	52
	6.0	78	52	52
	7.5	86	66	66

Note:- Based on the geotechnical investigation, fractured rock is encountered up to a depth of 4.5 m. Open excavation may be carried out where adequate working space is available and stable side slopes can be maintained. However, where vertical excavation faces are required or where site constraints prevent safe sloping of the excavation, a suitable shore piling system shall be provided to ensure the stability of the excavation and the safety of adjoining structures, utilities, and personnel.

For Landchester Engineers	For Landchester Engineers
Prepared by	Reviewed and authorized by
Adnan Siddiqui	Gaurav D. Hande
B.Tech. in Civil Engineer	M.E. Geotech

REFERENCES

Laboratory Tests on Soil Samples	Relevant IS Code
Bulk Density	IS 2720 (Part-2)-1973
Natural Moisture Content	IS 2720 (Part-2)-1973
Specific Gravity	IS 2720 (Part-3)-1980
Direct Shear Test	IS 2720 (Part-13)-1986
Triaxial Test	IS 2720 (Part-11)-1981
Grain Size Analysis	IS 2720 (Part-4)-1985
Liquid Limit and Plastic Limit	IS 2720 (Part-5)-1985
Laboratory Tests on Rock Samples	**Relevant IS Code**
Bulk Density	IS 13030-1991
Moisture Content	IS 13030-1991
Specific Gravity	IS 13030-1991
Point Load	IS 8764-1998
Unconfined Compressive Strength	IS 9143-1979
Laboratory Tests on Soil Sample (Chemical)	**Relevant IS Code**
Chlorides (NO2Cl)	BS EN 1377 (Part-3)
Sulphate (SO42-)	IS 2720 (Part-27)-1977
pH	IS 2720 (Part-26)-1987
Organic Matter	IS 2720 (Part-22)-1977
Laboratory Tests on water Sample (Chemical)	**Permissible Limit as per**
Chlorides (Cl-) (mg/l)	500
Sulphate (SO42-) (mg/l)	400
pH Value	Not less than 6
Organic Matter (mg/l)	200
Inorganic Matter (mg/l)	3000
Total Suspended Matter (mg/l)	2000

Relevant IS Codes used for Calculations
Code of Practice for Calculation of Settlements of Foundations (IS: 8009-1976)
Code of Practice for Design and Construction of Shallow Foundations on Rocks (IS: 12070-1987)
Quantitative Classification Systems of Rock Mass — Guidelines (IS: 13365-1998)

ANNEXURE I: LOCATION PLAN

LOCATION PLAN

ANNEXURE II: BORELOGS

Landchester Engineers

Project : Geotechnical Investigation - SEEPZ Mumbai

Client: M/s. TRACTEBEL Engineering pvt ltd

Borehole No.:	BH 01	**Start Date:**	06-06-2026	**End Date:**	09-06-2026
Easting :	276439.30742	**Northing :**	2116031.37383	**T.D.(m):**	10.50
Equipment:	Calyx	**Core barrel type**	Single Tube	**W.T.(m):**	4.10
Drilling Method:	Rotary Drilling	**Type of Bit:**	Diamond Bit	**Drilling Fluid:**	Water
Casing Size:	100/NX	**Casing Depth(m)**	4.00	**Core diameter (mm):**	55

FIELD BOREHOLE LOG SHEET

Depth (m) Below EGL	Lithology	Description	Sample & Insitu Test depth (m)	Sample Type	Sample Number	SPT Blow Counts 15 cm	30 cm	45 cm	SPT "N" value	Penetration rate	TCR (%)	RQD (%)	Core Piece No.	Fracture Index (FI)	Colour of Return Water
0.0		Filling material Soil and Gravel													
0.5															
1.0															
1.5			1.50	SPT	1.00	-	-	-	Refusal	-	-	-	-	-	
2.0		Light Brown , Completely weathered Rock													
2.5															
3.0			3.00	Core	2	-	-	-	-	-	7.33	Nil		V	
3.5		Light Brown , Completely weathered Rock													
4.0															
4.5			4.50	Core	3	-	-	-	-	-	8.93	NIl		V	
5.0		Light Brown, Highly weathered Rock													
5.5															
6.0			6.00	CORE	4	-	-	-	-	-	25.13	14.90		IV	
6.5		Light Brown, Highly weathered Rock													
7.0															
7.5			7.50	CORE	5	-	-	-	-	-	21.33	Nil		IV	
8.0		Light Brown ,Moderately weathered Rock													
8.5															
9.0			9.00	CORE	6	-	-	-	-	-	21.33	7.33		III	
9.5		Light Brown ,Slightly weathered Rock													
10.0															
10.5			10.5	CORE	7	-	-	-	-	-	36.30	30.30		II	

SPT-	(Standard Penetration Test - S1,S2,S3...)	I	Fresh	R	SPT Refusal	Ground water Level	
UDS	(Undisturbed Sample - U1,U2,U3....)	II	Slightly weathered	EGL	Existing Ground Level		
DS	(Disturbed Sample - D1,D2,D3....)	III	Moderately weathered	F.I.	Fracture Index		
RC/SC	(Rock /Soil Core-C1,C2,C3....)	IV	Highly weathered	PLI	Point Load Index		
	Wash Boring	V	Completely weathered	UCS	Unconfined Compressive Strength		
	Fill	Comp. Weath Rock	VI	Residual Soil	TCR	Total Core Recovery	
	Soil	Highly Weath Rock	TD	Termination depth	SCR	Solid Core Recovery	
	Murrum/ Boulders	Mod. Weath Rock	R.L.	Reduced Level	RQD	Rock Quality Designation	
	Fresh Rock	Slightly Weath Rock					

Prepared By		Checked By	
Name	Signature	Name	Signature
Adnan Siddiqui		Gaurav D. Hande	

Landchester Engineers

Project : Geotechnical Investigation - SEEPZ Mumbai

Client: M/s. TRACTEBEL Engineering pvt ltd

Borehole No.:	BH 02	**Start Date:**	11-06-2026	**End Date:**	12-06-2026
Easting	276372.54789	**Northing :**	2116076.32202	**T.D.(m):**	15.00
Equipment:	Calyx	**Core barrel type**	Single Tube	**W.T.(m):**	3.70
Drilling Method:	Rotary Drilling	**Type of Bit:**	Diamond Bit	**Drilling Fluid:**	Water
Casing Size:	100/NX	**Casing Depth(m)**	4.00	**Core diameter (mm):**	55

FIELD BOREHOLE LOG SHEET

Depth (m) Below EGL	Lithology	Description	Sample & Insitu Test depth (m)	Sample Type	Sample Number	SPT Blow Counts 15 cm	30 cm	45 cm	SPT "N" value	Penetration rate	TCR (%)	RQD (%)	Core Piece No.	Fracture Index (FI)	Colour of Return Water
0.0		Filling material Soil and Gravel													
0.5															
1.0															
1.5			1.50	SPT	1.00	4/100	-	-	Refusal	-	-	-	-	-	
2.0		Light Brown , Completely weathered Rock													
2.5															
3.0			3.00	Core	1	-	-	-	-	-	12.30	Nil		V	
3.5		Light Brown , Completely weathered Rock													
4.0															
4.5			4.50	Core	2	-	-	-	-	-	15.10	6.60		V	
5.0		Light Brown , Highly weathered Rock													
5.5															
6.0			6.00	CORE	3	-	-	-	-	-	18.46	7.13		IV	
6.5		Light Brown, Highly weathered Rock													
7.0															
7.5			7.50	CORE	4	-	-	-	-	-	29.13	16.00		IV	
8.0		Light Brown Moderately weathered Rock													
8.5															
9.0			9.00	CORE	5	-	-	-	-	-	37.80	37.80		II	
9.5		Light Brown Highly weathered Rock													
10.0															
10.5			10.5	CORE	6	-	-	-	-	-	23.80	Nil		IV	
11.0		Light Brown , Highly weathered Rock													
11.5															
12.0			12.0	CORE	7	-	-	-	-	-	31.00	Nil		IV	
12.5		Light Brown, Slightly weathered Rock													
13.0															
13.5			13.5	CORE	8	-	-	-	-	-	54.00	54.00		II	
14.0		Light Brown, Slightly weathered Rock													
14.5															
15.0			15.0	CORE	9	-	-	-	-	-	64.10	64.10		II	

SPT-	(Standard Penetration Test - S1,S2,S3...)	I	Fresh	R	SPT Refusal	Ground water Level	
UDS	(Undisturbed Sample - U1,U2,U3....)	II	Slightly weathered	EGL	Existing Ground Level		
DS	(Disturbed Sample - D1,D2,D3....)	III	Moderately weathered	F.I.	Fracture Index		
RC/SC	(Rock /Soil Core-C1,C2,C3....)	IV	Highly weathered	PLI	Point Load Index		
	Wash Boring	V	Completely weathered	UCS	Unconfined Compressive Strength		
	Fill / Comp. Weath Rock	VI	Residual Soil	TCR	Total Core Recovery		
	Soil / Highly Weath Rock	TD	Termination depth	SCR	Solid Core Recovery		
	Murrum/ Boudlers / Mod. Weath Rock	R.L.	Reduced Level	RQD	Rock Quality Designation		
	Fresh Rock / Slightly Weath Rock						

Prepared By		Checked By	
Name	Signature	Name	Signature
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Landchester Engineers

Project : Geotechnical Investigation - SEEPZ Mumbai

Client: M/s. TRACTEBEL Engineering pvt ltd

Borehole No.:	BH 03	**Start Date:**	14-06-2026	**End Date:**	15-06-2026
Easting	276429.56642	**Northing :**	2115990.9541	**T.D.(m):**	15.00
Equipment:	Calyx	**Core barrel type**	Single Tube	**W.T.(m):**	3.90
Drilling Method:	Rotary Drilling	**Type of Bit:**	Diamond Bit	**Drilling Fluid:**	Water
Casing Size:	100/NX	**Casing Depth(m)**	4.00	**Core diameter (mm):**	55

FIELD BOREHOLE LOG SHEET

Depth (m) Below EGL	Lithology	Description	Sample & Insitu Test depth (m)	Sample Type	Sample Number	SPT Blow Counts 15 cm	30 cm	45 cm	SPT "N" value	Penetration rate	TCR (%)	RQD (%)	Core Piece No.	Fracture Index (FI)	Colour of Return Water
0.0	.	Filling material Soil and Gravel													
0.5															
1.0															
1.5			1.50	SPT	1.00	4/100	-	-	Refusal	-	-	-	-	-	
2.0		Light Brown, Completely weathered Rock													
2.5															
3.0			3.00	Core	1	-	-	-	-	-	4.60	Nil		V	
3.5		Light Brown, Completely weathered Rock													
4.0															
4.5			4.50	Core	2	-	-	-	-	-	6.60	Nil		V	
5.0		Light Brown , Highly weathered Rock													
5.5															
6.0			6.00	CORE	3	-	-	-	-	-	16.00	Nil		V	
6.5		Light Brown , Highly weathered Rock													
7.0															
7.5			7.50	CORE	4	-	-	-	-	-	15.80	Nil		V	
8.0		Light Brown , Highly weathered Rock													
8.5															
9.0			9.00	CORE	5	-	-	-	-	-	14.00	Nil		V	
9.5		Light Brown , Moderately weathered Rock													
10.0															
10.5			10.5	CORE	6	-	-	-	-	-	35.00	30.20		IV	
11.0		Light Brown, Completely weathered Rock													
11.5															
12.0			12.0	CORE	7	-	-	-	-	-	15.30	Nil		V	
12.5		Light Brown Highly weathered Rock													
13.0															
13.5			13.5	CORE	8	-	-	-	-	-	13.00	6.70		IV	
14.0		Light Brown Slightly weathered Rock													
14.5															
15.0			15.0	CORE	9	-	-	-	-	-	25.80	25.80		II	

SPT-	(Standard Penetration Test - S1,S2,S3...)	I	Fresh	R	SPT Refusal	Ground water Level	
UDS	(Undisturbed Sample - U1,U2,U3....)	II	Slightly weathered	EGL	Existing Ground Level		
DS	(Disturbed Sample - D1,D2,D3....)	III	Moderately weathered	F.I.	Fracture Index		
RC/SC	(Rock /Soil Core-C1,C2,C3....)	IV	Highly weathered	PLI	Point Load Index		
	Wash Boring	V	Completely weathered	UCS	Unconfined Compressive Strength		
.	Fill	Comp. Weath Rock	VI	Residual Soil	TCR	Total Core Recovery	
	Soil	Highly Weath Rock	TD	Termination depth	SCR	Solid Core Recovery	
	Murrum/ Boudlers	Mod. Weath Rock	R.L.	Reduced Level	RQD	Rock Quality Designation	
	Fresh Rock	Slightly Weath Rock					

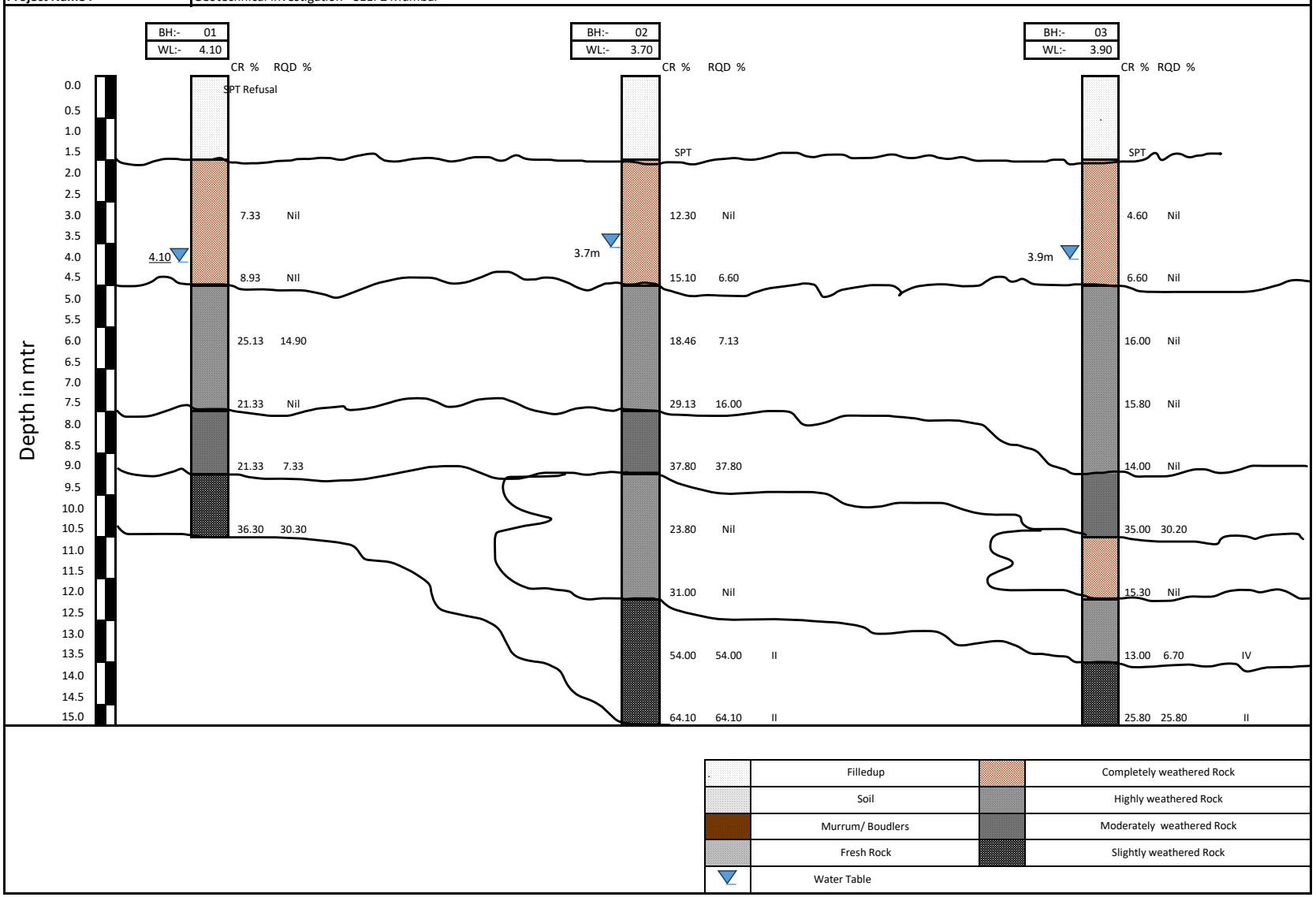
Prepared By		Checked By	
Name	Signature	Name	Signature
Adnan Siddiqui		Gaurav D. Hande	

ANNEXURE III:
SUB SOIL PROFILE

Landchester Engineers

SUB SOIL PROFILE

Project Name :- Geotechnical Investigation - SEEPZ Mumbai



	Filledup		Completely weathered Rock
	Soil		Highly weathered Rock
	Murrum/ Boudlers		Moderately weathered Rock
	Fresh Rock		Slightly weathered Rock
	Water Table		

Geotechnical investigation | Pile load test | Rock anchoring | Lab testing | Micro Piling
Shop no. 16, Green Palms, Plot no. 18-19, Sector 15, Ghansoli, Navi Mumbai, Maharashtra 400701

ANNEXURE IV:
LABORATORY RESULT SHEET

SUMMARY SHEET

Project Name: "Project : Geotechnical Investigation - SEEPZ Mumbai ".

Client: -Tractbel Engineering pvt ltd

Bore Hole:	**01**	**Location:**	**Andheri**		
Easting :		**276439.307**	**Northing :**	**2116031.374**	
Elevation:		**25.3m**			
Testing Date:-		**20-06-2026 to 22-06-2026**		**Water Table**	**4.1**

Field Test Results			Lab Test Results														
Depth of Sample below reference		Type of Sample	Tests on Rocks														
			Uniaxial Compressive Strength	Point Load Index	Water Absorption	Specific Gravity	Bulk Density	Unit Weight of Rock	Core Recovery	Rock Quality Designation	Modulus of Elasticity	Poisson's Ratio of Rock	Tri-Axial Test		Water Camical Test		
From	To												C	PHI	PH	Sulphate Content (%	Cloride Content (%)
(m)	(m)		(MPa)	(Mpa)	(%)		(g/cc)	(KN/m^3)	(%)	(%)	(Mpa)		Mpa	Deg			
0	1.5	Filling material	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.5	3	Boulder ,Cobble,	-	2.19	0.52	2.59	2.59	25.41	7.33	nil	-	-	-	-	-	-	-
3	4.50	Core	-	3.21	0.55	2.6	2.6	25.51	8.93	nil	-	-	-	-	6.45	0.0028	0.0021
4.5	6.00	Core	-	2.05	0.68	2.62	2.62	25.70	25.13	12.9	1.15E+04	0.23	-	-	-	-	-
6	7.50	Core	-	2.12	0.42	2.62	2.62	25.70	21.33	nil	-	-	-	-	-	-	-
7.5	9.00	Core	55.26	2.35	0.52	2.65	2.65	26.00	21.33	7.33	-	-	-	-	-	-	-
9	10.50	Core	54.78	2.45	0.68	2.65	2.65	26.00	36.3	30.3	-	-	13	40	-	-	-

Note: - 1. Wherever UCS has been not performed in that case UCS is derived by multiplying 15 to the point load index. (As per IS 8764: 1998)

SUMMARY SHEET

Project Name: "Project : Geotechnical Investigation - SEEPZ Mumbai ".

Client: -Tractbel Engineering pvt ltd

Bore Hole:	**02**	**Location: -**	**Andheri**
Easting :		**276372.54789**	**Northing :** **2116076.32202**
Elevation:		**25.9m**	
Testing Date:-		**20-06-2026 to 22-06-2026**	**Water Table** **3.7**

Field Test Results			Lab Test Results														
Depth of Sample		Type of Sample	Tests on Rocks										Tri-Axial Test		Water Camical Test		
From	To		Uniaxial Compressive Strength	Point Load Index	Water Absorption	Specific Gravity	Bulk Density	Unit Weight of Rock	Core Recovery	Rock Quality Designation	Modulus of Elasticity	Poisson's Ratio of Rock	C	PHI	PH	Sulphate Content	Cloride Content
(m)	(m)		(MPa)	(Mpa)	(%)		(g/cc)	(KN/m3)	(%)	(%)	(Mpa)	-	Mpa	Deg			
0	1.5	Filling material	-	-	-	-	-		-	-	-	-	-	-	-	-	-
1.5	3	Core	-	-	-	-	-		12.3	nil	-	-	-	-	-	-	-
3	4.50	Core	-	1.57	0.58	2.61	2.61	25.60	15.1	6.6	-	-	-	-	6.48	0.0026	0.002
4.5	6.00	Core	-	1.99	0.52	2.65	2.65	26.00	18.46	7.13	-	-	-	-	-	-	-
6	7.50	Core	-	2.12	0.67	-	2.64	25.90	29.13	16	-	-	-	-	-	-	-
7.5	9.00	Core	57.29	2.35	-	2.62	2.62	25.70	37.8	37.8	1.69E+03	0.17	-	-	-	-	-
9	10.50	Core	-	2.45	-	2.65	2.65	26.00	23.8	nil	-	-	-	-	-	-	-
10.5	12.00	Core	-	2.39	0.55	2.65	2.65	26.00	31	nil	-	-	-	-	-	-	-
12.00	13.50	Core	53.46	2.51	0.61	2.63	2.63	25.80	54	54	-	-	14	35	-	-	-
13.5	15.00	Core	54.82	2.55	0.68	2.63	2.63	25.80	64.1	64.1	-	-	15	37	-	-	-

Note: - 1. Wherever UCS has been not performed in that case UCS is derived by multiplying 15 to the point load index. (As per IS 8764: 1998)

SUMMARY SHEET

Project Name: "Project : Geotechnical Investigation - SEEPZ Mumbai ".																	
Client: -Tractbel Engineering pvt ltd																	
Bore Hole:	**03**		**Location: -**	**Andheri**													
Easting :		**276429.56642**		**Northing :**	**2115990.95413**												
RL		**25.3m**															
Testing Date:-		**20-06-2026 to 22-06-2026**									**Water Table**				**3.9**		
Field Test Results		Lab Test Results															
Depth of Sample		Type of Sample	Tests on Rocks														
			Uniaxial Compressive Strength	Point Load Index	Water Absorption	Specific Gravity	Bulk Density	Unit Weight of Rock	Core Recovery	Rock Quality Designation	Modulus of Elasticity	Poisson's Ratio of Rock	Tri-Axial Test		Water Camical Test		
From	To												C	PHI	PH	Sulphate Content	Cloride Content
(m)	(m)		(MPa)	(Mpa)	(%)		(g/cc)	(KN/m3)	(%)	(%)	(MPa)	-	Mpa	Deg			
0	1.5	Filling material	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.5	3	Core	-	-	-	-	-	-	4.6	nil	-	-	-	-	-	-	-
3	4.50	Core	-	2.12	0.58	2.62	2.62	25.70	6.6	nil	-	-	-	-	6.41	0.0025	0.0022
4.5	6.00	Core	-	2.05	0.6	2.65	2.65	26.00	16	nil	-	-	-	-	-	-	-
6	7.50	Core	-	2.13	0.61	2.59	2.59	25.41	15.8	nil	-	-	-	-	-	-	-
7.5	9.00	Core	-	2.35	0.68	2.6	2.6	25.51	14	nil	-	-	-	-	-	-	-
9	10.50	Core	48.75	2.45	0.68	2.63	2.63	25.80	35	28.2	-	-	14	38	-	-	-
10.5	12.00	Core	-	2.39	0.63	2.65	2.65	26.00	15.3	nil	-	-	-	-	-	-	-
12	13.50	Core	-	2.51	0.55	2.65	2.65	26.00	13	6.7	-	-	-	-	-	-	-
13.5	15.00	Core	52.15	2.55	0.58	2.63	2.63	25.80	25.8	25.8	2.11E+04	0.25	-	-	-	-	-

Note: - 1. Wherever UCS has been not performed in that case UCS is derived by multiplying 15 to the point load index. (As per IS 8764: 1998)

ANNEXURE V:
SBC CALCULATION

Name of Project	Geotechnical Investigation - SEEPZ Mumbai AUTHORITY, ANDHERI (E), MUMBAI, MAHARASHTRA

Bearing Capacity Analysis for Foundation on Rock

Analysis as per IS: 12070-1987

BORE HOLE : 01

BEARING CAPACIYT ANALYSIS FOR OPEN FOUNDATIONS ON ROCK :-

1) Presumptive Values of safe bearing capacity as per clause 5.2 of IS 12070 -1987

2) Based on UCS value : Clause 6.2 of IS 12070-1987

Rock Type : Highly Weathered Rock — Foundation Depth : 3.00 m

Below Founding Level : Rock Core Recovery 7.33 % — RQD Value nil %

Based on UCS value : Clause 6.2 of IS 12070-1987

$q_s = q_c \times N_j$

qs=Safe Bearing Capacity	-	
qc=Avg.UCS of rock cores	40.5	MPa
Nj Bearing Pressure Coefficient -Depends on spacing of discontitouties	0.1	
Factors for Calculation		
correction for saturation / submerged condition	0.5	
Correction for orientation of joints/slope	0.5	
Correction for Solution Cavities	1	

Safe Bearing Capacity = 103.24 t/m^2

Based on RMR value : Clause 5.3 of IS 12070-1987

Class of rock	I	II	III	IV	V
Description of rock	Very Good	Good	Fair	Poor	Very Poor
RMR	100-81	80-61	60-41	40-21	20-0
qnet safe (T/m²)	600-448	440-288	280-141	135-48	45-30

RMR value for design =	25	Class of Rock :	IV	Rock Description :	Poor Rock

qnet safe = 66 t/m^2

Recommended Safe Bearing Capacity = 66.316 t/m^2

The Rock Stratum will undergo Immediate Settlements only

$$S_i = \frac{[q * B * (1 - \mu^2) * I]}{E}$$

Where

1) S_i = immediate settlement =

2) q = net intensity of pressure = 66.32 t/m2

3) μ = Poisson's ratio = 0.23

4) I = rigidity factor = 1.83

5) Modulus of elasticity = $1.15*10^7$ KN/m^2

a) For isolated footing of maximum width, B = 3 m & Allouable Settelment = 25 mm

Immediate settlement Si = 0.294 mm Safe

b) For isolated footing of maximum width, B = 4.5 m & Allouable Settelment = 25 mm

Immediate settlement Si = 0.441 mm Safe

c) For raft foundation maximum width, B = 14 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 1.37 mm Safe

d) For raft foundation maximum width, B = 15 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 1.47 mm Safe

Name of Project	Geotechnical Investigation - SEEPZ Mumbai AUTHORITY, ANDHERI (E), MUMBAI, MAHARASHTRA

Bearing Capacity Analysis for Foundation on Rock

Analysis as per IS: 12070-1987

BORE HOLE : 01

BEARING CAPACIYT ANALYSIS FOR OPEN FOUNDATIONS ON ROCK :-

1) Presumptive Values of safe bearing capacity as per clause 5.2 of IS 12070 -1987

2) Based on UCS value : Clause 6.2 of IS 12070-1987

Rock Type : Highly Weathered Rock — Foundation Depth : 4.50 m

Below Founding Level : Rock Core Recovery 8.93 % — RQD Value nil %

Based on UCS value : Clause 6.2 of IS 12070-1987

$q_s = q_c \times N_j$

qs=Safe Bearing Capacity	-	
qc=Avg.UCS of rock cores	30.75	MPa
Nj Bearing Pressure Coefficient -Depends on spacing of discontitouties	0.1	
Factors for Calculation		
correction for saturation / submerged condition	0.5	
Correction for orientation of joints/slope	0.5	
Correction for Solution Cavities	1	

Safe Bearing Capacity = 78.39 t/m^2

Based on RMR value : Clause 5.3 of IS 12070-1987

Class of rock	I	II	III	IV	V
Description of rock	Very Good	Good	Fair	Poor	Very Poor
RMR	100-81	80-61	60-41	40-21	20-0
qnet safe (T/m²)	600-448	440-288	280-141	135-48	45-30

RMR value for design =	22	Class of Rock :	IV	Rock Description :	Poor Rock

qnet safe = 52.6 t/m^2

Recommended Safe Bearing Capacity = 52.6 t/m^2

The Rock Stratum will undergo Immediate Settlements only

$$S_i = \frac{[q * B * (1 - \mu^2) * I]}{E}$$

Where

1) S_i = immediate settlement =

2) q = net intensity of pressure = 52.58 t/m2

3) μ = Poisson's ratio = 0.23

4) I = rigidity factor = 1.83

5) Modulus of elasticity = $1.15*10^7$ KN/m^2

a) For isolated footing of maximum width, B = 3 m & Allouable Settelment = 25 mm

Immediate settlement Si = 0.233 mm Safe

b) For isolated footing of maximum width, B = 4.5 m & Allouable Settelment = 25 mm

Immediate settlement Si = 0.350 mm Safe

c) For raft foundation maximum width, B = 14 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 1.09 mm Safe

d) For raft foundation maximum width, B = 15 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 1.17 mm Safe

Name of Project	Geotechnical Investigation - SEEPZ Mumbai AUTHORITY, ANDHERI (E), MUMBAI, MAHARASHTRA

Bearing Capacity Analysis for Foundation on Rock

Analysis as per IS: 12070-1987

BORE HOLE : 01

BEARING CAPACIYT ANALYSIS FOR OPEN FOUNDATIONS ON ROCK :-

1) Presumptive Values of safe bearing capacity as per clause 5.2 of IS 12070 -1987

2) Based on UCS value : Clause 6.2 of IS 12070-1987

Rock Type : Highly Weathered Rock — Foundation Depth : 6.00 m

Below Founding Level : Rock Core Recovery 2.62 % — RQD Value 21.33 %

Based on UCS value : Clause 6.2 of IS 12070-1987

$q_s = q_c \times N_j$

qs=Safe Bearing Capacity	-	
qc=Avg.UCS of rock cores	47	MPa
Nj Bearing Pressure Coefficient -Depends on spacing of discontitouties	0.1	
Factors for Calculation		
correction for saturation / submerged condition	0.5	
Correction for orientation of joints/slope	0.5	
Correction for Solution Cavities	1	

Safe Bearing Capacity = 119.81 t/m^2

Based on RMR value : Clause 5.3 of IS 12070-1987

Class of rock	I	II	III	IV	V
Description of rock	Very Good	Good	Fair	Poor	Very Poor
RMR	100-81	80-61	60-41	40-21	20-0
qnet safe (T/m²)	600-448	440-288	280-141	135-48	45-30

RMR value for design =	32	Class of Rock :	IV	Rock Description :	Poor Rock

qnet safe = 98 t/m^2

Recommended Safe Bearing Capacity = 98.368 t/m^2

The Rock Stratum will undergo Immediate Settlements only

$$S_i = \frac{[q * B * (1 - \mu^2) * I]}{E}$$

Where

1) S_i = immediate settlement =

2) q = net intensity of pressure = 98.37 t/m2

3) μ = Poisson's ratio = 0.23

4) I = rigidity factor = 1.83

5) Modulus of elasticity = $1.15*10^7$ KN/m^2

a) For isolated footing of maximum width, B = 3 m & Allouable Settelment = 25 mm

Immediate settlement Si = 0.436 mm Safe

b) For isolated footing of maximum width, B = 4.5 m & Allouable Settelment = 25 mm

Immediate settlement Si = 0.654 mm Safe

c) For raft foundation maximum width, B = 14 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 2.04 mm Safe

d) For raft foundation maximum width, B = 15 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 2.18 mm Safe

Name of Project	Geotechnical Investigation - SEEPZ Mumbai AUTHORITY, ANDHERI (E), MUMBAI, MAHARASHTRA

Bearing Capacity Analysis for Foundation on Rock

Analysis as per IS: 12070-1987

BORE HOLE : 01

BEARING CAPACIYT ANALYSIS FOR OPEN FOUNDATIONS ON ROCK :-

1) Presumptive Values of safe bearing capacity as per clause 5.2 of IS 12070 -1987

2) Based on UCS value : Clause 6.2 of IS 12070-1987

Rock Type : Highly Weathered Rock — Foundation Depth : 7.50 m

Below Founding Level : Rock Core Recovery 21.33 % — RQD Value 7.33 %

Based on UCS value : Clause 6.2 of IS 12070-1987

$q_s = q_c \times N_j$

qs=Safe Bearing Capacity	-	
qc=Avg.UCS of rock cores	55.26	MPa
Nj Bearing Pressure Coefficient -Depends on spacing of discontitouties	0.1	
Factors for Calculation		
correction for saturation / submerged condition	0.5	
Correction for orientation of joints/slope	0.5	
Correction for Solution Cavities	1	

Safe Bearing Capacity = 135.48 t/m^2

Based on RMR value : Clause 5.3 of IS 12070-1987

Class of rock	I	II	III	IV	V
Description of rock	Very Good	Good	Fair	Poor	Very Poor
RMR	100-81	80-61	60-41	40-21	20-0
qnet safe (T/m²)	600-448	440-288	280-141	135-48	45-30

RMR value for design =	38	Class of Rock :	IV	Rock Description :	Poor Rock

qnet safe = 125.84211 t/m^2

Recommended Safe Bearing Capacity = 125.84 t/m^2

The Rock Stratum will undergo Immediate Settlements only

$$S_i = \frac{[q * B * (1 - \mu^2) * I]}{E}$$

Where

1) S_i = immediate settlement =

2) q = net intensity of pressure = 125.84 t/m2

3) μ = Poisson's ratio = 0.32

4) I = rigidity factor = 1.83

5) Modulus of elasticity = $1.15*10^7$ KN/m^2

a) For isolated footing of maximum width, B = 3 m & Allouable Settelment = 25 mm

Immediate settlement Si = 0.53 mm Safe

a) For isolated footing of maximum width, B = 3 m & Allouable Settelment = 25 mm

Immediate settlement Si = 0.79 mm Safe

c) For raft foundation maximum width, B = 14 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 2.47 mm Safe

d) For raft foundation maximum width, B = 15 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 2.64 mm Safe

Name of Project	Geotechnical Investigation - SEEPZ Mumbai AUTHORITY, ANDHERI (E), MUMBAI, MAHARASHTRA

Bearing Capacity Analysis for Foundation on Rock

Analysis as per IS: 12070-1987

BORE HOLE : 02

BEARING CAPACIYT ANALYSIS FOR OPEN FOUNDATIONS ON ROCK :-

1) Presumptive Values of safe bearing capacity as per clause 5.2 of IS 12070 -1987

2) Based on UCS value : Clause 6.2 of IS 12070-1987

Rock Type : Highly Weathered Rock — Foundation Depth : 3.00 m

Below Founding Level : Rock Core Recovery 15.10 % — RQD Value nil %

Based on UCS value : Clause 6.2 of IS 12070-1987

$q_s = q_c \times N_j$

qs=Safe Bearing Capacity	-	
qc=Avg.UCS of rock cores	24	MPa
Nj Bearing Pressure Coefficient -Depends on spacing of discontitouties	0.1	
Factors for Calculation		
correction for saturation / submerged condition	0.5	
Correction for orientation of joints/slope	0.5	
Correction for Solution Cavities	1	

Safe Bearing Capacity = 57.74 t/m^2

Based on RMR value : Clause 5.3 of IS 12070-1987

Class of rock	I	II	III	IV	V
Description of rock	Very Good	Good	Fair	Poor	Very Poor
RMR	100-81	80-61	60-41	40-21	20-0
qnet safe (T/m²)	600-448	440-288	280-141	135-48	45-30

RMR value for design =	22	Class of Rock :	IV	Rock Description :	Poor Rock

qnet safe = 52.578947 t/m^2

Recommended Safe Bearing Capacity = 52.579 t/m^2

The Rock Stratum will undergo Immediate Settlements only

$$S_i = \frac{[q * B * (1 - \mu^2) * I]}{E}$$

Where

1) S_i = immediate settlement =

2) q = net intensity of pressure = 52.58 t/m2

3) μ = Poisson's ratio = 0.17

4) I = rigidity factor = 1.83

5) Modulus of elasticity = $1.69*10^6$ KN/m^2

a) For isolated footing of maximum width, B = 3 m & Allouable Settelment = 25 mm

Immediate settlement Si = 1.627 mm Safe

b) For isolated footing of maximum width, B = 4.5 m & Allouable Settelment = 25 mm

Immediate settlement Si = 2.441 mm Safe

c) For raft foundation maximum width, B = 14 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 7.59 mm Safe

d) For raft foundation maximum width, B = 15 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 8.14 mm Safe

Name of Project	Geotechnical Investigation - SEEPZ Mumbai AUTHORITY, ANDHERI (E), MUMBAI, MAHARASHTRA

Bearing Capacity Analysis for Foundation on Rock

Analysis as per IS: 12070-1987

BORE HOLE : 02

BEARING CAPACIYT ANALYSIS FOR OPEN FOUNDATIONS ON ROCK :-

1) Presumptive Values of safe bearing capacity as per clause 5.2 of IS 12070 -1987

2) Based on UCS value : Clause 6.2 of IS 12070-1987

Rock Type : Highly Weathered Rock — Foundation Depth : 4.50 m

Below Founding Level : Rock Core Recovery 15.10 % — RQD Value 6.60 %

Based on UCS value : Clause 6.2 of IS 12070-1987

$q_s = q_c \times N_j$

qs=Safe Bearing Capacity	-	
qc=Avg.UCS of rock cores	30	MPa
Nj Bearing Pressure Coefficient -Depends on spacing of discontitouties	0.1	
Factors for Calculation		
correction for saturation / submerged condition	0.5	
Correction for orientation of joints/slope	0.5	
Correction for Solution Cavities	1	

Safe Bearing Capacity = 73.18 t/m^2

Based on RMR value : Clause 5.3 of IS 12070-1987

Class of rock	I	II	III	IV	V
Description of rock	Very Good	Good	Fair	Poor	Very Poor
RMR	100-81	80-61	60-41	40-21	20-0
qnet safe (T/m²)	600-448	440-288	280-141	135-48	45-30

RMR value for design =	22	Class of Rock :	IV	Rock Description :	Poor Rock

qnet safe = 52.578947 t/m^2

Recommended Safe Bearing Capacity = 52.579 t/m^2

The Rock Stratum will undergo Immediate Settlements only

$$S_i = \frac{[q * B * (1 - \mu^2) * I]}{E}$$

Where

1) S_i = immediate settlement =

2) q = net intensity of pressure = 52.58 t/m2

3) μ = Poisson's ratio = 0.17

4) I = rigidity factor = 1.83

5) Modulus of elasticity = $1.69*10^6$ KN/m^2

a) For isolated footing of maximum width, B = 3 m & Allouable Settelment = 25 mm

Immediate settlement Si = 1.627 mm Safe

b) For isolated footing of maximum width, B = 4.5 m & Allouable Settelment = 25 mm

Immediate settlement Si = 2.441 mm Safe

c) For raft foundation maximum width, B = 14 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 7.59 mm Safe

d) For raft foundation maximum width, B = 15 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 8.14 mm Safe

Name of Project	Geotechnical Investigation - SEEPZ Mumbai AUTHORITY, ANDHERI (E), MUMBAI, MAHARASHTRA

Bearing Capacity Analysis for Foundation on Rock

Analysis as per IS: 12070-1987

BORE HOLE : 02

BEARING CAPACIYT ANALYSIS FOR OPEN FOUNDATIONS ON ROCK :-

1) Presumptive Values of safe bearing capacity as per clause 5.2 of IS 12070 -1987

2) Based on UCS value : Clause 6.2 of IS 12070-1987

Rock Type : Highly Weathered Rock — Foundation Depth : 6.00 m

Below Founding Level : Rock Core Recovery 29.13 % — RQD Value 16.00 %

Based on UCS value : Clause 6.2 of IS 12070-1987

$q_s = q_c \times N_j$

qs=Safe Bearing Capacity	-	
qc=Avg.UCS of rock cores	47	MPa
Nj Bearing Pressure Coefficient -Depends on spacing of discontitouties	0.1	
Factors for Calculation		
correction for saturation / submerged condition	0.5	
Correction for orientation of joints/slope	0.5	
Correction for Solution Cavities	1	

Safe Bearing Capacity = 114.35 t/m^2

Based on RMR value : Clause 5.3 of IS 12070-1987

Class of rock	I	II	III	IV	V
Description of rock	Very Good	Good	Fair	Poor	Very Poor
RMR	100-81	80-61	60-41	40-21	20-0
qnet safe (T/m²)	600-448	440-288	280-141	135-48	45-30

RMR value for design =	22	Class of Rock :	IV	Rock Description :	Poor Rock

qnet safe = 52.578947 t/m^2

Recommended Safe Bearing Capacity = 52.579 t/m^2

The Rock Stratum will undergo Immediate Settlements only

$$S_i = \frac{[q * B * (1 - \mu^2) * I]}{E}$$

Where

1) S_i = immediate settlement =

2) q = net intensity of pressure = 52.58 t/m2

3) μ = Poisson's ratio = 0.17

4) I = rigidity factor = 1.83

5) Modulus of elasticity = $1.69*10^6$ KN/m^2

a) For isolated footing of maximum width, B = 3 m & Allouable Settelment = 25 mm

Immediate settlement Si = 1.627 mm Safe

b) For isolated footing of maximum width, B = 4.5 m & Allouable Settelment = 25 mm

Immediate settlement Si = 2.441 mm Safe

c) For raft foundation maximum width, B = 14 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 7.59 mm Safe

d) For raft foundation maximum width, B = 15 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 8.14 mm Safe

Name of Project	Geotechnical Investigation - SEEPZ Mumbai AUTHORITY, ANDHERI (E), MUMBAI, MAHARASHTRA

Bearing Capacity Analysis for Foundation on Rock

Analysis as per IS: 12070-1987

BORE HOLE : 02

BEARING CAPACIYT ANALYSIS FOR OPEN FOUNDATIONS ON ROCK :-

1) Presumptive Values of safe bearing capacity as per clause 5.2 of IS 12070 -1987

2) Based on UCS value : Clause 6.2 of IS 12070-1987

Rock Type : Highly Weathered Rock — Foundation Depth : 7.50 m

Below Founding Level : Rock Core Recovery 37.80 % — RQD Value 37.80 %

Based on UCS value : Clause 6.2 of IS 12070-1987

$q_s = q_c \times N_j$

qs=Safe Bearing Capacity	-	
qc=Avg.UCS of rock cores	57.29	MPa
Nj Bearing Pressure Coefficient -Depends on spacing of discontitouties	0.1	
Factors for Calculation		
correction for saturation / submerged condition	0.5	
Correction for orientation of joints/slope	0.5	
Correction for Solution Cavities	1	

Safe Bearing Capacity = 140.46 t/m^2

Based on RMR value : Clause 5.3 of IS 12070-1987

Class of rock	I	II	III	IV	V
Description of rock	Very Good	Good	Fair	Poor	Very Poor
RMR	100-81	80-61	60-41	40-21	20-0
qnet safe (T/m²)	600-448	440-288	280-141	135-48	45-30

RMR value for design =	38	Class of Rock :	IV	Rock Description :	Poor Rock

qnet safe = 125.84211 t/m^2

Recommended Safe Bearing Capacity = 125.84 t/m^2

The Rock Stratum will undergo Immediate Settlements only

$$S_i = \frac{[q * B * (1 - \mu^2) * I]}{E}$$

Where

1) S_i = immediate settlement =

2) q = net intensity of pressure = 125.84 t/m2

3) μ = Poisson's ratio = 0.23

4) I = rigidity factor = 1.83

5) Modulus of elasticity = $1.15*10^7$ KN/m^2

a) For isolated footing of maximum width, B = 3 m & Allouable Settelment = 25 mm

Immediate settlement Si = 0.558 mm Safe

b) For isolated footing of maximum width, B = 4.5 m & Allouable Settelment = 25 mm

Immediate settlement Si = 0.837 mm Safe

c) For raft foundation maximum width, B = 14 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 2.60 mm Safe

d) For raft foundation maximum width, B = 15 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 2.79 mm Safe

Name of Project	Geotechnical Investigation - SEEPZ Mumbai AUTHORITY, ANDHERI (E), MUMBAI, MAHARASHTRA

Bearing Capacity Analysis for Foundation on Rock

Analysis as per IS: 12070-1987

BORE HOLE : 03

BEARING CAPACIYT ANALYSIS FOR OPEN FOUNDATIONS ON ROCK :-

1) Presumptive Values of safe bearing capacity as per clause 5.2 of IS 12070 -1987

2) Based on UCS value : Clause 6.2 of IS 12070-1987

Rock Type : Highly Weathered Rock — Foundation Depth : 3.00 m

Below Founding Level : Rock Core Recovery 6.60 % — RQD Value nil %

Based on UCS value : Clause 6.2 of IS 12070-1987

$q_s = q_c \times N_j$

qs=Safe Bearing Capacity	-	
qc=Avg.UCS of rock cores	31.80	MPa
Nj Bearing Pressure Coefficient -Depends on spacing of discontitouties	0.1	
Factors for Calculation		
correction for saturation / submerged condition	0.5	
Correction for orientation of joints/slope	0.5	
Correction for Solution Cavities	1	

Safe Bearing Capacity = 77.97 t/m^2

Based on RMR value : Clause 5.3 of IS 12070-1987

Class of rock	I	II	III	IV	V
Description of rock	Very Good	Good	Fair	Poor	Very Poor
RMR	100-81	80-61	60-41	40-21	20-0
qnet safe (T/m²)	600-448	440-288	280-141	135-48	45-30

RMR value for design =	25	Class of Rock :	IV	Rock Description :	Poor Rock

qnet safe = 66.32 t/m^2

Recommended Safe Bearing Capacity = 66.32 t/m^2

The Rock Stratum will undergo Immediate Settlements only

$$S_i = \frac{[q * B * (1 - \mu^2) * I]}{E}$$

Where

1) S_i = immediate settlement =

2) q = net intensity of pressure = 66.32 t/m2

3) μ = Poisson's ratio = 0.23

4) I = rigidity factor = 1.83

5) Modulus of elasticity = $2.11*10^7$ KN/m^2

a) For isolated footing of maximum width, B = 3 m & Allouable Settelment = 25 mm

Immediate settlement Si = 0.16 mm Safe

b) For isolated footing of maximum width, B = 4.5 m & Allouable Settelment = 25 mm

Immediate settlement Si = 0.24 mm Safe

c) For raft foundation maximum width, B = 14 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 0.75 mm Safe

d) For raft foundation maximum width, B = 15 m & Allouable Settelment = 76.00 mm

Immediate settlement Si = 0.80 mm Safe

Name of Project	Geotechnical Investigation - SEEPZ Mumbai AUTHORITY, ANDHERI (E), MUMBAI, MAHARASHTRA

Bearing Capacity Analysis for Foundation on Rock

Analysis as per IS: 12070-1987

BORE HOLE : 03

BEARING CAPACIYT ANALYSIS FOR OPEN FOUNDATIONS ON ROCK :-

1) Presumptive Values of safe bearing capacity as per clause 5.2 of IS 12070 -1987

2) Based on UCS value : Clause 6.2 of IS 12070-1987

Rock Type : Highly Weathered Rock — Foundation Depth : 4.50 m

Below Founding Level : Rock Core Recovery 16.00 % — RQD Value nil %

Based on UCS value : Clause 6.2 of IS 12070-1987

$q_s = q_c \times N_j$

qs=Safe Bearing Capacity	-	
qc=Avg.UCS of rock cores	30.75	MPa
Nj Bearing Pressure Coefficient -Depends on spacing of discontitouties	0.1	
Factors for Calculation		
correction for saturation / submerged condition	0.5	
Correction for orientation of joints/slope	0.5	
Correction for Solution Cavities	1	

Safe Bearing Capacity = 75.39 t/m^2

Based on RMR value : Clause 5.3 of IS 12070-1987

Class of rock	I	II	III	IV	V
Description of rock	Very Good	Good	Fair	Poor	Very Poor
RMR	100-81	80-61	60-41	40-21	20-0
qnet safe (T/m²)	600-448	440-288	280-141	135-48	45-30

RMR value for design =	22	Class of Rock :	IV	Rock Description :	Poor Rock

qnet safe = 52.58 t/m^2

Recommended Safe Bearing Capacity = 52.58 t/m^2

The Rock Stratum will undergo Immediate Settlements only

$$S_i = \frac{[q * B * (1 - \mu^2) * I]}{E}$$

Where

1) S_i = immediate settlement =

2) q = net intensity of pressure = 52.58 t/m2

3) μ = Poisson's ratio = 0.23

4) I = rigidity factor = 1.83

5) Modulus of elasticity = $2.11*10^7$ KN/m^2

a) For isolated footing of maximum width, B = 3 m & Allouable Settelment = 25 mm

Immediate settlement Si = 0.13 mm Safe

b) For isolated footing of maximum width, B = 4.5 m & Allouable Settelment = 25 mm

Immediate settlement Si = 0.19 mm Safe

c) For raft foundation maximum width, B = 14 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 0.59 mm Safe

d) For raft foundation maximum width, B = 15 m & Allouable Settelment = 76.00 mm

Immediate settlement Si = 0.64 mm Safe

Name of Project	Geotechnical Investigation - SEEPZ Mumbai AUTHORITY, ANDHERI (E), MUMBAI, MAHARASHTRA

Bearing Capacity Analysis for Foundation on Rock

Analysis as per IS: 12070-1987

BORE HOLE : 03

BEARING CAPACIYT ANALYSIS FOR OPEN FOUNDATIONS ON ROCK :-

1) Presumptive Values of safe bearing capacity as per clause 5.2 of IS 12070 -1987

2) Based on UCS value : Clause 6.2 of IS 12070-1987

Rock Type : Highly Weathered Rock — Foundation Depth : 6.00 m

Below Founding Level : Rock Core Recovery 15.80 % — RQD Value nil %

Based on UCS value : Clause 6.2 of IS 12070-1987

$q_s = q_c \times N_j$

qs=Safe Bearing Capacity	-	
qc=Avg.UCS of rock cores	32	MPa
Nj Bearing Pressure Coefficient -Depends on spacing of discontitouties	0.1	
Factors for Calculation		
correction for saturation / submerged condition	0.5	
Correction for orientation of joints/slope	0.5	
Correction for Solution Cavities	1	

Safe Bearing Capacity = 78.33 t/m^2

Based on RMR value : Clause 5.3 of IS 12070-1987

Class of rock	I	II	III	IV	V
Description of rock	Very Good	Good	Fair	Poor	Very Poor
RMR	100-81	80-61	60-41	40-21	20-0
qnet safe (T/m²)	600-448	440-288	280-141	135-48	45-30

RMR value for design =	22	Class of Rock :	IV	Rock Description :	Poor Rock

qnet safe = 52.578947 t/m^2

Recommended Safe Bearing Capacity = 52.579 t/m^2

The Rock Stratum will undergo Immediate Settlements only

$$S_i = \frac{[q * B * (1 - \mu^2) * I]}{E}$$

Where

1) S_i = immediate settlement =

2) q = net intensity of pressure = 52.58 t/m2

3) μ = Poisson's ratio = 0.17

4) I = rigidity factor = 1.83

5) Modulus of elasticity = $2.11*10^7$ KN/m^2

a) For isolated footing of maximum width, B = 3 m & Allouable Settelment = 25 mm

Immediate settlement Si = 0.13 mm Safe

b) For isolated footing of maximum width, B = 4.5 m & Allouable Settelment = 25 mm

Immediate settlement Si = 0.20 mm Safe

c) For raft foundation maximum width, B = 14 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 0.61 mm Safe

d) For raft foundation maximum width, B = 15 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 0.65 mm Safe

Name of Project	Geotechnical Investigation - SEEPZ Mumbai AUTHORITY, ANDHERI (E), MUMBAI, MAHARASHTRA

Bearing Capacity Analysis for Foundation on Rock

Analysis as per IS: 12070-1987

BORE HOLE : 03

BEARING CAPACIYT ANALYSIS FOR OPEN FOUNDATIONS ON ROCK :-

1) Presumptive Values of safe bearing capacity as per clause 5.2 of IS 12070 -1987

2) Based on UCS value : Clause 6.2 of IS 12070-1987

Rock Type : Highly Weathered Rock — Foundation Depth : 7.50 m

Below Founding Level : Rock Core Recovery 37.80 % — RQD Value 37.80 %

Based on UCS value : Clause 6.2 of IS 12070-1987

$q_s = q_c \times N_j$

qs=Safe Bearing Capacity	-	
qc=Avg.UCS of rock cores	35.25	MPa
Nj Bearing Pressure Coefficient -Depends on spacing of discontitouties	0.1	
Factors for Calculation		
correction for saturation / submerged condition	0.5	
Correction for orientation of joints/slope	0.5	
Correction for Solution Cavities	1	

Safe Bearing Capacity = 86.42 t/m^2

Based on RMR value : Clause 5.3 of IS 12070-1987

Class of rock	I	II	III	IV	V
Description of rock	Very Good	Good	Fair	Poor	Very Poor
RMR	100-81	80-61	60-41	40-21	20-0
qnet safe (T/m²)	600-448	440-288	280-141	135-48	45-30

RMR value for design =	38	Class of Rock :	IV	Rock Description :	Poor Rock

qnet safe = 66.32 t/m^2

Recommended Safe Bearing Capacity = 66.32 t/m^2

The Rock Stratum will undergo Immediate Settlements only

$$S_i = \frac{[q * B * (1 - \mu^2) * I]}{E}$$

Where

1) S_i = immediate settlement =

2) q = net intensity of pressure = 66.32 t/m2

3) μ = Poisson's ratio = 0.23

4) I = rigidity factor = 1.83

5) Modulus of elasticity = $2.11*10^7$ KN/m^2

a) For isolated footing of maximum width, B = 3 m & Allouable Settelment = 25 mm

Immediate settlement Si = 0.16 mm Safe

b) For isolated footing of maximum width, B = 4.5 m & Allouable Settelment = 25 mm

Immediate settlement Si = 0.24 mm Safe

c) For raft foundation maximum width, B = 14 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 0.75 mm Safe

d) For raft foundation maximum width, B = 15 m & Allouable Settelment = 75.00 mm

Immediate settlement Si = 0.80 mm Safe

ANNEXURE VI
RMR CALCULATION

Landchester Engineers

RMR CALCULATION SHEET AS PER IS: 13365 (Part-1) 1981

BOREHOLE - 02

Depth below EGL		CORE RECOVERY (%)	RQD(%)	UCS (MPa)	POINT LOAD (MPa)	UCS RATING	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	Class No.	Description
From (m)	To (m)													
0.00	1.50	-	-	-	-	-	-	-	-	10	-	0.00	0.00	0.00
1.50	3.00	12.30	nil	-	-	0	3	5	10	10	-7	21	IV	Poor Rock
3.00	4.50	15.10	6.60	-	1.57	4	3	5	10	7	-7	22	IV	Poor Rock
4.50	6.00	18.46	7.13	-	1.99	4	3	5	10	7	-7	22	IV	Poor Rock
6.00	7.50	29.13	16.00	-	2.12	4	3	5	10	7	-7	22	IV	Poor Rock
7.50	9.00	37.80	37.80	57.29	2.35	7	3	8	20	7	-7	38	IV	Poor Rock
9.00	10.50	23.80	nil	-	2.45	7	3	5	10	7	-7	25	IV	Poor Rock
10.50	12.00	31.00	nil	-	2.39	7	3	5	10	7	-7	25	IV	Poor Rock
12.00	13.50	54.00	54.00	53.46	2.51	7	13	8	20	7	-7	48	III	Fair Rock
13.50	15.00	64.10	64.10	54.82	2.55	7	13	8	20	7	-7	48	III	Fair Rock

Landchester Engineers

RMR CALCULATION SHEET AS PER IS: 13365 (Part-1) 1981

BOREHOLE - 03

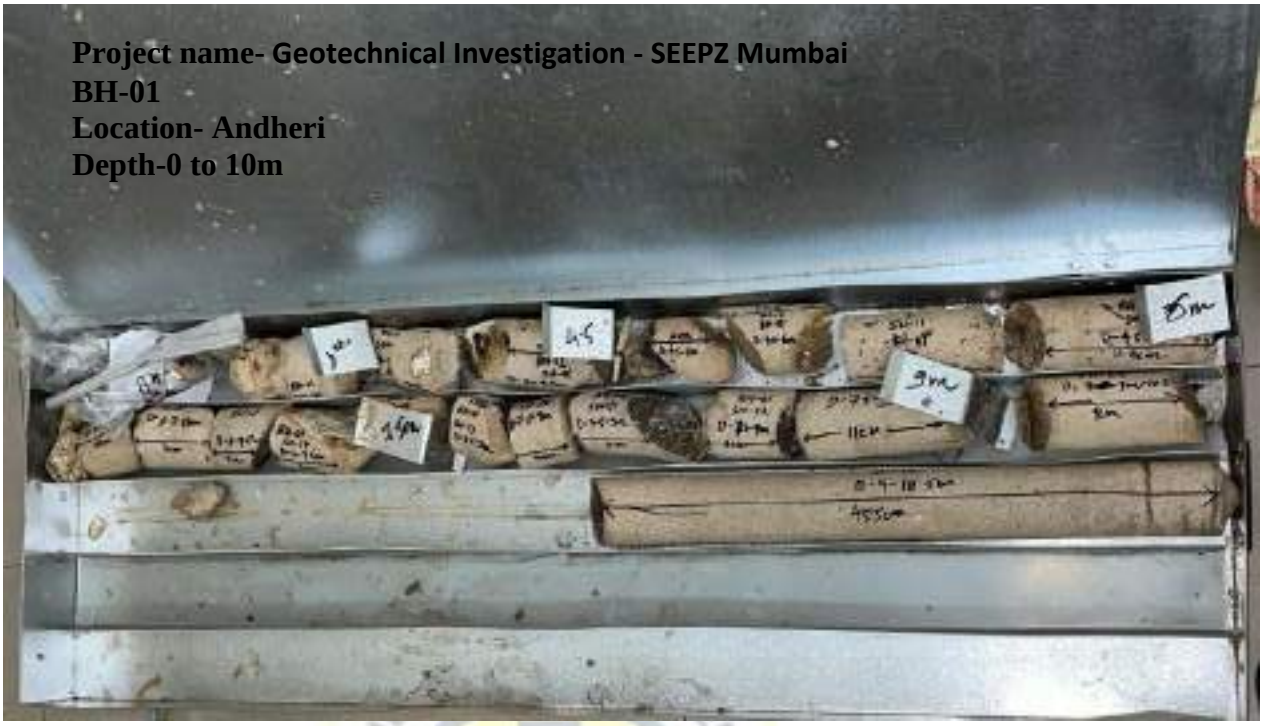
Depth below EGL		CORE RECOVERY (%)	RQD(%)	UCS (MPa)	POINT LOAD (MPa)	UCS RATING	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	Class No.	Description
From (m)	To (m)													
0.00	1.50											0	V	Very Poor Rock
1.50	3.00	4.60	nil	-	2.26	4	3	5	10	10	-7	25	IV	Poor Rock
3.00	4.50	6.60	nil	-	2.12	4	3	5	10	10	-7	25	IV	Poor Rock
4.50	6.00	16.00	nil	-	2.05	4	3	5	10	7	-7	22	IV	Poor Rock
6.00	7.50	15.80	nil	-	2.13	4	3	5	10	7	-7	22	IV	Poor Rock
7.50	9.00	14.00	nil	-	2.35	7	3	5	10	7	-7	25	IV	Poor Rock
9.00	10.50	35.00	28.20	48.75	2.45	7	8	8	20	7	-7	43	III	Fair Rock
10.50	12.00	15.30	nil	-	2.39	7	3	5	10	7	-7	25	IV	Poor Rock
12.00	13.50	13.00	6.70	-	2.51	7	3	5	10	7	-7	25	IV	Poor Rock
13.50	15.00	25.80	25.80	52.15	2.55	7	8	8	20	7	-7	43	III	Fair Rock

RMR CALCULATION SHEET AS PER IS: 13365 (Part-1) 1981

BOREHOLE - 01

Depth below EGL		CORE RECOVERY (%)	RQD(%)	UCS (MPa)	POINT LOAD (MPa)	UCS RATING	RQD RATING	SPACING OF JOINT RATING	CONDITION OF JOINT RATING	GROUND WATER RATING	STRIKE & DIP ORIENTATION OF JOINTS	RMR	Class No.	Description
From (m)	To (m)													
0.00	1.50	-	-	-	-	-	-	-	-	10	-	10	V	Very Poor Rock
1.50	3.00	7.33	nil	-	2.19	4	3	5	10	10	-7	25	IV	Poor Rock
3.00	4.50	8.93	nil	-	3.21	4	3	5	10	10	-7	25	IV	Poor Rock
4.50	6.00	25.13	12.90	32.20	2.05	4	3	5	10	7	-7	22	IV	Poor Rock
6.00	7.50	21.33	nil	-	2.12	4	3	5	20	7	-7	32	IV	Poor Rock
7.50	9.00	21.33	7.33	55.26	2.35	7	3	8	20	7	-7	38	IV	Poor Rock
9.00	10.50	36.30	30.20	54.78	2.45	7	8	8	25	7	-7	48	III	Fair Rock

ANNEXURE VII
SITE & COREBOX PHOTOGRAPHS


Project name- Geotechnical Investigation - SEEPZ Mumbai
BH-01
Location- Andheri
Depth-0 to 10m

BH-02
Depth - 0 - 15m
Box No- 02/10
Work Start Date - 11/6/26
Work End Date - 12/06/26

Project name- Geotechnical Investigation - SEEPZ Mumbai
BH-03
Location- Andheri
Depth-0 to 15m

BH-01

Latitude: 19.125283
Longitude: 72.87471
Elevation: 41.31±1.05 m
Accuracy: 12.44 m
Time: 06-06-2026 18:22
Note: collected sample at 1.5m
SAVSOL
Powered by NoxCam

BH-02

Latitude: 19.125586
Longitude: 72.874036
Elevation: 41.0±1.06 m
Accuracy: 5.434 m
Time: 11-06-2026 12:07
Note: point 2

BH-03

itude: 19.124614
gitude: 72.874857
vation: 30.09±12.6 m
curacy: 12.75 m
e: 14-06-2026 11:14
e: point 3

NEST III - CO_OP5 - CONSTRUCTION AREA 261007				
	CONSTRUCTION AREA (SQ.M)			
FLOORS	TOWER - A	TOWER - B	TOWER - C	TOTAL
BASEMENT 1		8472.47	NA	8,472.47
PLINTH GROUND FLOOR (Including Substation area)	1,514.14	3,002.38	3,624.53	8,751.65
PODIUM 1			10,505.25	10,505.25
PODIUM 2			10,052.11	10,052.11
1ST FLOOR			10,417.35	10,417.35
2nd FLOOR	1,637.17	3,221.90	3,562.01	8,421.08
3rd FLOOR	1,637.17	3,221.90	3,562.01	8,421.08
4th FLOOR (REFUGE)	1,740.48	3,427.58	3,810.01	8,978.06
5th FLOOR	1,637.17	3,221.90	3,562.01	8,421.08
6th FLOOR	1,637.17	3,221.90	3,562.01	8,421.08
7th FLOOR	1,637.17	3,221.90	3,562.01	8,421.08
8th FLOOR (REFUGE)	1,740.48	3,427.58	3,810.01	8,978.06
9th FLOOR	1,637.17	3,221.90	3,562.01	8,421.08
10th FLOOR	1,637.17	3,221.90	3,562.01	8,421.08
TERRACE FLOOR OHT/ LIFT MACHINE ROOM LEVEL ROOFTOP LEVEL	2,728.12	4917.23	5,530.23	13,175.58
TOTAL CONSTRUCTION AREA (SQ.M)				**1,38,278.05**
TOTAL CONSTRUCTION AREA (SQ.FT)				**14,88,424.97**

TECHNICAL DATASHEET

TECHNICAL INFORMATIONS FOR ELECTRICAL EQUIPMENTS
(TO BE FILLED BY THE TENDERER)

Sr. No	ITEMS	SPECIFICATIONS	CONTRACTOR RESPONSE
1	**11KV VCB PANEL**		
		Panel Make	
		Switchgear Make	
		Panel Type	
		Rated Voltage	
		Frequency	
		Phases	
		Busbar Rating	
		VCB Rated Current	
		Short Circuit Breaking Current	
		Short Circuit Making Current	
		Rated Short-Time Withstand Current	
		Insulation Level	
		VCB Technology	
		Operating Mechanism	
		Protection Relay	
		Busbar Material	
		Enclosure	
		Degree of Protection	
		Cable Entry	
		Earthing Switch	
		Protection	
		Metering	
2	**TRANSFORMER**		
		Transformer Make	
		Transformer Type	
		Application	
		Rated Power	
		Number of Phases	
		Frequency	
		HV Rated Voltage	
		LV Rated Voltage	
		Vector Group	
		HV Tapping	
		Tap Changer	
		Cooling	
		Impedance	
		Efficiency	
		Earthing Terminals	
3	**DIESEL GENERATOR**	Diesel Generater	
		Engine Make	
		Alternate Make	
		DG Set Rating	
		Prime Power	

Sr. No	ITEMS	SPECIFICATIONS	CONTRACTOR RESPONSE
		Standby Power	
		Rated Voltage	
		Rated Frequency	
		Phase	
		Engine Type	
		Acoustic Enclosure	
		Control Panel	
		Canopy	
4	**LT PANELS**		
		Panel Make	
		Switchgear Make	
		System Voltage	
		Frequency	
		System (phase)	
		Busbar Material	
		Earth Busbar	
		Enclosure	
		Sheet Thickness	
		Degree of Protection	
		Others	
5	**LT CABLE**		
		Cable Make	
		Cable Type	
		Rated Voltage	
		Conductor	
		Conductor Type	
		No. of Cores	
		Conductor Size	
		Insulation	
		Insulation Voltage	
		Inner Sheath	
		Armour	
		Outer Sheath	
6	**CABLE TRAYS**		
		Cable Tray Make	
		Type	
		Material	
		Sheet Thickness	
		Finish	
		Tray Width	
		Tray Height	
		Tray Length	
7	**BUSDUCTS**		
		Busduct Make	
		System	
		Standard	

Sr. No	ITEMS	SPECIFICATIONS	CONTRACTOR RESPONSE
		Rated Voltage	
		Rated Frequency	
		No. of Phases	
		Rated Current	
		Conductor Material	
		Conductor Finish	
		Insulation	
		Insulation System	
		Enclosure	
		Enclosure Protection	
		Paint/Finish	
8	**DISTRIBUTION BOARD**		
		Distribution Board (DB) Make	
		Ways	
		Rated Voltage	
		Enclosure	
		Sheet Thickness	
		Degree of Protection	
		Finish	
		Colour	
		Incoming Cable	
		Outgoing Cable	
		Door	
		Earthing	
9	**LT WIRES**		
		Wire make	
		Standard	
		Rated Voltage	
		Conductor	
		Conductor Sizes	
		Conductor Type	
		Conductor Class	
		Insulation	
		Insulation Type	
		Flame Retardance	
		Smoke Emission	
		Halogen	
10	**VEHICLE CAR CHARGING STATION**		
		EV Car Charger Make	
		Charger Type	
		Input Supply	
		Input Frequency	
		Rated Charging Capacity	
		Output Voltage	
		Output Current	
		Connector	
		No. of Charging Guns	

Sr. No	ITEMS	SPECIFICATIONS	CONTRACTOR RESPONSE
		Charging Cable	
		Cable Length	
		Power Factor	
		Network Connectivity	
		IP Rating	
		IK Rating	
		Enclosure	
		Standard	
11	**LIGHT**		
		Light Make	
		Type	
		Rated Voltage	
		Frequency	
		Power	
		Luminous Flux	
		LED Efficacy	
		Colour Temperature	
		CRI	
		Driver	
		Beam Angle	
		Housing	
		Diffuser	
		Mounting	
		IP Rating	
		IK Rating	
		Surge Protection	
		Dimming	
12	**FIRE ALARN PANEL (FACP)**		
		Panel Make	
		System Type	
		Configuration	
		Panel Type	
		No. of Loops	
		Loop Capacity	
		Communication	
		Display	
		Event Memory	
		BMS Interface	
		Repeater Panel	
		Networking	
		Power Supply	
		Battery Backup	
		Enclosure	
		Mounting	
		IP Rating	
13	**NETWORK CONTROLLER**		
		Make	

Sr. No	ITEMS	SPECIFICATIONS	CONTRACTOR RESPONSE
		Controller Type	
		Processor	
		RAM	
		Storage	
		Network Interfaces	
		Security	
		User Management	
		Power Supply	
		Mounting	
		Warranty	
14	**AMPLIFIER**		
		Make	
		Application	
		Amplifier Type	
		Rated Output Power	
		Output Channels	
		Frequency Response	
		Signal-to-Noise Ratio	
		Audio Outputs	
		Volume Control	
		Redundancy	
		Communication	
		Remote Monitoring	
		Construction	
		Compliance	
		Warranty	
15	**CAMERA**		
		Make	
		Camera Type	
		Sensor	
		Resolution	
		Viewing Angle	
		IR Illumination	
		Motion Detection	
		Privacy Masking	
		Network Interface	
		Protocol Support	
		ONVIF	
		PoE	
		IR Control	
		Tamper Detection	
		Housing	
		Ingress Protection	
		Impact Protection	
		Power Supply	
		Warranty	

SCHEDULE OF TECHNICAL DATA – HVAC EQUIPMENT

AHU WITH 6-ROW COOLING COIL & AXIAL FLOW FANS ,VRV OUTDOOR UNITS, DUCT, 315 mm JET FAN & CO SENSOR

Preliminary technical data filled against the uploaded CPWD HVAC schedule. The schedule requires AHU casing, coil, filter and fan-motor particulars and specifically shows 6-row coil; final selection is subject to approved manufacturer.

AHU-01 – 12.5 TR (Ceiling Suspended)

A. DOUBLE SKINNED AIR-HANDLING UNIT

S. No.	Technical Parameter	Offered / Proposed Data
1	Make of AHU	Approved equivalent / reputed make
2	Capacity CFM	5,000 CFM
3	Material/Gauge Casing & Drain Pan	Double skin GI; 25 mm PUF insulated panel; 1.0 mm GI skin; GI/SS drain pan
4	Overall Size (L×B×H), m	Approx. 2.20 × 1.10 × 1.10 m
5	Type of AHU	Horizontal, ceiling suspended
6	Overall Weight, kg	450

B. COOLING COIL

S. No.	Technical Parameter	Offered / Proposed Data
1	Make	Approved equivalent / reputed make
2	Material of Tube/Fins	Copper tubes / Aluminium fins
3	No. of Fins/cm	4–5
4	No. of Rows Deep	6 ROW
5	Dia of Tubes	12.7 mm OD
6	Face Area, m^2	0.70 m^2
7	Cooling Capacity, kcal/hr	37,800 kcal/hr
8	Face Velocity, m/s	≈ 2.0
9	Test Pressure, kg/cm^2	10

C. FILTER SECTION

S. No.	Technical Parameter	Offered / Proposed Data
1	Make	Approved equivalent / reputed make
2	Type of Filters	Pre-filter + fine filter
3	No. of Filters	As per module arrangement
4	Size of Filters	Approx. 610 × 610 mm modular
5	Air Velocity through Filter, m/s	≈ 2.0–2.5
6	Efficiency of Filter	Pre-filter ≥90% down to 10 micron; final filter as required

D. FAN & FAN MOTOR

S. No.	Technical Parameter	Offered / Proposed Data
1	Make of Fans & Motor	Approved equivalent / reputed make
2	Type of Fan	Backward-curved centrifugal fan
3	No. of Fan	1 No.
4	Width & Dia of Fan	Approx. 500–630 mm; final as selected
5	Type of Blade	Backward-curved, dynamically balanced
6	Air Quantity CMH	15,000 CMH
7	Static Pressure, mm WG	≈ 40

8	Fan Discharge Velocity	≈ 8–10 m/s
9	Type of Balancing	Dynamic
10	Brake Horse Power, HP	3.0
11	Horse Power of Motor, HP	5
12	Motor RPM	≈ 1450
13	Fan Speed	To suit selected duty
14	Type of Drive	Direct Driven

AHU-02 – 3.75 TR (Ceiling Suspended)

A. DOUBLE SKINNED AIR-HANDLING UNIT

S. No.	Technical Parameter	Offered / Proposed Data
1	Make of AHU	Approved equivalent / reputed make
2	Capacity CMH	1,500 CFM
3	Material/Gauge Casing & Drain Pan	Double skin GI; 25 mm PUF insulated panel; 1.0 mm GI skin; GI/SS drain pan
4	Overall Size (L×B×H), m	Approx. 1.60 × 0.85 × 0.90 m
5	Type of AHU	Horizontal, ceiling suspended
6	Overall Weight, kg	250

B. COOLING COIL

S. No.	Technical Parameter	Offered / Proposed Data
1	Make	Approved equivalent / reputed make
2	Material of Tube/Fins	Copper tubes / Aluminium fins
3	No. of Fins/cm	4–5
4	No. of Rows Deep	6 ROW
5	Dia of Tubes	12.7 mm OD
6	Face Area, m^2	0.45 m^2
7	Cooling Capacity, kcal/hr	11,340 kcal/hr
8	Face Velocity, m/s	≈ 2.0
9	Test Pressure, kg/cm^2	10

C. FILTER SECTION

S. No.	Technical Parameter	Offered / Proposed Data
1	Make	Approved equivalent / reputed make
2	Type of Filters	Pre-filter + fine filter
3	No. of Filters	As per module arrangement
4	Size of Filters	Approx. 610 × 610 mm modular
5	Air Velocity through Filter, m/s	≈ 2.0–2.5
6	Efficiency of Filter	Pre-filter ≥90% down to 10 micron; final filter as required

D. FAN & FAN MOTOR

S. No.	Technical Parameter	Offered / Proposed Data
1	Make of Fans & Motor	Approved equivalent / reputed make
2	Type of Fan	Backward-curved centrifugal fan

3	No. of Fan	1 No.
4	Width & Dia of Fan	Approx. 500–630 mm; final as selected
5	Type of Blade	Backward-curved, dynamically balanced
6	Air Quantity CMH	4,500 CMH
7	Static Pressure, mm WG	≈ 40
8	Fan Discharge Velocity	≈ 8–10 m/s
9	Type of Balancing	Dynamic
10	Brake Horse Power, HP	1.0
11	Horse Power of Motor, HP	2
12	Motor RPM	≈ 1450
13	Fan Speed	To suit selected duty
14	Type of Drive	Direct Driven

- **Mounting clarification: AHU-01 and AHU-02 are ceiling-suspended units. The AHU mounting arrangement shall include suitable suspension/support rods, vibration isolation, access clearance for filters and coil maintenance, and proper condensate drain arrangement. Final support details shall be confirmed with approved shop drawings and structural provisions.**

AXIAL FLOW FAN – TECHNICAL DATA

Required air quantities: 44,000 / 22,000 / 12,500 / 8,000 CFM. Motor ratings below are preliminary selections and shall be confirmed from the manufacturer's fan curve.

Tag	Air Qty CFM	Type	Static Pressure mm WG	Motor HP	RPM
AF-01	44,000	Axial Flow Fan	25	25	720
AF-02	22,000	Axial Flow Fan	20	10	960
AF-03	12,500	Axial Flow Fan	15	5	960
AF-04	8,000	Axial Flow Fan	15	3	960

AXIAL FAN COMMON TECHNICAL DATA

S. No.	Technical Parameter	Offered / Proposed Data
1	Manufacturer	Approved equivalent / reputed make
2	Type	Axial flow fan
3	Blade	Aluminium/FRP aerodynamic blades, dynamically balanced
4	Insulation Class	Class F
5	Type of Drive	Direct driven
6	Noise Level	≤ 75 dB(A) at 1 m, subject to final selection
7	Balancing	Dynamic balancing as per manufacturer standard
8	Performance Verification	Manufacturer fan curve / test certificate

DAIKIN VRV OUTDOOR UNITS, DUCT, 315 mm JET FAN & CO SENSOR

E. DAIKIN VRV OUTDOOR UNIT – 6 HP

S. No. / Technical Parameter	Offered / Proposed Data
1. Make	Daikin
2. Type	VRV Outdoor Unit

3. Nominal Capacity	6 HP class; approx. 16 kW cooling capacity
4. Refrigerant	R-410A / as per selected approved model
5. Power Supply	As per selected Daikin model; typically 220–240 V, 1Ph, 50 Hz for applicable model
6. Compressor	Hermetically sealed inverter compressor
7. Condenser	Air-cooled, fin & tube type
8. Control	Inverter / VRV variable refrigerant flow control
9. Protection	High/low pressure, overload and other manufacturer-standard protections
10. Installation	Outdoor, weather-resistant construction

F. DAIKIN VRV OUTDOOR UNIT – 16 HP

S. No. / Technical Parameter	Offered / Proposed Data
1. Make	Daikin
2. Type	VRV Outdoor Unit
3. Nominal Capacity	16 HP class; approx. 45 kW cooling capacity
4. Refrigerant	R-410A / as per selected approved model
5. Power Supply	380–415 V, 3Ph, 50 Hz
6. Compressor	Hermetically sealed inverter / scroll compressor, as per selected model
7. Condenser	Air-cooled, fin & tube type
8. Control	Inverter / VRV variable refrigerant flow control
9. Installation	Outdoor, weather-resistant construction
10. Final Selection	Model, dimensions, sound level and electrical data shall be confirmed from approved Daikin catalogue/submittal

G. DUCT – TECHNICAL DATA

S. No. / Technical Parameter	Offered / Proposed Data
1. Material	Galvanized Iron (GI) sheet
2. Construction	Pittsburgh lock / TDF or approved equivalent
3. Pressure Class	As per system static pressure and project specification
4. Duct Insulation	25 mm thick thermal insulation with vapour barrier, where applicable
5. External Finish	Aluminium foil vapour barrier / approved finish
6. Main Duct Velocity	Approx. 6–8 m/s, subject to final design
7. Branch Duct Velocity	Approx. 4–6 m/s, subject to final design
8. Flexible Connection	Canvas / flexible connector at AHU and fan connections
9. Turning Vanes	Provided at bends where required
10. Volume Control Damper	GI opposed/single blade type, as required
11. Access Door	Insulated access door at required locations
12. Joint Sealing	Approved duct sealant at joints and seams
13. Testing	Duct leakage / inspection as per project specification

H. 315 mm DIA AXIAL JET FAN – TECHNICAL DATA

S. No. / Technical Parameter	Offered / Proposed Data
1. Type	Axial Jet Fan
2. Nominal Diameter	315 mm
3. Air Quantity	Approx. 2,500–3,500 CFM; final selection as per manufacturer fan curve
4. Thrust	To be selected based on basement ventilation calculation
5. Motor Rating	Approx. 1.5–2.2 kW; final as per manufacturer fan curve
6. Power Supply	415 V, 3Ph, 50 Hz
7. Motor Protection	IP55 minimum

8. Insulation Class	Class F
9. Drive	Direct driven
10. Impeller / Blades	Aerodynamic aluminium / FRP blades
11. Balancing	Dynamic balancing
12. Speed	As per manufacturer selection, typically application-dependent
13. Reversible Operation	Where required by approved smoke-control strategy
14. Noise Level	≤75 dB(A) at 1 m, subject to final selection
15. Application	Basement car-park ventilation / impulse ventilation

I. CO SENSOR – TECHNICAL DATA

S. No. / Technical Parameter	Offered / Proposed Data
1. Type	Carbon Monoxide (CO) Gas Sensor
2. Sensing Technology	Electrochemical
3. Measuring Range	0–300 ppm
4. Output	4–20 mA and/or RS-485 Modbus
5. Power Supply	24 V DC
6. Accuracy	Approx. ±3 ppm or ±5% of reading, subject to selected manufacturer
7. Enclosure	IP65 or better
8. Display	Digital display, if required
9. Communication	BMS / Ventilation Control Panel interface
10. Application	Basement car-park CO monitoring and automatic ventilation control
11. Installation	At locations and heights recommended by sensor manufacturer / ventilation design
12. Alarm / Control Setpoints	To be finalized as per project, statutory and fire/life-safety requirements

CONTRACTOR TECHNICAL SUBMISSION DOCUMENT

TECHNICAL INFORMATIONS FOR WATER SUPPLY / FIRE FIGHTING PUMPS & EQUIPMENTS AND WATER TREATMENT UNIT ETC.
(TO BE FILLED BY THE TENDERER)

S.NO	Items		Specifications	Contractor response
(I).	**ELECTRICALLY OPERATED FIRE PUMP**		**HYDRANT, SPRINKLERS, WATER CURTAIN & JOCKEY PUMP:**	
			1. Discharge	
		:	2. Total head at full discharge	
		:	3. Type	
		:	4. Make and Model No.	
		:	5. BHP absorbed	
		:	(a) at rated head and discharge	
			(b) at 150% of rated discharge and 65% of rated head.	
			6. Casing material.	
		:	7. Impeller material.	
		:	8. Shaft material.	
		:	9. No. of stages.	
		:	10. Type of drive.	
		:	11. Type of sealing.	
		:	**MOTOR:**	
			1. Make.	
		:	2. Type.	

S.NO	Items		Specifications	Contractor response
		:	3. Protection type.	
		:	4. Insulation class.	
		:	5. Electrical particulars (Voltage/No. of phase/frequency).	
		:	6. I.S. conforming to	
		:	7. H.P. (App.)	
		:	8. Speed.	
		:		
(II).	**DIESEL FIRE PUMP**		**<u>Diesel Engine:</u>**	
			1. Make & Model No.	
		:	2. Type.	
		:	3. H.P.	
		:	4. Speed.	
		:	5. No. of cylinders.	
		:	6. I.S/BS Standard conforming to	
		:	7. Type of cooling.	
		:	8. Fuel consumption at full load.	
		:	9. Overload capacity.	
		:	10. Isolation efficiency.	

S.NO	Items		Specifications	Contractor response
(III).	**RAW WATER PUMPS**		**PUMP:**	
		:	1. Discharge	
		:	2. Head	
		:	3. Type	
		:	4. H.P of Motor	
		:	5. Other Details	
(IV).	**GARDEN HYDRANT PUMPS**		**PUMP:**	
		:	1. Discharge	
		:	2. Head	
		:	3. Type	
		:	4. H.P of Motor	
		:	5. Other Details	
(V).	**HYDRO PUMPS (FOR DOMESTIC WATER)**		**PUMP:**	
		:	1. Discharge.	
		:	2. Total head at full discharge.	
		:	3. Make and Model No.	
		:	4. Type.	
		:	5. Frame size.	
		:	6. BHP absorbed	

S.NO	Items		Specifications	Contractor response
		:	(a) at rated head and discharge.	
		:	7. Casing material.	
		:	8. Impeller material.	
		:	9. Shaft material.	
		:	10. No. of stages.	
		:	11. Type of drive.	
		:	12. Type of seal.	
			MOTOR:	
		:	1. Make.	
		:	2. Frame size.	
		:	3. Type.	
		:	4. Protection type.	
		:	5. Insulation class.	
		:	6. Electrical particulars (Voltage/No. of phase/frequency).	
		:	7. I.S. conforming to	
		:	8. H.P.	
		:	9. Speed.	
(VI).	**MULTIGRADE PRESSURE SAND FILTER & ACTIVATED CARBON FILTER**		**FILTERS**	
		:	1. Make	

S.NO	Items		Specifications	Contractor response
		:	2. Model	
		:	3. Dia Meter	
		:	4. Height	
		:	5. Type of Flow	
		:	6. Material of Construction	
		:	7. Shell/Dished end thickness	
		:	8. Max. working pressure	
		:	9. Hydro test pressure	
		:	10. Max. Flow rate	
		:	11. Min. flow rate	
		:	12. Filtration Rate	
		:	13. Inlet/outlet pipe Size	
		:	14. Type of Media	
		:	15. Media Quantity	
		:	16. Type of Valve	
		:	17. Back Wash Frequency	
		:	18. Pressure drop across bed	
(IX).	**SUMP PUMPS (FOR SEWAGE)**		**PUMPS**	
		:	1. Discharge	

S.NO	Items		Specifications	Contractor response
		:	2. Head	
		:	3. Type	
		:	4. Solid Handling Capacity	
		:	5. H.P of Motor	
		:	6. Other Details	
(X).	**SUMP PUMPS (FOR DRAINAGE)**		**PUMPS**	
		:	1. Discharge	
		:	2. Head	
		:	3. Type	
		:	4. Solid Handling Capacity	
		:	5. H.P of Motor	
		:	6. Other Details	
(XI).	**ELECTRIC CONTROL PANEL**		**PANEL**	
		:	1. Make	
		:	2. Make of switch fuse unit/breaker used.	
		:	3. Thickness of sheet metal used.	
		:	4. Make of contractors.	
		:	5. Make of cables and size of cables for different motors.	
	.	:	6. Any other informations.	

S.NO	Items		Specifications	Contractor response
Note:-				
The Tenderer must give as maximum as possible information. They may add any other relevant information's also, if required.				

APPROVED MAKE

Approved Makes for Architecture & Interior		
Si.	**Materials**	**Approved Make**
1	PPC / OPC Cement	ACC/ Ultratech / Ambuja
2	WHITE CEMENT	J.K. White / Birla White / Travancore
3	REIN FORCEMENT STEEL	SAIL/TATA/RINL/JSW
4	STRUCTURAL STEEL SECTIONS	Sail / Tata Steel Ltd. /RINL/ Jindal Steel & Power Ltd
5	SUPER PLASTICIZERS	Mc Bauchemie / Fosroc / Sika
6	WATER PROOFING COMPOUND (LIQUID)	Fosroc / CICO / Laticrete
7	AAC BLOCK	Godrej TUFF / Builtech / Magicrete Building Solution
8	AAC BLOCK ADHESIVE	Godrej TUFF / Builtech / Magicrete Building Solution
9	POLYMER MODIFIED CEMENTITIOUS GROUT	Bal Endura / Webber / Myk Laticrete / Kerakoll / Fosroc
10	STAINLESS STEEL	Jindal Stainless Steel/ Kich / Dorma / Geze / Ozone
11	EPOXY MORTAR	Fosroc / Sika / Cico / Laticrete / Kerakoll
12	CEMENTOUS GROUT	Xypex / Fosroc / Krytone
13	CRYSTALINE CEMENTIOUS WATERPROOFING COMPOUND	Xypex Construction Chemicals / Krytone / Sunanda/Penetron
14	POLYMERIC CEMENTIOUS COATING	BASF / CICO / Fosroc
15	NON-MODIFIED / NON BITUMENOUS HIGH SOLID / LIQUID APPLIED POLYURETHANE MEMBRANE	BASF / Fosroc / Sika
16	ELASTOMERIC ACRYLIC U.V. RESISTANT LIQUID APPLIED COATING	BASF / Fosroc / Sika
17	APP WATERPROOFING MEMBRANE	STP / Texsa / Bitumat Co. Ltd / Tikitar / Bengal Bitumen / Dermabit / Pidilite
18	EXPANSION JOINT- Modular	Hercules / Bizzar / Ztech / Devin
19	LIST OF RMC PRODUCER	Relcon / Prism
20	FLUSH DOORS	Duro / Merino / Century
21	UPVC WINDOWS/ DOORS / VENTILATORS	Encraft / Aluplast / Rehau / Wintech
22	WOODEN / METAL / GLAZE-FIRE RATED DOOR SHUTTERS	Navair / Sukri / Promat / Kutty
23	NATURAL WOOD VENEERS	Green Ply / Truwood / Century/ Archid
24	ANTI STATIC HIGH PRESSURE LAMINATE	Formica / Bakelite Hylam / Decolam Merino/Century
25	ALUMINIUM EXTRUSIONS	Hindalco / Nalco / Jindal

Si.	Materials	Approved Make
26	HINGES & BRASSWARE	Shalimar/ Indo-Brass / Earl Bihari / Magnum/Kich
27	ALL TYPES OF GLASS	Saint Gobain
28	FIRE-RATED GLASS (TWO HOUR FIRE RATING) TRANSPARENT CLEAR GLASS	Saint Gobain
29	GYPSUM BOARD	St. Gobain Gyproc Gypsum
30	CALCIUM SILICATE BOARD FOR FIRE RATED DOOR SHUTTERS	Supalux / Master Board / Starpan
31	INTUMESCENT STRIP FOR FRD SHUTTERS	Promat / Pemko / Intumex / Astoflame
32	ALL HARDWARE AND FITTINGS FOR ALL TYPES OF GLAZING / DOORS / WINDOWS ETC.	Dorma / Hafele / Gezei / Kich / Godrej / Assa-Abloy
33	STEEL FIRE RATED DOOR SHUTTER	Sukri / Shakti-Met / Godrej / Navair / Adhunik
34	DASH / STUD / ANCHOR FASTENERS	Hilti / Fischer / Bosch
35	LOCKS IN CABINETS	Dorma / Hafele / Gezei / Kich / Godrej / Assa-Abloy
36	MDF BOARD	Nuwood / Duratuff/Century/Kitply/Greenply
37	ADHESIVES	Mapei -keralastic-t/ Keramol Grey/ Anchor / Dunlop / Pidilite-Fevicol
38	EPDM GASKET	Hanu / Anand
39	STAINLESS STEEL DOOR HANDELS / LOCKS AND FITTINGS	Dorma / Hafele / Geze
40	MOISTURE RESISTANT BOARDS	Saint Gobain Gyproc / USG Boral
41	SS MESH	Gkd / Wmw
42	COMMERCIAL PLY / BOARD	Duro / Century / Archid / Durian/ Merino
43	HARDWARE ACCESSORIES FOR FIRE DOORS / PANIC BAR / PANIC TRIM / DOOR CLOSER / HINGES / MORTISE LOCK	Dorma/ Geze / Hafele / Assa-Abloy
44	CPVC PIPES & FITTINGS	Astral / Supreme / Finolex
45	STAINLESS STEEL PIPES & FITTINGS	Tata / Jindal
46	VITREOUS CHINA WARE	Kohler/ Hindware / Parryware
47	RCC PIPES	Pragati / Lakshmi / Sood & Sood / Jain & Co
48	UPVC PIPES & FITTINGS	Supreme / Prince / Astral / Finolex
49	STAINLESS STEEL SINKS	Neelkanth / Nirali / Cera/Anupam

Si.	Materials	Approved Make
50	SPUN CAST IRON PIPES & FITTINGS (IS:3989)	Jaiswal Neco/ RIF / SKF / BIC
51	STONEWARE PIPES AND GULLY TRAPS	Perfect / Burn / Anand / Parry
52	GUNMETAL VALVES (FULL WAY VALVE)	Zoloto / Castle/ Kartar
53	CI DOUBLE FLANGED SLUICE VALVE	Kirloskar / Ivc
54	CI MANHOLE FRAME & COVERS AND CI GRATING	Neco / RIF / SKF / BIC
55	SANITARY CP FITTINGS & ACCESSORIES	Oriental Series Of Marc Or Equivalent Series Of Kohler/ Jaquar / Grohe
56	FLOOR TRAPS	Jayna / Chilly / Nirali
57	LOOKING MIRROR	AIS / Saint Gobain/ Modiguard
58	PVC WATER TANK	Sintex / Polycon
59	CERAMIC TILES	H & R Johnson / Simpolo / Somany / Kajaria / Asian (Agl) / Orient
60	VITRIFIED TILES	H & R Johnson / Simpolo / Somany / Kajaria / Asian (Agl) / Orient
61	ADHESIVE FOR FLOOR VITRIFIED TILES / MARBLE STONE / GRANITE STONE ETC.	Laticrete / Ferrouscrete / Ballendura
62	LAMINATED FLOOR	Action Tesa / Pergo
63	COMPOSITE MARBLE / GRANITE / ENGINEERED STONE	Asian / Johnson / Kalinga
64	WATER BASED MELAMINE POLISH	Premium Quality- Asian Paints / Pidilite Industries/ ICI Dulux / Berger
65	EPOXY PRIMER AND PAINTS	Premium Quality- : ICI Dulux/Nerolac / Asian Paints/ Berger
66	FIRE RETARDANT PAINTS	1st Quality Products Of: Asian Paints / Berger Paints / Shalimar
67	SYTHETIC ENAMEL PAINT / PRIMER / DISTEMPER / EXTERIOR	Premium Quality- : Asian / Berger / ICI(Dulux) / Nerolac
68	TEXTURE PAINT	Premium Quality- : Spectrum / Asian / Heritage / Berger / Dulux
69	WALL PUTTY / COURSE PUTTY	Premium Quality- : Birla White / J.K White / Ferrous Crete / Berger
70	CLAMP SYSTEM FOR DRY STONE CLADDING	Hilti / Fischer / Bosch
71	TILE ADHESIVE / EPOXY GROUTS	Ferrous Crete / Balll Endura / Pidilite / Lati Crete
72	FLOOR HARDNERS	Piditop 333 By Pidilite / Fosroc / Sika / Firmae / Ironite / Ferrok / Haronate
73	ALUMINIUM COMPOSITE PANELS	Alucobond / Aludecor / Renobond / Alpulic

Si.	Materials	Approved Make
74	METAL FALSE CEILING	Armstrong / Saingobin / Hunter Douglas / Aura -Asipl
75	CALCIUM SILICATE FALSE CEILING	Everest / NCL / Aerolite
76	CALSIUM SILICATE CEILING TILE/BOARD	Gyproc / Boral / Hilux / Aerolite / Armstong (Mylar)
77	GYPSUM PLASTER	Ferrouscrete / Gyproc / Ultratech
78	READY MIX PLASTER	Ferrouscrete / Ultratech / Saintgobin
79	FALSE CEILING GRID SYSTEM	Gyproc / Armstrong/USG Boral
80	POLYSULPHIDE SEALANT	Fosroc / Pidilite / Tuffseal / Sikka
81	PAVERS / GRASS PAVERS / KERB STONE	Ovilite / Victoria / Kjs / Unistone / Pinacalle / Chellsia
82	BUILDING SIGNAGE	Hindustan Signage Pvt.Ltd / Pr Graphics / Motivatte Solution / Galaxy Signage, Signsutra
83	Toilet Cubicles	Merino/Greenlam/T-line
84	ACP	EURO BOUND / VIVA
85	ACRYLIC EMULSON PAINT	ASIAN PAINTS / BIRLA OPUS

	ITEM	MAKE
1	Rising Mains	Legrand / EAE / Godrej/ Schneider
2	L.T. Panel / MDB: PTTA -- do -- : TTA	Adlec / Tricolite / Vidhyut Control / Ambit / Shivalic / SPC / Powertron (Delhi) Legrand-Rittal/ Schneider-Rittal / LK-Rittal / Siemens-Rittal
3	MCB-DB / SDB (Factory built)	Legrand / Hager / Schneider / LK/ Siemens
4	Feeder Pillar	Adlec / Tricolite / Vidhyut Control / Ambit / Shivalic / Powertron (Delhi) / SPC
5	Air Circuit Breaker	Siemens (3WL) / LK / Schneider (Master pact NW) / Legrand (DMX^3)
6	MCCB	LK / Schneider (Compact NSX) / Legrand (DPX) / Siemens (Sentron-3VL).
7	MCB	Legrand (Lexic) / Hager / LK / Schneider (Acti-9)/ Siemens (Beta Gard) / Panasonic / Eaton
8	RCCB / RCBO / ELCB	Legrand / Hager / LK / Schneider / Siemens / Eaton
8a	ON LOAD change over switch	LK / HPL- Socomec / ASCO
9	Fuses	Legrand / LK / Schneider / Siemens
10	Contactor	Legrand / LK / Schneider / Siemens / Hager
11	Relays	Rishabh / Essen / LK / Minilec / Siemens / Schneider
12	Timer	LK / Siemens / Hager / Legrand / Schneider
13	Indication Lamps (LED)	LK / Siemens / ESPEE / Essen / C&S-Raas control
14	Selector Switch / Push Button	Siemens / Key Cee / BCH / LK / Rishabh
15	Instruments (A / V / Frequency)	A M / A E / IMP / Rishab / Minilec
15a	Digital Meter / Multifunction Meters	LK / Schneider / Conzerv / Neptune / Rishabh / Minilec / Secure
15b	Digital Energy Meter	LK / Conzerv / Secure / Rishabh / Minilec
16	Terminals	Elmax / Tosha / Essen / Wago / Connectwell
17	Clamp-on type terminal strip	Elmax / WAGO
18	CT & PT	AE / Ind Coil / LK / Kappa / Rishabh (CTs only) / Neptune
19	L T Armored-Al / Cu Cable: (XLPE) Control Cable-Cu: (PVC)	Universal / KEI / Havells / RR Cable / Polycab
20	Lugs / Thimbles etc.	Dowells / Reycham / Commet
21	Compression Glands	HMI / Commet / Dowells / Siemens / Raychem / Gripwell
22	PVC insulated single core stranded Cu wire-(Cl-2)	Universal / KEI / Havells / RR Cable / Polycab
23	Perforated Cable tray (IEC)	OBO Betterman / Unistrut / Legrand
23a	Perforated Cable tray (IS)	Venus/ Slotco/ Pilco/ Reeco / Indiana
23b	Wire Cable Tray (IEC)	OBO Betterman / Legrand / C&S-Gewis
24	PVC Conduit / Accessories	AKG / BEC / Polypack
25	HDPE PIPE	Dura-line / Rex Poly-extrusion / Tirupati
26	Steel Conduit / Accessories	RM CON / BEC / Steel Craft
27	Steel Pipes	RM CON / BEC / Surya / Indian Tube Co / Jindal
28	Switches and Sockets	Legrand / Schneider / Norisys / Panasonic. (Model to be approved-minimum 3rd range from basic model shall be used)
29	Metal Clad Industrial Power Socket with MCB	Legrand / Siemens / Hager

30	Weather-proof Industrial plug & socket 3/4/5/6 pin	Schneider / Legrand / C&S-Gewiss / Cape Electronics
31	Floor Duct	Legrand / MK / OBO Bettermann
32	Unit DOL/Star-Delta Starters	LK / Schneider / Siemens
33	Luminaries (Indoor)-LED Luminaries (Outdoor)-LED	Forma / Regent / Light Plus ERCO/ iGuzzini / Fagerhult Forma / Regent / Light Plus / K-lite We-ef/ ERCO/ iGuzzini / EWO/ LEC
34	Flame Proof Luminaries	Baliga / FCG / Bajaj / Cromton
35	Exit signage	Prolite / Divinity / Regent
36	Ceiling fans	Bajaj / Crompton / Usha / Havells / Panasonic
37	Exhaust fans	Bajaj / Havells / Crompton / Kruger
38	D G Set	Jakson-Cummins / Caterpillar / MTU
38a	Anti-vibration mountings	Dunlop/ GERB/ RESISTOFLEX /Easy Flex
39	Servo Voltage Stabilizer	Automatic Electric / Piyush (PACT) / Fuzi Electric / Powertron Products (Delhi)
40	L T Capacitor bank	Epcos-TDK / LK / ABB / Schneider / Legrand
41	APFC Relay	LK / Epcos-TDK / Legrand / Schneider / Neptune (Ducati)
41a	Active Harmonic Filter	P2 Power / Schneider / Siemens / Delta / LK
42	SPD	OBO Bettermann / DEHN / ERICO / Legrand/ Eaton
43	Lightning protection system	OBO Bettermann / DEHN / JEF
44	Street Light Pole (GI) Street Light Pole (AL)	Bajaj / Transrail / Valmont / LMI / K-lite Rosa / Technilum / Heper Alcopole / Bega
45	Lifts	Otis / Kone / Schindler / Johnson Lift / ThyssenKrupp
46	: ON LINE UPS (with Isolation Transformer)	Fuji Electric / Legrand-Numeric / Delta / Powertron-Products, Delhi./ Schneider/ Vertib / Pegasus (AAL) / Eaton
47	SMF chargeable Battery	Exide / Amar raja / AMCO
48	Occupancy Sensors	Lutron/ Crestron/ Schneider/ Legrand/ Cape Elect./Ltech

	H T EQUIPMENT	
1	Transformer (11/0.433KV)	Ames Impex/ ABB / Raychem / Danish Tr. PL / ECS/ Siemens/Cahore / Ames Impex / Recons / Schneider
2	Vacuum Circuit Breaker	Schneider / ABB / Siemens / LK
3	Ring Main Unit (RMU)	Schneider / ABB / Siemens / LK
4	33/11KV (E/UE) XLPE Cable	Universal / Havells / KEI / RR Cable / Polycab
5	33/11KV Cable Termination Kit	Raychem / MECP-M Seal / 3M

	FIRE ALARM SYSTEM	
1	Fire Alarm System	Mircom/Cerberus/XLS300/FCI-JCI/Gamewell
2	Repeater Panel / Software	Mircom/Cerberus/XLS300/FCI-JCI/Gamewell
3	Detectors	Mircom/Cerberus/XLS300/FCI-JCI/Gamewell
4	Modules & RI	Mircom/Cerberus/XLS300/FCI-JCI/Gamewell

	PA SYSTEM	
1	PA Controller	Bose/ Heinrich/ Biamp
2	Amplifier	Bose/ Heinrich/ Biamp
3	Speaker	Bose/ Heinrich/ Biamp
4	Paging Station	Bose/ Heinrich/ Biamp

	CCTV SYSTEM	
1	Camera	Pelco/Honeywell/Axis
2	Keyboard Controller	Pelco/Honeywell/Axis
3	Digital Video Recorder (NVR)	Pelco/Honeywell/Axis
4	TV / Monitor	Sony/LG/Panasonic/Samsung

5	RG-11 Coaxial Cable	Universal / KEI / Havells / RR Cable / Polycab
6	CAT-6 Cable	Systimax/Panduit/Siemon/Legrand
7	Power Cable	Universal / KEI / Havells / RR Cable / Polycab
8	Fibre Optic Cable	Molex / Panduit / Siemon
9	PoE Switch	Cisco / Juniper/ Techroutes/ extreme
10	Router	Cisco / Juniper/ Techroutes/ extreme
11	Patch Panel	Systimax/Panduit/Siemon/Legrand
12	Rack	Valrack/ Rittal/ Emerson/ APC/ Legrand
13	Wireless LAN Controller	Cambium/Cisco/Arista

	EPABX SYSTEM	
1	EPABX System	Avaya/Cisco/Techroutes/alcatel
2	IP Phone	Avaya/Cisco/Techroutes/alcatel

Note : this list only to be followed if any makes are not mentioned in tendered BOQ document.

HVAC EQUIPMENT – MAKE LIST

Proposed Makes for BOQ Items

S. No.	Description of Item	Make – 1	Make – 2	Make – 3
1	VRV/VRF Outdoor Unit	Daikin	Mitsubishi Electric	Hitachi
2	Ceiling Suspended AHU	Carrier	Blue Star	Zeco
3	Y-Joints for VRF Indoor Unit	Daikin	Mitsubishi Electric	Hitachi
4	Individual Wired/Wireless Remote Controller	Daikin	Mitsubishi Electric	Hitachi
5	Central Controller / Programmable Controller	Daikin	Mitsubishi Electric	Hitachi
6	Axial Flow Fan – Lift Pressurization / Smoke Extraction	Systemair	Kruger	Nicotra Gebhardt
7	Inline Fan	Systemair	Kruger	Nicotra Gebhardt
8	Jet Fan – 315/350 mm	Systemair	Kruger	FläktGroup
9	UPVC Condensate Drain Pipe	Supreme	Astral	Ashirvad
10	Refrigerant Copper Pipe	Rajco	Mandev	Multicore
11	GI Ducting / GI Sheet	Tata Steel	JSW	SAIL
12	Grille / Diffuser / VCD	Caryaire	Systemair	TROX
13	Fire Damper	TROX	Ruskin	Systemair
14	Smoke Damper	TROX	Ruskin	Systemair
15	Volume Control Damper	Caryaire	Systemair	TROX
16	Electrical Panel for VRV Outdoor Units	Schneider Electric	Siemens	L&T
17	MCCB	Schneider Electric	Siemens	ABB
18	Control Cable	Polycab	KEI	Finolex
19	Cable Tray	MEM	OBO Bettermann	Indiana
20	GI/Structural Supports & Accessories	Tata Steel	Jindal	SAIL

Note: Final makes shall be subject to project specifications, consultant/client approval, approved vendor list and equipment compatibility. For VRF systems, branch joints/controllers should preferably be of the same manufacturer as the selected VRF system.

LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIALS PLUMBING SYSTEM

S. No.	Details of Materials / Equipment	Manufacturer's Name
1.	Vitreous China Sanitaryware	Aquaviva/Hindware/Vaalve Bathware
2.	Wc Pan Connector	Supreme/Prince/Mc Alpine
3.	Bath Fittings	Aquaviva/Hindware/Vaalve Bathware
4.	Stainless Steel Sink	Paryware/Nilkanth
5.	Auto Urinal Flush System	Euronics/Cmr/Roca
6.	Hand Drier	Euronics/Cmr/Kopal
7.	Cistern	Viega/Gebrit/Hindware
8.	Cp Brass Fittings	Aquaviva/Hindware/Vaalve Bathware
9.	Geyser	Racold/Bajaj/Havells
10.	Floor Drain Fixture Rain Water Outlets	Viega/Gmgr/Gebrit
11.	Cp Grating For Floor Trap	Viega/Gmgr/Neer
12.	Cast Iron Pipes & Fittings Manhole Cover & Frame	
13.	Pp Pipes	Huliot//Wavin
14.	Pp Fittings	Huliot/Astral/Wavin/
15.	C. As Per Is: 1536 (Pipes & Fittings) (Ci Class La Pipes)	Neco/ Iisco/Kesoram Calcutta
16.	D. Di Manhole Covers & Frames	Skf/ Neco
17.	Cila Fittings	Skf/ Neco
18.	Suspended Manhole & Gully Trap	Patel Pattern
19.	Drip Seal	Acqua Bond/Binod Cement Companey/Meggaseal
20.	GI / MS PIPE (IS : 1239 And IS : 3589)	TATA STEEL/JINDAL
21.	Gi Pipe Fittings	Nvr/Mac/Zoloto M/Unik
22.	Gi Pipe Sealent	Henkel- Loctite 55
23.	Pipe Clamp & Support	Chilly Euro Clamp/Kanwal

S. No.	Details of Materials / Equipment	Manufacturer's Name
24.	D.I Pipes	Electro Steel/Jindal/Lancokalahasthi
25.	Upvc Pipe	Supreme/Akg/Astral
26.	Cpvc Pipes	Ajay/Ashirwad/Astral/Akg
27.	Rcc Pipe	Om Spun Pipe/Pragati/Local Isi Approved
28.	Stoneware Pipe,Gulley Trap	Om Spun Pipe /Rajura/Perfect Potteries
29.	Gm /Forged Brass Ball Valves	Utam/Vtm/Audco/Leader
30.	Sluice Valve	Utam/Vtm/Audco/Leader
31.	Butterfly Valve	Utam/Vtm/Audco/Leader
32.	Check Valve-Wafer Type	Utam/Vtm/Audco/Leader
33.	Check Valve-Dual Plate	Utam/Vtm/Audco/Leader
34.	Check Valve-Forged Screwed	Utam/Vtm/Audco/Leader
35.	Pressure Reducing Valve	Honeywell/ Zoloto/ New /Leader
36.	Solenoid Valve	Danfos/ Honeywell
37.	Thermostatic Valve	Oventrop
38.	Air Release Valve	Advance/ Sant /Leader
39.	Ball Float Valve	Zoloto
40.	Nrv-Ball Type-Sewage Application	Danfos/Silverspark/Normex
41.	Y Strainer Ci	Emerald/Sant/Zoloto
42.	Hydropneumatic System	Grundfos/Ksb/Willo-Mather & Platt
43.	Storm Water Drainage & Sewage Sump Pumps	Grundfos/Ksb/Willo-Mather & Platt
44.	Transfer Pumps	Grundfos/Xylem/Willo-Mather & Platt/Kirloskar
45.	Self-Priming Pump	Johnson/Kirloskar
46.	Mechanical Seal	Burgmann/Sealol
47.	Couplings	Love Joy
48.	Antyvibration Mounting & Flexible Connection	Dunlop/Kanwal Industries/Resistoflex
49.	Pressure Gauge	H Guru/Fiebig/Emerald

S. No.	Details of Materials / Equipment	Manufacturer's Name
50.	Water Meter (Mechanical Type)	Kranti/Actaris/Kent/Capstan
51.	Electronic Flow Meter	Krohne/Rockwin
52.	Level Controller & Indicator Water	Eleggent Controll/Technika/Techtrol
53.	Paints	Asian Paints/Berger
54.	Mh/Water Tank Plastic Step	Kgm/Patel/Pranali Industries
55.	Insulation For Hot Water Pipe	Armacell-Armaflex/K-Flex/Thermaflex
56.	Three Way Motorised Valve	Danfoss/Honeywell/Siemens/Aip
57.	Grease Trap	Aco/Wade
58.	Welding Rods	Ador/Essab
59.	Fastener	Fisher/Hilti
60.	Fire Sealant	Birla 3m/Hilti
61.	Manhole(Prefabricated)	Ok Plat/Crescent Foundary
62.	Temperature Sensor/Gauge	Forbes Marshall/Wika
63.	Dosing Pumps	Lmi/Pulser Feeder/Toschon
64.	Flanges	Class 150 Table H
65.	U.V Sterlizer	Alfa/Eureka
66.	Flow Control Devices	Aquaplus/Jaquar/Rst
67.	Solar Pannel & Heat Pump	Greentrk/ Epl India/

LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIALS FIRE FIGHTING SYSTEM

S. No.	Details of Materials / Equipment	Manufacturer's Name
1.	C.I. Manholes Frame & Cover	Neco/ Skf /Rif
2.	Butterfly Valve	Utam/Vtm/Audco
3.	Gate Valve	Utam/Vtm/Audco/Leader
4.	Non Return Valve	Utam/Vtm/Audco/Leader
5.	Ball Valve	Utam/Vtm/Audco/Leader
6.	Di Fittings	V.S/Johnson/ Sant
7.	Dash Fasteners	Hilti/ Fisher
8.	Automatic Air Vent	Cim/Aip/Zoloto
9.	Pipe Hangers/Clamps/Support	Euro Clamp/ Chilly/Gripple
10.	Paint	Shalimar/ Berger/ Nerolac
11.	Fire Hose	Padmini/Newage/Minimax
12.	Fire Hydrant Valve	Padmini/Newage/Minimax
13.	First Aid Hose Reel Drum & Tubing	Padmini/Newage/Minimax
14.	Branch Pipe	Padmini/Newage/Minimax
15.	Double/Single Headed Landing Valves	Padmini/Newage/Minimax
16.	Fire Man Axe	Padmini/Newage/Minimax
17.	Fire Brigade Inlet Connection	Padmini/Newage/Minimax
22.	Battery Charger	Bch/Hbl/Kinetic
23.	Ms Pipe	Tata Steel/Jindal Hissar
24.	Sprinkler Head	Padmini/Newage/Minimax
25.	Alarm Control Valve	Tyco/Viking/Omex/Eversafe
26.	Flow Switch	System Sensor/Honeywell/Potter/Omex
27.	Welding Rod	Esab/ Ador/ Superon Oerlikon
28.	Pressure Switch	System Sensor/Honeywell/Potter
29.	Controls	Honeywell/ Siemens/ Danfoss
30.	Vibration Eliminator	Resistoflex/ Kanwel
31.	G.I Fittings	Unik/ Zoloto
32.	Hooter	Honeywell/ Siemens/ Danfoss

S. No.	Details of Materials / Equipment	Manufacturer's Name
33.	Sluice Valve	Leader/ Audco/ Sant
34	Y Strainer	Emeral/Sant/Zoloto
35.	Deluge Valve	Viking/Tyco/Hd
36.	Water Curtain Nozzle	Viking/Tyco/Hd
37.	Fire Extinguishers	Padmini/Newage/Minimax
38.	Flexible Drop Connection	Padmini/Newage/Minimax
39.	Electrical Pannel Dection & Supperession System	Padmini/Newage/Minimax
40.	Pipe Protection Wrapping	Pipekote/Coatek
41.	Inspector Test Assembly	Eversafe/Viking/Victaulic
42.	Fire Buckets	Padmini/Newage/Minimax
43.	Foot Valve	Kirloskar/Normex
44.	Mechanical Seal	Burgmann/Sealol
45.	Pressure Gauge	Hguru/Emerald/Fiebig
ELECTRICAL ACCESSORIES		
46.	Motor Control Center	TricoliteElectrical/Kushwaha Electrical Services/Sk Power Solution
47.	Variable Speed Drives	Danfos/Abb/Siemens
48.	Moulded Case Circuit Breaker(Mcb)	L&T/Schneider Electric/Siemens
49.	Starter Contactor	Larsen & Turbo
50.	Miniature Circuit Breaker(Mcb)	Hager/ Schneider Electric/Siemens
51.	Overload Relays With Built In Single Phase Preventer	L&T/Schneider Electric/Siemens
52.	Current Transformer	Gilbert & Maxwell/Pragati/Automatic Electric
53.	Rotary Switch	L&T/Schneider Electric/Siemens
54.	Timer Delay Relay	L&T/Schneider Electric/Siemens
55.	Timer	Asia Brown/L&T/ Siemens/Ge Power
56.	Selector Switch,Toggle Switch	L&T/Kaycee
57.	Change Over Switch	L&T/Hpl-Socomec

S. No.	Details of Materials / Equipment	Manufacturer's Name
58.	Electronic Digital Meter	L&T/Schneider Electric/Siemens
59.	Indicating Lamps Led Type, Push Button	L & T / Schneider Electric/Siemens
60.	Pvc Insulated Aluminium/Copper Conductor, Aurmered Mv Cable(1100 V Grade)	Finolex/Polycab/Havells
61.	Metalic Conduit	Bec/Akg
62.	Pvc Conduit & Accessaris	Bec/Akg/Polycab
63.	Sandwitched Construction Bus Ducts	Control & Switchgear-Henikwon/ Schneider Electric
64.	Cable Tray (Factory Fabricated)	Sllotco/Neeedo/Mem
65.	Lt Jointing Kit/Termination	Birla-3m/Raychem
66.	Bimettalic Cable Lugs	Comet/Dowells(Biller India)
67.	Protection Relay	
68.	Numeric Type	Abb/Areva/L&T/ Siemens/Woodword
69.	B.Electromagnetic Type	Abb/Areva/L&T

Note: The contractor has to furnish the certificate stating that the material for firefighting system shall be supplied as per specification from the original manufacturer / authorized dealer and also he has to produce the documents in support of the statement.

Tender Drawings.

Stage 1: Demolition of the Existing Ground + 03 RCC Structure of SDF 01, Sub-station, and Canteen Building and Associated Allied Works.

Sr.	Drawing List	Drawing Name	Revision No.
1.	TCE.14697B-CV-3003-CV-10001	MASTER PLAN	P0
2.	TCE.14697B-CV-3003-CV-10002	GROUND & FIRST FLOOR PLAN	P0
3.	TCE.14697B-CV-3003-CV-10003	SECOND & THIRD FLOOR PLAN	P0
4.	TCE.14697B-CV-3003-CV-10004	SDF 1-EXISTING SITE PHOTOS	P0
5.	W.004717-Z-20307-006	DRONE IMAGERY	P0
6.	W.004717-Z-20307-006	NEST 3-DRONE IMAGERY	P0
7.	W.004717-Z-20307-016	WATER SUPPLY MAP	P0
8.	W.004717-Z-20307-017	STROMWATER DRAINAGE MAP	P0
9.	W.004717-Z-20307-018	SEWAGE NETWORK MAP	P0

Stage 2: Construction of New Enterprises & Services Tower (NEST).

Sr. No.	Drawing No.	Drawing Title
		Architecture/Landscape/ Interior
1	W.004717-Z-20301-101	SITE LAYOUT
2	W.004717-Z-20301-102	GROUND FLOOR
3	W.004717-Z-20301-103	BASEMENT FLOOR
4	W.004717-Z-20301-104	1st PODIUM FLOOR
5	W.004717-Z-20301-105	2nd PODIUM FLOOR
6	W.004717-Z-20301-106	1ST TYPICAL FLOOR
7	W.004717-Z-20301-107	TYPICAL FLOOR
8	W.004717-Z-20301-108	4th & 8th REFUGE FLOOR
9	W.004717-Z-20301-111	SECTION 1 & 2
10	W.004717-Z-20301-112	SECTION 3 & ELEVATION A
11	W.004717-Z-20301-113	ELEVATION B, C, D