

Request for Proposal
For
Design, Construction, Commissioning and Handing over
Along with Facility Management and
5 years Operation and Maintenance of
Integrated Command and Control Centre Building
At Panjabari near Vipanan Kendra
In Guwahati, Assam
On
DESIGN, BUILD AND OPERATE BASIS

Volume II: Scope of Work including Functional & Technical Specifications



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SCHEDULE A – SCOPE OF WORKS

SCHEDULE A

1.0 PART A: DESIGN, CONSTRUCTION, COMMISSIONING AND HANDING OVER

1.1 PROJECT DESCRIPTION

Guwahati City has been shortlisted as the smart city under the 'Smart City Mission' of Ministry of Urban Development (MoUD). For monitoring and control of operations pertaining to many city wide services mainly City Surveillance, Integrated Traffic management & other ICT based smart solutions, a city operation centre called as ICCC (Integrated Command Control Centre) is proposed to be developed. Moreover, presently the Guwahati Smart City Mission is being implemented by a Special purpose vehicle (SPV) created under India's Company Act 2013 with the name Guwahati Smart city Limited (GSCL) having its office in a rented space in Down Town, Guwahati. It is envisaged that the permanent Office premises for the GSCL shall also be accommodated in the first floor of the ICCC building. This Project involves construction of this ICCC building with the following amenities.

The ICCC building will accommodate GSCL office space, City Operation centre, War room, Server Room / Data Centre, Network Room & Network operation centre, Electrical Room / UPS Room and Conference Room. Some facilities for the convenience for Staff such as Storage, Toilets, Lunch Room, Pantry, etc. have also been proposed in this building. This electrical system has been adequately designed as per the load requirement of the specialty services of the building. Complete DG back up has been proposed for any emergency requirement. Efficient cooling system has been provided to keep all the special equipments under the desired temperature, and to have a comfortable environment for the end user. All the rooms are sufficiently lighted with the natural as well as the artificial lighting system. Integrated Building management System has been proposed to facilitate the smart functions of the building block.

Guwahati Smart City Limited (GSCL) is planning to implement the following smart solutions in a phase wise manner to improve the quality of life of the citizen of Guwahati:

- 1. City Surveillance**
- 2. ICT Enabled Solid Waste Management**
- 3. Smart Lighting**
- 4. Smart Traffic**
- 5. Smart Parking**
- 6. Environmental Sensors**
- 7. Flood Monitoring System**
- 8. Smart Governance and Citizen Services**

All these components will be monitored centrally at City Operation Centre (COC) in integrated manner & this project involves construction of this COC building. COC will have collaborative monitoring with different departments and city operators.

However, implementation of smart component considered above will be executed as a separate tender package and not integral to construction of COC building, i.e to this project.

A piece of land has been identified at Panjabari for the ICCC building. It is a 535 sq.mt of land with 22mt as width & 24.30 mts as Length, abutting a 6.6m wide approach road on southern side, to be utilized for construction of COC building. This plot is falling under "Moderate intensity" zone as per GMDA Development Intensity Zone Plan. The site should be thoroughly cleaned of all trees, bushes, debris and leveled before starting the construction.



1.2 SCOPE OF WORKS

- i. The Scope includes designing and building Integrated Command and Control Centre Building, in accordance with the Authority's Requirements as briefly specified herein below. Unless explicitly excluded otherwise, Contractor shall be responsible for making the facility fit for the intended purpose while performing all of its obligations covered under the Contract Document in its entirety. The Scope includes construction of the main ICCC Building, along with Pump Room for housing Utilities, compound walls and gate, and any other miscellaneous structures required for the development of whole ICCC Campus, as per the Conceptual design provided as a part of this tender.
- ii. Currently, Schematic /Tender Stage drawings and Design Criteria / Design Basis Reports, Brief Technical Specifications for certain items of work are available. Scope includes further detailing, as deemed necessary (without changing the foot print of the proposed "buildings and space planning", without changing design intent, form, shape, elevation and feel of the building), developing required specifications, preparing Good for Construction (GFC) coordinated drawings and construct entire campus in

accordance with the same.

- iii. Contractor has to appoint his own Green Building Facilitation consultant at his cost for evaluation of Consultant's conceptual design of buildings to meet for at least GRIHA four star rating, as per Government mandate or take into account the strategies for GOLD level rating under suitable IGBC rating system. It would be Contractor's responsibility for carrying out all procedures required to get the project registered and licensed/ rated under green certification.
- iv. Contractor has to appoint his own licensed and registered Architect and Structural Engineer and any other consultant/ expert/ engineer, as required to get the approval from concerned authorities such as GMDA, GMC and any other department for permission/NOC required for construction of the building. Contractor shall be responsible for understanding all the approvals required, procuring documents, submission of required documents, permission drawings etc. and getting the approval procedure completed, before, during and after execution of the building.
- v. Contractor has to appoint his own Façade consultant at his own cost and the consultant shall be responsible for the structural correctness, strength, stability and safety of the façade, including, but not limited to, curtain wall and metal façade panels.
- vi. The scope of works covers Designing, supply, installation and construction works including supply of all labour, technical personnel, materials, equipment etc. required for proper completion of the work. It shall also include all other related works required for satisfactory completion of the work although they may not be specifically mentioned in the subsequent clauses and all such incidental items not mentioned of the job as a whole, but as desired and as directed by the Authority. The Contractor shall give all notices; pay all taxes, fees, and duties etc. that are required for all work including temporary works.
- vii. All works required to be carried out to make the building functional are part of contractor's responsibility.
- viii. Contractor shall appoint his own consultants to accomplish the above including but not limited to:
 - a. Architects
 - b. Structural Designers.
 - c. MEP Designers
 - d. Lighting Consultant
 - e. Façade Consultant
 - f. Traffic Consultant
 - g. Interior Designer
 - h. Liaisoning Consultant for statutory approvals.
- a. Subsequent to award of works to the Contractor by the Authority, the Contractor shall submit necessary GFC drawings to the Engineer In Charge/Consultant for review and upon approval of same by Engineer In Charge/ Consultant, shall co-

ordinate & supervise these works for proper installation, testing, commissioning and completion of the works in entirety.

- b. Contractor shall be responsible for schedule, execution of work, quality, performance of work and performance of obligations covered under the agreement and payments.
- c. The Contractor shall also arrange, at its cost, necessary infrastructure and logistical support, including power, water, storage space, hoisting/lifting arrangements at site, scheduling and monitoring of works.
- d. The Contractor will, therefore, be totally responsible for getting the said works executed, conforming to the approved drawings, specifications, other instructions from the Authority / PMC and the time schedule previously agreed to. All intimations/directions from the Authority / PMC shall be followed, for proper and timely implementation.
- e. The Contractor shall immediately submit the overall project time schedule, detailed time schedule governing the works, so as to ensure overall completion as originally stipulated once the contract is awarded.
- f. The Contractor's responsibility will include close coordination and management on a day-to-day basis with all involved agencies, severally and collectively, and ensure that their works fit in with the overall timely execution, quality and safety plan. Such coordination shall extend from the stage of Statutory approvals, Detailed designing, preparing of shop drawings for the respective trades, preparation of co-ordinated service drawings, discussions with the PMC and the Authority, getting the shop drawings approved, material specifications, samples etc., duly approved, planning all phases of execution such as project planning and scheduling, procurement, fabrication, installation, testing and commissioning as well as planning of all manpower, construction equipment, construction sequence etc. The Contractor shall arrange facilities such as open space for building their office and storage, water, power, toilet for workers & staff, scaffolding, hoisting equipment etc. This shall as well include but not limited to, Security & safety measures, water, power, lighting for execution, testing and commissioning of the respective system, programming, coordinating or organizing work to ensure the correct timing, sequencing and completion of all operations, preparing co-ordinate working drawings for all the services etc. All the above shall be inclusive of this bid's scope of works and no additional cost shall be provided for any such works.
- g. The Contractor shall also ensure coordinated planning and execution so that obstruction, interference, rework and other conflicts do not occur at any stage. The Contractor for this purpose shall draw coordination action plan for the review and approval of the Authority / PMC and on their approval shall ensure that all agencies adhere to the coordination action plan through periodic review, reporting and taking counter-measures in case of any slippage in any of the activities. The Contractor shall be required to furnish weekly status report of performance, deficiencies, correction plan, coordination aspects etc.
- h. The Contractor shall take such necessary steps as required to ensure that the coordination action plan is implemented in full. The Contractor shall also engage experienced technical staff in sufficient numbers to perform the role of

- coordination / monitoring / management of works.
- i. The Contractor shall be held responsible for procurement of materials (whether Indian or imported; controlled or uncontrolled) as required.
 - j. The Contractor shall ensure to adopt modern and safe construction practices duly deploying speedy construction techniques, high degree of planning.
 - k. The Contractor shall raise their running account bills on the Authority. The Contractor shall verify the bill in line with the Contract agreement with Authority and forward to PMC for further certification.
 - l. Ensuring timely delivery of all data and inputs regarding green building certification.
 - m. Coordinate well in advance for leaving holes/openings in concrete member/masonry wall for pipes, ducts, holes etc. to avoid rework, chasing required for recessed services. The Contractor shall make the surface good.
 - n. Monitoring & Coordinating for cutting and pinning ends of support for pipes, equipment, appliances, fittings and the like to walls, floors, and partitions soffits etc. including making the surface good.
 - o. Monitoring & Coordinating for cutting and making good openings in false ceiling, bulkheads, for grilles, diffusers, luminaries, sprinkler heads, loudspeakers and the like wherever required as per coordinated services drawings prepared by the Contractor
 - p. Provision of reference grid lines /markers and levels, including checking and verification as required at all stages.
 - q. Coordinating to protect their finished work.
 - r. Regular housekeeping, cleaning and removing all rubbish and debris generated at the place of work to a designated place within the site. Further removing the debris from the designated area shall be done by the Contractor.
 - s. Cleaning the finished work as part of the final cleaning obligation including monitoring for cleaning the finished work to the satisfaction to the Authority/ PMC.
 - t. Programming, scheduling, monitoring, tracking necessary corrective action required & addressing delays / backlogs of the works and co-ordination of the works to comply with the agreed overall construction schedule.
 - u. Coordinating with various agencies and arranging for handing over their respective works to the Authority / Consultant including preparation of the as – Built drawings, O&M manuals , Guarantees/ warrantees etc. for all services and forwarding the same to all concerned (both hard copy & soft copy).
 - v. Contractor shall make his own arrangements for drawing and distribution of water. Contractor shall also make his own arrangements for other facilities like compressors; DG sets etc. for unhindered progress of work.
 - w. List of tender drawings issued at the time of calling of tenders for this work is given elsewhere in this Contract document. These drawings are meant for Contractor's guidance only.
 - x. Nearest GTS permanent bench mark shall be arranged by the contractor and all other layout, fixing levels etc. shall be done by the Contractor at his own cost. The Contractor shall protect and maintain, during the course of execution of the work,

the main centre lines and bench marks, so that they are left undisturbed even after completion of his work.

- y. Contractor to develop all detailed design, design calculations and Good for Construction drawings in reference to the conceptual drawings and schematic design provided for all the major systems, before execution of the work and necessary approvals on the Design, design calculations and drawings, including shop drawings and relevant data sheets for MEP disciplines and all selected material approvals to be taken by the contractor from Authority/ PMC.
- z. Unless otherwise specified, the specifications are intended to include everything obviously requisite and necessary for proper and entire completion of the work and shall be read in conjunctions with the relevant specifications and codes of practice. These specifications shall have precedence in case anything contrary to this is stated anywhere in the contract document. The decision of PMC/Authority shall be final, on any issue arising out of such discrepancies.
- aa. Contractor will carry out Soil Investigations and Geotechnical Surveys and any other investigations required for the overall completion of the project, as per the design and structural intent. The information about the site of work and site conditions in the Tender Documents is given in good faith for guidance only but the Contractor shall satisfy himself regarding all aspects of site conditions. The Contractor must satisfy himself regarding the character and volume of all work under this tender and expected surface, sub-surface and/or sub- soil water to be encountered. The location of the works and the general site particulars are as generally shown on the Site plans
- bb. Contractor has to cooperate with all other Contractor on completion of Construction of the building while shifting of MSI components happens within the premises.
- cc. Contractors shall follow the Interface matrix for satisfactory completion of Project. Contractor shall coordinate with Concerned Authorities / State agencies / Various other Contractors and Vendors appointed by GSCL for this project and according finalize the his Space / Sizing requirements, implementation schedule . All the Statutory Charges/ Fees. etc required for the same shall be paid by the Contractor to the concerned authority. Later on the same shall be reimbursed by GSCL at actual on submission of original invoices.

INTERFACE MATRIX

Sr.No	Description	Coordination
1	Assessment of Power Requirement, Location and Space required for Supply of Power Equipments.	GSCL/APDCL
2	Bringing Power Supply upto Plot Boundary	APDCL/ Charges required for the same will be Reimbursed by GSCL

3	Bringing Water supply upto Plot Boundary	Local Service Provider. Charges required for the same will be Reimbursed by GSCL
4	Approval and NOC for Building permission/ Fire/ Lift/Electrical works/Plumbing and any other work	Concerned Authorities. All the Statutory Charges required for the same will be Reimbursed by GSCL
5	For Space/Sizing requirement and Project Implementation schedule	ICT Contractor / Interior Fit out Contractor/ Other Vendors/Agencies appointed by GSCL for this project
6	For all Statutory / planning /Designing / Safety / Environmental norms	With Relevant departments. All the Statutory Charges required for the same will be Reimbursed by GSCL

1.3 DESIGN AND DRAWINGS TO BE SUBMITTED FOR REVIEW AND APPROVAL

On Award of work the Contractor shall submit the design and Drawing for review and approval. Drawings mentioned in the list below are indicative and for Information. Contractor shall not limit himself to the same but it is in scope of Contractor to submit all required design and drawings for review and approval as per Instruction from Engineer-In-Charge. Hard copies of all Good for Construction drawings (GFC) shall be submitted in suitable readable scale preferably in A1 paper size. Soft copies of all GFC drawings shall be submitted in AutoCAD format.

Sr.No	Documents
Civil drawings	
1	Geotechnical investigation report
2	Topography survey layout
3	Civil / structural design basis report
4	Structural design (calculations) report for CCC Building each RCC Elements wise including structural analysis model.
5	Site grading layout
6	Detail Structural Drawings for Building, UGT, Lifts, Overhead tanks, Security Guard Room etc.
7	Design and Drawings required for Roads, Miscellaneous Civil Structures, compound wall
Architectural Drawings	
8	Floor Plans, sections, Elevations
9	Finishing Schedules
Note: For Electrical, HVAC, Plumbing, Fire fighting and BMS, design & drawing requirements are given in respective technical specifications sections.	

1.4 STATUTORY APPROVALS:

At present, no process has been initiated towards procuring approvals for the Building plans and the layout for Construction.

Contractor shall also be responsible for understanding all the approvals required, including procuring documents, plans, records and getting the approval procedure completed, before, during and after execution of the building. This also includes approaching and procuring necessary land records etc., if required, along with sourcing of Utilities from the Govt. bodies, etc.

Contractor has to appoint his own licensed and registered Architect and Structural Engineer and any other consultant/ expert/ engineer, as required to get the required and necessary approvals including but not limited to Building Permission from Guwahati Municipal Corporation (GMC), Guwahati metropolitan Development authority, NOC from Director, Fire & Emergency Services, Assam Power Distribution Limited for Power sourcing etc and any other relevant concerned authorities for construction of the building.

No work shall be executed without proper approval from concerned authorities. One copy of approvals shall always be maintained at site for inspection.

Presently there are 25-30 nos. of trees exists within the site, which needs to be cut. Contractor has to initiate all necessary NOC requirements, cutting of Trees with Forest Department, Govt of Assam.

In case statutory fees are to be paid for the approvals, the same shall be directly paid by the contractor to the authorities as per demand notes received. All the statutory fees required to be paid during the construction and during the Operation and Maintenance phase are to be paid by the Contractor and necessary records are to be maintained for final handover to Authority at the end of O&M or DLP period whichever is later. The fees paid by the Contractor shall be reimbursed by GSCL at actual in the next RA Bill on submission of all supporting vouchers. These amounts shall be beyond contract price.

1.5 ARCHITECTURAL WORKS

Scope of Architectural works to be initiated after execution of Civil and Structural works, Architectural scope of works will comprise of all sub structure and super structure works, like brickwork, plaster, finishing, flooring, painting, doors, window, false ceiling, false flooring or cavity flooring, structural glazing, skylight, automated gates, rolling shutters, decorative exterior finishes, stone and metal/GRC Jali/cladding, sculpture integrated to exterior if any, false ceiling, internal wall cladding, aluminium and gypsum decorative features, ACP cladding at interior and exterior of the building, water proofing wherever applicable, Hardscape work outside the buildings or in courtyard, paving work and construction related to external parking, drainage, all interior and furniture works, making provisions for MEP works, finishing in all aspect after installation of MEP system and all other allied works along with making provisions for glass cleaning and other maintenance of finishing of the building.

The scope will include complete solution for facade treatment comprised of design,

supply, storage, fabrication and handing over in good condition of items like Textured painting, structural glazing, ACP cladding, stainless steel decorative railing work with or without Glass panels, Metal or GRC Jali/ cladding work, MS decorative grill and gate.

The scope include construction of boundary wall with grill, security and allied rooms, provision of crossing over services at necessary locations of boundary and external wall of building. The scope will also include enclosure to DG, transformer etc as per design. The scope is limited upto the boundary of plot in general, but for services and drainage, sewerage, rain water harvesting systems, the scope may be extended upto nearest tapping / outfall point whatsoever is applicable.

Scope includes Submission of Shop drawings or fabrication drawings or assembly drawing whatsoever is applicable for fabricated items. Scope includes gathering samples of Architectural materials, display, preparation of material selection and approval board, multiple alternative physical mock up and any other formalities required for material approval by Authority and PMC.

Construction of partition work, using non masonry materials like Gypsum board, Calcium silicate board, Aluminium or CRCA or GI framework with panel inserts using Particle board, block board, ply wood, gypsum panels, glass, Aluminium composite Panels along with providing all clips, gaskets, sealants, beads, providing insulations, joint fillers all complete as per design. Provisions for doors, windows, service opening, louvers, exhaust fans should be made as per details as will be provided time to time during or prior to construction. Scope of partition includes treatments of partitions with painting, decorative and acoustic panelling, provision for exhibits placed in partitions, provision for mounting of light fixture and switches, junction boxes and other electro mechanical assemblies in partitions etc as per design.

Scope of partition include providing shop drawings, fabrication details based on basic layout and construction of partitions as per design and approved specification, construction of special type false ceiling as per design and according to manufacturer's data sheet, supplying and fixing in desired position, lighting fixture or luminaries inside the building, supplying, fixing or placing in desired position, cleaning and handing over in new condition all modular and customized furniture in all spaces, Scope of furniture include provisions for electrical and network connectivity within furniture wherever required,.

Design, Supplying, fitting and fixing in position and handing over in new condition all

Internal and external signage, including Statutory signage as per design requirement for the complete building and for the overall ICCC campus.

Selection of all the Architectural finishes, plumbing fixtures, hardware, etc. shall be as per the make & specifications approved by GSCL. Contractor is required to obtain approval of the sample of each material from Architect /Engineer In charge before execution

1.6 CIVIL AND STRUCTURAL WORKS

- i. Broadly the scope of civil covers the following buildings, structures, facilities and works:

Civil & Structural works for buildings / utilities / external civil works as listed below:

- a. Site grading
 - b. Compound Wall
 - c. Roads and Drains
 - d. ICCC Building
 - e. Rain water collection sump/ Rain water Harvesting (if required)
 - f. Utility Structures and Civil works like UG Tank, cable Trenches, Storm Water Drains etc.
- ii. The scope of work shall be inclusive of sub structure and super structures and allied works as required for successful completion of construction works.
- iii. All works shall be carried out in accordance with the technical requirements of the specification and as directed by Authority / PMC.
- iv. The scope of the Civil works to be carried out includes but not limited to the following items-
- a. Clearing of site vegetation, excavation in all types of soil, soft rock, hard rock, site grading, etc.
 - b. Back-filling of area wherever specified and filling of foundations and drainage work as specified. The excavated reusable material in general shall be used by the Contractor for back filling purpose.
 - c. Waterproofing treatment of roofs and sunken areas
 - d. PCC below all foundations and grade slab.
 - e. Underside bedding of pathways and landscape
 - f. Dewatering during construction without any extra cost as required.
 - g. Providing facilities (QA & QC laboratory for testing of materials) throughout the contract period for sampling the construction materials for testing as and when required as per the specification and as directed by the Authority.
 - h. Procurement, Supply and Storage of materials like cement, aggregates, reinforcement steel, couplers, HT steel wire / strands, wire fabric, admixture,

concrete blocks, expansion joint materials, sealants, structural steel etc.

- i. Production of concrete in fully computerized batching plant and placing with concrete pumps / placer booms/ tower cranes etc. in various buildings or sourcing Concrete from similar quality of RMC plant.
- j. Re-do of defect works rejected by Authority / PMC.
- k. Formwork for concrete.
- l. Precast concrete covers
- m. Reinforced concrete work in raft, pile foundation, isolated footings, walls, columns, slabs, beams, underground trenches etc.
- n. Reinforcement work
- o. Fabrication & erection of structural steel work, embedded parts, pipe sleeves, etc. including painting if any.
- p. Fixing expansion joint materials and caulking of joints.
- q. Brick / Concrete block masonry works.
- r. Finishing works - Partition walls, ACP Cladding, GI sheet perforated screen, Cast Iron railing, S.S. railing, glass railing, plastering, flooring, painting etc.
- s. Providing and laying flooring as per specifications.
- t. Supplying and fixing steel doors, windows, rolling shutters, Automatic sliding doors/ shutters and Fire proof doors as per drawings and specifications.
- u. Landscaping – Hardscape and Softscape related works.

1.7 HVAC – SCOPE OF WORKS

- i. This section covers Air-conditioning & Ventilation system proposed for ICCC at Guwahati under the 'Smart City Mission' of Ministry of Urban Development (MoUD). The scope of work covers design, manufacture, supply, installation, inspection, testing, commissioning and carrying out performance guarantee tests at site for Air-conditioning & Ventilation systems, as per the Specification requirements.
- ii. The Bidder shall satisfy himself regarding the equipment capacity required for maintaining the end conditions inside air conditioned and ventilated spaces before submitting their offer. The Bidder shall have to guarantee the end conditions mentioned in following clauses. The location of air conditioning & ventilation equipment, layout of ducting, piping etc. shall be designed by the Bidder and approved by the Consultant / Owner. Bidder to check location of indoor & outdoor units, adequacy of shafts for refrigerant pipe routing, exhaust of air etc. as per architectural drawings. In case of any observations / modifications required on the same, Bidder to indicate along with their technical offer. Afterwards no changes / modifications will be entertained in the layout.

- iii. Any items or parts whether specifically mentioned or not but required for functional completeness of the system, shall be provided by the successful Bidder as a part of the contract.
- iv. The scope of work for the entire Air Conditioning & Ventilation (HVAC) system shall comprise of the followings but not limited to the following:
- Air-cooled floor mounted Precision type air-conditioning units (1 Working + 1 Standby) for Network Room & Data Centre with R-410a / R407C / Eco friendly refrigerant having Zero Ozone Depletion Potential (ODP) and Low Global Warming Potential (GWP), of capacities as specified in the specification for reference purpose only. Outdoor condensing unit shall comprise of air-cooled condenser with fan. Indoor unit shall consist of filter section, P-I-D Controller, electrical power switch board, multi rows deep copper cooling coil with aluminium fins, Dehumidification cycle, modular panel cabinet construction, cabinet insulation, fan section with dynamically balanced centrifugal fans with motor and drive, high technology scroll compressor, accessible refrigeration control.
 - Air cooled full inverter VRF type air-conditioning system for other areas with R-410a / R407C / Eco friendly refrigerant having Zero Ozone Depletion Potential (ODP) and Low Global Warming Potential (GWP), of capacities as specified in the specification for reference purpose only, complete with Indoor Unit with filters; evaporator cooling coil; fan with motor & drive arrangement; power & control components with wiring, Air cooled condensing unit with compressor(s); multi row deep air cooled condenser coil; condenser fan with motor & drive; controls; power & control components with wiring, Stands for Outdoor Condensing Units, Initial charge of refrigerant and oil, Electronic remote control unit, Refrigerant Piping with fittings & insulation, Filter Dryer, Refrigerant Solenoid / Manual Valves, Expansion Valve etc.
 - Axial Flow Fans for exhaust ventilation of Service Room of Capacities as specified in specification for reference only, complete with fan, electrical motor, mounting accessories, vibration isolators, bird screen, cowl etc. along with air intake louver / grilles.
 - Propeller type exhaust air fans for exhaust ventilation of small Electrical Rooms & Toilets at each floor of Capacities as specified in specification for reference only, complete with fan, electrical motor, mounting accessories, bird screen, cowl etc. along with air intake louver / grilles.
 - Air Distribution System comprising of galvanized steel ductwork conforming to IS:655 / SMACNA as applicable & shall have minimum zinc deposition of 180 gm/sq.m or better as per IS:277, Fusible link type UL listed Fire Dampers, Manual Volume Control Duct Dampers, Grilles, Grille Collar Dampers, Air Transfer Grilles, Diffusers, Diffuser Collar Dampers, Louvers, Non-return Dampers etc. – All complete with fittings, flanges, bracings & supports.
 - Condensate Drain Water Piping complete with Supports, Valves, Fittings Insulation and all Related Accessories.
 - Thermal Insulation of Supply & Return Air Ducting complete with all accessories

and finishes (including Protective Coating on the insulated ducts exposed to atmosphere) as per specifications.

- Acoustic Insulation of Supply & Return Air Ducting complete with all accessories and finishes as per specifications.
- Under deck insulation for the exposed roof of air-conditioned spaces.
- Local Electrical Isolators for Outdoor Condensing Units & Other HVAC Equipment.
- Power Cabling / Wiring, Control Cabling / Wiring & Earthing of Various HVAC Equipment / Motors complete with Cables / Wires, Bare GI strips/ wires, cable trays, supports, installation, saddles, cable ties, cable tags, ferrules, cable glands, lugs, nuts/ bolts/ hardware etc.
- Base Frame with foundation bolts for equipment and vibration isolators, mounting frames for fans, cooling coils, louvers & other HVAC equipment, as required.
- Grouting & Finishing of Foundations.
- Painting of Equipment, Supports etc.
- One Set of Special Erection & Maintenance Tools & Tackles.
- Start Up & Essential Spares.
- All accessories required for system completion and required for normal operation of equipment.
- Shop Inspection & Testing.
- Packing, marking and forwarding.
- Complete erection of all equipment covered under this contract.
- Testing and trial run of equipment.
- Pre-commissioning checks and commissioning of all equipment.
- Carrying out field performance testing of equipment at site as per relevant standards, air balancing and demonstrating guaranteed performance parameters and handing over the systems.
- Associated minor civil works including but not limited to making & repairing of openings in brick works, etc. to be executed by the contractor
- HVAC systems to have interface with fire detection alarm (FDA) panel to trip the system in case of fire.
- Factory Acceptance Tests (FAT) and Site Acceptance Tests (SAT) including loop checking & commissioning, trial runs of all the above systems to meet the design specifications & functional requirements.
- Operation and comprehensive maintenance including all consumables is included in the scope of work after handing over for a period mentioned elsewhere in the Contract Document

v. **General Notes for Scope of Works**

- Engineering Responsibility of the System: The responsibility of system design, manufacturing, erection, working and safety will solely be responsibility of the Contractor for the parameters as mentioned in the tender documents. The Contractor shall study design depicted in these documents thoroughly and point out reservations, if any, at tender stage only.
- Codes and Standards: A reference made to various codes and standards in these Contract document shall imply reference to the latest version of that standard, including such revisions/amendments as may be issued by the relevant Authority during the duration of the contract and the corresponding clause(s) therein shall hold valid in place of those referred to.
- Performance Tests: The contractor shall guarantee the satisfactory functioning of the system to maintain the specified design conditions. The contractor shall also give summer, monsoon and winter performance tests of the system after the same is completed and commissioned. These tests shall be carried out during the first summer, monsoon and winter following the completion and commissioning. Before taking over the installation, the system will be run by the contractor continuously for 72 hours to demonstrate the satisfactory functioning and performance of the system installed.
- Samples: Before undertaking fabrication and/or installation, the contractor shall manufacture, at his own cost, a sample of every type of item. The PMC / Authority will approve these samples. The contractor shall proceed further only after the above referred approval.
- Noise and Vibration Levels: Noise & vibration level shall be as per specification requirements. Necessary provisions of duct Sound Attenuators and/or acoustic insulation are to be included by the HVAC contractor whether or not forming part of the specifications and/or basis of design. All HVAC equipment shall be provided with proper vibration isolators to ensure vibration free operation.
- The Contractor shall be required to submit the detailed shop drawings indicating P & I drawings, Ducting layouts, Foundation details, Dimensional drawings of entire AC & Ventilation system. These detailed shop drawings shall be submitted to PMC / Authority for their comments & approval.
- For specific electrical requirements, refer separate section of this specification.

1.8 FIRE FIGHTING WORKS – SCOPE OF WORKS

- i. The scope of the Contractor shall comprise design, engineering, manufacturing, inspection & testing at works, packing, forwarding, supply to site, unloading at site, storage at site, construction, installation, erection, testing, commissioning, performance testing at site, and other related items of work for the complete firefighting works comprising of the following major items:
 - a. Internal hydrant system.
 - b. External hydrant system.
 - c. Related piping with all accessories.
 - d. All type of valves, connections, headers.
 - e. Hydrant valves, hose reel, hose pipes, Fire hose cabinets etc.
 - f. Electrical and diesel operated Firefighting pumps with all accessories.
 - g. Electrical works, Panels, cables and earthing.
 - h. Automatic sprinkler system with accessories.
 - i. Appropriate Fire extinguishers for common areas and for Equipment rooms, etc.
 - j. All other allied and necessary equipment and accessories to complete the system up to the satisfaction of Authority and for proper functioning of the entire system.
- ii. The detailed Scope of works is defined in the technical specifications section.

1.9 PLUMBING – SCOPE OF WORKS

- i. All the work shall be carried out in a workmanship like manner and as per the best practices of the trade. The scope of work shall include supply of all material, labour and T&P, installation, testing in position and commissioning of followings –
 - a. Sanitary fixtures and accessories.
 - b. C.P. bathroom fittings and accessories
 - c. Soil, waste and vent pipes with fittings
 - d. Rain water disposal pipes with fittings
 - e. Water supply pipes with fittings
 - f. External sewerage system
 - g. External Drainage system
 - h. External water supply system
 - i. All kind of water supply and waste disposal pumps.
 - j. Construction of Tube-well/ Bore-well, as per the required depths for drawing ground water. Any permission related to this are to be taken by Contractor from concerned authorities.
 - k. Connection to municipal mains in case of storm water drains to the nearest point available outside site premises.
 - l. Connection of Sewerage line to Septic tank and further cleaning of the tank as per requirement during Facility and Management period.
- ii. Detailed Scope of works for plumbing works are defined in the technical specifications section.

1.10 ELECTRICAL WORKS

SCOPE OF WORK - ELECTRICAL

- 1.1. The scope of work of the BIDDER covers the design, detailed engineering, preparation of construction drawing, manufacture, acceptance testing at manufacturer's works or at any accredited agency; supply, packing, forwarding and delivery from manufacturer's works/ place of storage to erection site including transit insurance; unloading, storage at site, moving from place of storage to place of installation, assembly, cleaning/ lubricating, touch up painting, erection, testing, commissioning & performance demonstration and handing over of the complete electrical system equipment along with all necessary spares of original ratings & specifications including 5 years O&M for the **ICCC BUILDING AT GUWAHATI**.
- 1.2. Electrical System for ICCC BUILDING AT GUWAHATI shall be read in conjunction with typical Single Line Diagram, Drg. No. TCE.10477A-EL-4001-AU-40002 and consists of following:
 - a. 33 kV Medium Voltage Incomer power supply arrangement through 33 kV underground cable upto APDCL Tariff Meter shall be under the scope of APDCL. The work shall be carried out on depository basis.
 - b. The battery limit of BIDDER shall start after Tariff Meter.
 - c. 33 kV Medium Voltage (MV) AL, XLPE, Armoured Cable with laying & termination accessories from Tariff Meter to 33/0.433 kV Compact Substation.
 - d. Outdoor type, 33/0.433 kV Compact Substation with MV VCB, Dry type Transformer and LV Switchgear with all accessories. DC Power Pack for DC Supply Requirement for CSS shall be considered along with CSS. Although Dry Type Transformer has been proposed but Bidder shall obtain prior approval from APDCL for the Type of transformer such as Oil or Dry.
 - e. 415 V LV Outdoor type Diesel Generator set with 100% emergency backup with acoustic enclosure, AMF Panel, Exhaust System & Chimney, Canopy etc.
 - f. 415 V LT Indoor Power Control Centre (PCC) Panel with Incomers, Auto transfer switch & Outgoing feeders as per requirement.
 - g. Indoor type Automatic Power Factor Correction Panel of adequate kVAR rating to maintain unity power factor. No Load Compensation for Transformer is also to be considered of adequate kVAR rating.
 - h. LV cabling system consisting of Power & Control cables, prefabricated GI Ladder/ Perforated type cable trays , raceways & associated accessories including support structures. All LT cable shall be conforming to IS 7098 Part-I for XLPE cables. Cables up to & including 6 mm² shall be copper multi-stranded conductor with XLPE insulation, galvanized steel round wire armoured & cables of cross section

area more than 6 mm² shall be Aluminium multi-stranded conductor with XLPE insulation & galvanized steel flat strip armoured. All control cables shall be 650 V grade copper conductors FRLS PVC insulated cables conforming to IS 1544- Part I

- i. LED based Indoor & outdoor Illumination System for buildings. For outdoor illumination, building peripheral lighting shall be designed for 50 Lux level.
- j. Lighting and Receptacle system controlled by lighting panels and raw power panels installed in respective areas.
- k. Required no. of Lighting Distribution Boards, Raw Power Distribution Boards, Emergency Lighting Distribution Boards at strategic locations.
- l. Lighting circuit for Building Peripheral Illumination shall be based on Astronomical Time Switch.
- m. 2 x 100% modular redundant adequate rating three phase UPS system with Static By- Pass and 2 x 100% Lead Acid SMF VRLA battery bank with 30 min back up for providing power supply to Desktop / Workstations through Output UPS Distribution Board.
- n. UPS of adequate kVA rating for Emergency Illumination with 30 min Battery Backup (SMF VRLA type Battery) with UPS Distribution Board. Emergency Lighting System shall be considered for 15% of total lighting.
- o. One no. Bharat DC -001 EV Charger shall be considered for ICCB Building. EV Charger shall be suitable to operate on 415 Volts 3 phase, 4 wires, 50 Hz. AC.Supply.
- p. Point wiring system for Lighting, Raw power and UPS socket outlets etc.
- q. Necessary fencing and gate arrangement for 33 kV Substation & MS supporting structures for cable, cable laying, lighting fixture etc.
- r. Earthing System for MV/LV electrical equipment & Conventional Lightning Protection System for the premises.
- s. Passenger Lift as per Architectural Layout and NBC requirement.
- t. All mounting and foundation support and hardware accessories for electrical equipment/system installations.
- u. Foundation for the electrical equipment and other civil works associated with equipment/system electrical installations like cutting of roads, laying of DWC pipes, providing water proof sealing etc.
- v. Relay Co-ordination for entire electrical system under scope as specified above with reference to upstream and downstream distribution system.

- w. Continuous Monitoring of Electrical Power & Energy Parameters like Voltage, Current, Power Factor, Frequency, Kilo Watts, Kilowatt-hours etc.
 - x. Liaisoning with APDCL, CEIG and any other statutory regulatory body as relevant for getting complete approval of Electrical installation works.
 - y. Any other item which is required for the completion of the work for the ICC building but not mentioned above is deemed to be included in the BIDDER's scope of work.
- 1.3. This specification is the minimum requirement and should be read in conjunction with relevant latest IS/IEC/DISCOM/APDCL specifications, requirements, rules and regulations. The BIDDER shall refer the most stringent specification. Any additional requirements shall be offered by BIDDER as per DISCOM/APDCL specifications, requirements, rules and regulations, the same shall be indicated in the BID write up and a separate Bill of Quantities (BOQ) for additional or modified items shall be submitted along with the BID write up.
 - 1.4. The BIDDER's scope shall include measurement of soil resistivity at site at minimum two places by Wenner's four electrode method as per IS:3043-2018. The measurements shall be carried in the presence of the PURCHASER and the results/report shall be certified by Govt. Authorized Labs or agencies. The earthing system shall be designed for the actual mean soil resistivity value obtained.
 - 1.5. Statutory approvals, any technical requirement for new connection from APDCL for the electrical systems installed shall also be in the BIDDER's scope.
 - 1.6. All civil works associated with equipment/system electrical installations like embedment, chipping, punching, making holes, openings in walls, pipe sleeves, fire/water proof sealing etc. shall be in BIDDER's scope.
 - 1.7. The PURCHASER shall carry out inspection and testing at manufacturer's works for this contract. No equipment shall be delivered without prior written confirmation from the Engineer In-charge. In case factory inspection is carried out then all travelling and lodging expenses for maximum three persons from PURCHASER / APDCL side shall be borne by the BIDDER, also all expenses related to testing shall be to BIDDER's account.
 - 1.8. BIDDER shall make his own arrangement of 415 V, 50 Hz, TPN Construction Power supply at site to carry out all the site activities. BIDDER shall use suitable size of cables and sub-distribution boards. All material like cables, switch-fuse units, sub-distribution boxes, etc. required for further distribution shall be arranged by BIDDER.
 - 1.9. All consumable such as welding, drilling, gas etc. as required shall be included in BIDDER's scope.
 - 1.10. All SAFETY considerations in design, manufacturing and installation of equipment and systems for safe operation & maintenance by PURCHASER's personnel and safe practices during installation at site shall be in the scope of the BIDDER. Cost towards

accomplishing the same shall be included in the BID price and no extra claim shall be entertained later.

- 1.11. Obtaining approval including load sanction/ release from APDCL, No Objection Certificates from APDCL, Electrical Inspector (CEIG), relevant government agencies, and statutory authority, as applicable is included in BIDDER's scope. All necessary legal fees required for various applications to APDCL, relevant government agencies, statutory authorities shall be paid by the CONTRACTOR. However, on submission of the original bills payment shall be made by the PURCHASER at actual basis.
- 1.12. Electric supply connection shall be provided by APDCL for which necessary liaison shall be done by BIDDER.
- 1.13. Inland and overseas transit insurance, transport, testing at site shall be in BIDDER's scope.
- 1.14. Tender BOQ and drawings, if provided, are for reference purposes only which are the minimum requirements; BIDDER shall ensure that design & equipment ratings shall be as per electrical system/specification requirements.
- 1.15. The BIDDER shall prepare design calculations based on parameters/ design criteria indicated in the specifications. The BIDDER shall carry out detailed engineering and prepare construction purpose drawings to make his/ her own estimate of ratings & quantities in accordance technical data sheets, other relevant details provided in the specifications. All documents shall be submitted to PURCHASER for approval before execution.
- 1.16. BIDDER shall take due care of the site Seismic conditions while designing all equipment/ components used in entire electrical systems covered in this specification. BIDDER shall furnish list of additional design parameters considered in design to fulfil the above requirement.
- 1.17. Design and detailed engineering of the materials procured by BIDDER is included in scope. BIDDER shall submit each document/ calculations of system which is included in scope to PURCHASER/ CONSULTANT for final review/ approval. All design documents/ calculations prepared by BIDDER shall be duly signed by BIDDER and stamped. Design documents/ calculations prepared by sub-BIDDERS shall be approved by BIDDER and stamped copy of approval along with no-deviation sheet from sub-BIDDER shall be submitted by the BIDDER to PURCHASER/ PURCHASER's Representative for final review/ approval.
- 1.18. Manufacturer's supervision for sub-BIDDER supplied material shall be provided by BIDDER and shall be included in offer.
- 1.19. BIDDER shall be solely responsible for any shortages or damages in transit for his supply scope, handling and/ or in storage of any materials and erection of the equipment, supply of erection tools at site. BIDDER shall ensure that it will not affect any activity or project schedule. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the BIDDER.

- 1.20. Nothing in this specification shall be construed to relieve the BIDDER of his/ her responsibilities towards following best engineering practices established in the country.
- 1.21. Even if all components of a system included in this specification are not explicitly identified and/ or listed herein, these shall be supplied under this contract to ensure completeness of the system and facilitate proper operation and easy maintenance of the plant. Any and all other works not indicated above but necessary/ required to complete the job in all aspects, are included in the BIDDER's scope.
- 1.22. The BIDDER shall indicate and include start up spares, essential spares, recommended spares and a set of special tools necessary for operation, routine maintenance of equipment supplied for a period of five years.
- 1.23. Equipment supplied shall be complete in every respect with all mountings, fittings, fixtures, and standard accessories normally provided with such equipment and / or needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in the Technical Specification unless included in the list of exclusions.
- 1.24. Submission of Type test reports of the equipment shall be made available as specified in specification or as asked by GSCL before or after the award of contract for evaluation. Type Tests shall be carried out at third party NABL accredited laboratory like ERDA, CPRI or equivalent .
- 1.25. Whether specifically called for or not, all accessories required for normal and satisfactory operation (as deemed by the PURCHASER) of the equipment shall be considered to be a part of the BIDDER's basic scope of supply and/ or work and no claims whatsoever, for extra payment on these grounds, will be accepted.
- 1.26. BIDDER should visit site and get himself/ herself ascertained regarding the scope of work for the complete Electrical works before submission of quote/ offer.
- 1.27. It is not the intent to completely specify herein all details of design and construction of the equipment and systems. Nevertheless, the Electrical system shall conform to high standard of engineering, design and workmanship in all respects and shall be capable of performing satisfactorily in continuous commercial operation under the specified environmental conditions. Any equipment or accessory which is required for fulfilling the system installation and satisfactory & safe operation shall be considered by bidder even though it is not specifically mentioned in the tender.
- 1.28. All equipment which are outdoor shall have minimum IP55 degree of protection. All cables laid outdoor shall be laid in DWC pipe at minimum depth of 1050 mm (as the top of the pipe). All earth pit chambers shall be camouflaged with the adjacent hardscape & landscape. All outdoor equipment shall be mounted at min. 300 mm above FFL for protection against water ingress. All steel supports that are provided for the installation of equipment or accessories shall be Galvanized iron.

- 1.29. PURCHASER reserves the right to issue addendum to the technical specification to indicate modification/ changes in the requirements, if so required at a later date.

2.0. INSTRUCTION TO BIDDERS

- 2.1. The BIDDER shall be responsible for all work and the delegation of work to a subcontractor shall not relieve him of this responsibility.
- 2.2. The BIDDER shall visit the project site prior to submitting a bid. Any conditions that prevent installation of equipment in the manner intended/ proposed shall be clarified prior to submission of the bid.
- 2.3. No consideration or allowance will be granted for failure to site visit, or for any alleged misunderstanding of materials to be furnished or work to be done.

3.0. APPLICABLE CODES AND STANDARDS

- 3.1. All the equipment and systems shall conform to the latest applicable National and International standards; and latest Rules and Regulation of the Local Authorities. The codes and standards mentioned in this specification shall be latest as on the day of execution of the works unless otherwise specified. The revisions in the relevant codes and standards if any after the date of award of contract shall be informed by the CONTRACTOR to the Consultant/ Owner within 30 days of the issue of such revision of the codes/ standards. Consultant/ Owner may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices. Any cost impact arising out of such revisions shall be mutually agreed. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility.

4.0. POWER DISTRIBUTION PHILOSOPHY

- 4.1. 33 kV Incoming AC power supply voltage to the ICCC shall be considered based on Load Demand as per Assam Electricity Regulatory Commissioning/ APDCL norms.
- 4.2. One (1) No. adequate rating Compact Substation (CSS) shall be considered to step down the 33 KV MV to 433 V LV for further distribution. DC Power Pack for DC Supply Requirement for CSS shall be considered along with CSS.
- 4.3. One no. adequate kVAR rating APFC capacitor banks with control panel consisting of automatic power factor correction relay to improve the power factor up to 0.99 shall be considered.
- 4.4. One no. self-sufficient standby DG set with all the required accessories and auxiliary systems like Acoustic enclosure, silencer, Metal stack (as per Pollution Control Board Regulations), AMF, Breaker and Protection panel with provision for incoming and outgoing cable connections, Fuel day tank, foundation, earthing and other utility piping shall be considered for supplying the 100% backup power in case of Grid power failure.
- 4.5. Provision of switchgear in the PCC shall be considered for another Similar Rating temporary DG set which can be vehicle mounted. Only one DG shall operate at a time.
- 4.6. The outgoings from the transformer through a transformer incomer breaker and DG incomer breaker shall be connected to the Main PCC outgoing bus through an Auto

Transfer Switch (ATS). All the outgoings shall be drawn from this Bus which will have both grid as well as DG power as per availability.

- 4.7. Further distribution of power to each area shall be carried out through dedicated Distribution Boards for each floor for lighting & receptacles.
- 4.8. 2 x 100% modular redundant adequate rating three phase UPS system with Static By-Pass and 2 x 100% Lead Acid SMF VRLA battery bank with 30 min back up shall be considered for providing power supply to Desktop/ Workstations through Output UPS Distribution Board.
- 4.9. Conventional non-redundant adequate rating UPS system with 100% Lead Acid SMF VRLA battery backup shall be considered for the emergency lighting through Output UPS Distribution Board with 30 min back up.
- 4.10. Normal Lighting for each floor shall be considered through separate Per Phase isolated Three phase Distribution Boards for each floor fed from the MLDB at Electrical Room.
- 4.11. A separate Emergency Lighting DB (ELDB) shall be considered for feeding the emergency lighting for each floor.
- 4.12. Dedicated Single phase power outlets for Workstation shall be provided from the UPS DB of the Workstation UPS.
- 4.13. Single phase power for General Purpose as well as Dedicated Power Outlets for Miscellaneous purpose shall be considered through separate Raw Power DBs located in each floor fed from Main PDB at the Electrical Room. Provision for three phase outgoing shall be considered at PDB as well as each RDB level.
- 4.14. All the cabling from the PCC to the individual floors shall be laid on Cable trays through a Dedicated RCC Duct with access window on each floor. The DB shall be suitably located near the area where the ducts are located.

5.0. DESIGN CRITERIA

- 5.1. The design criteria of electrical system shall be based on providing safe, reliable & stable power and efficient performance of electrical system

5.2. Compact Substation (CSS)

Outdoor type Compact Sub-Station shall be consisting of following major equipment:

HT Switchgear:

33 kV, 630 A, 25 kA for 1 sec horizontal draw out horizontal isolation type Vacuum Circuit Breaker (VCB) with spring charging motor rated 230 V AC, closing & tripping coils rated 24 V DC with numerical relay having 50 / 51 / 50N / 51N protection function relay. Interconnection between HT Switchgear and Transformer shall be using Al. Armored XLPE Cable.

Transformer:

3 phase, 50 Hz, 33/0.433 kV, Dyn11, core type, double wound with copper conductor Dry type Distribution Transformer, of adequate rating, having a no-load voltage ratio

of 33/0.433 kV with top HT & LT Bushings. Tappings +5% to –5% in steps of 2.5% shall be provided at line end of HV winding. Changing of taps shall be carried out by means Off load tap changing. Prior Approval for the type of transformer whether oil or dry shall be taken APDCL by contractor and APDCL specification shall be followed for the same.

The Transformer shall be sized taking into following consideration:

- Connected Loads.
- Load Factor & Diversity Factor.
- Power Factor & Efficiency.
- 10% contingency factor over cumulative maximum demand for future load growth.
- Transformer shall be loaded to maximum 80%.
- Voltage dips at the largest motor terminal during its starting on base load condition. The Voltage dip shall be less than 15% taking into consideration motor starting method.

LT Switchgear:

LT Switchgear compartment shall consist of following major item:

- Incoming & Outgoing Circuit Breaker: FP 25 kA (Minimum) Manually Fixed Type MCCB / ACB, of adequate rating, with Microprocessor Based release for O/L, S/C, E/F protection. MCCB to be considered upto 630A & ACB above 630A.
- Interconnection between Transformer and LT Switchgear shall be using Aluminium Busbar.
- CBCT with Earth Leakage Relay at outgoing.
- Metering - Multi Function Meter, Voltmeter, Voltmeter Selector Switch etc.

5.3. Emergency Power Supply – Diesel Generator (DG)

To ensure uninterrupted power supply, the ICCC building utilities shall be operated on DG Set Power Supply. 100% emergency backup shall be considered with 1 Nos. DG Set. The DG Set shall be sized taking into minimum following consideration:

- Connected Loads.
- Load Factor & Diversity Factor.
- Efficiency.
- 10% contingency factor over cumulative maximum demand for future load growth.
- Maximum 80% Loading of the DG Set at 0.8 Power Factor.
- Voltage dips at the largest motor terminal during its starting on base load condition. The Voltage dip shall be less than 15% taking into consideration motor starting method.
- The step loading of the engine of the DG.
- Exhaust Stack as per NBC / CPWD guidelines.
- CPCB guidelines shall be followed for permissible exhaust emission limit.
- While sizing DG set, firefighting main pump shall not be taken into consideration.

5.4. 415V LV Switchgear

- (i) All Panels shall be indoor/outdoor type having incoming breakers, Auto transfer Switch and outgoing switchgears as specified. The design shall be compartmentalized & cubical type. The degree of enclosure protection shall be IP 52 for indoor and IP55 for outdoor as per IS: 13947 (Part-I). All LT Panels except for PCC shall conform to Form 3B whereas PCC shall conform to Form 4B. The LT Panels shall be as per the standards IS/IEC 61439.
- (ii) PCC shall be of internal arc type tested with Internal Arc withstands level at rated fault level for 0.5s.
- (iii) All panels shall be provided with Aluminium busbar. Distribution boards with incomers below and including 63A shall be provided with tinned copper bus bars.
- (iv) The bus-bars shall be sized considering minimum following criteria:
 - Design ambient temperature 45⁰ C.
 - Final temperature of the bus-bars complying with requirements of relevant standards.
 - Sleeves made of insulating material on all bus bars.
 - Bus bars being inside the panel; De- rating for enclosure and ventilation.
 - Bus bar suitability for carrying rated current continuously. The current density (A/mm²) of the bus bar shall not exceed 0.8 for Aluminium bus and 1.2 for Copper bus.
 - Configuration of bus bars, Skin and Proximity effect.
 - The main bus shall be designed based on the load rating as well as the actual fault level for specified duration at the location of the panel with 10% positive tolerance.
- (v) Earth bus of the panel shall be sized suitable for the specified fault level for the same duration.
- (vi) Switchgear shall be sized/ selected considering the following parameters:
 - Rating suitable for carrying full load current of the equipment / feeder.
 - Suitability for Short Circuit Rating for specified duration.
 - Switchgear for motors shall be suitable for motor duty application with Type – 2 co-ordination.
 - In panel de-rating of minimum 20% or as provided in Manufacturer's catalogue, whichever is higher shall be considered.
 - Switchgear rating for individual capacitor bank shall be sized at 1.5 times the rated current rating.
 - MCCB shall be considered up to 630A & ACB above 630A. All MCCBs shall be rated for Bus fault level or next higher market rating available with and $I_{cs}=I_{cu}=100%$ for MCCBs.
 - Miniature Circuit Breaker (MCB) shall be considered where fault level is below 10kA. For capacitor duty D-curve MCB shall be selected and for other purposes C-curve MCB shall be used.
 - All LT panels shall be provided with Microprocessor based overload (O/L), Short circuit (SC) and Earth fault (E/F) release at the panel incomer. Outgoing shall be Microprocessor based overload (O/L) & Short circuit (SC) protection AND Earth fault (E/F)

- Surge Protection Device (SPD) shall be provided at incoming power panels and sub-distribution boards. SPDs shall be selected to meet the requirements of relevant LPZs. Lifts and fire panels shall be protected with SPD in control panels. All SPDs shall have status indication to show their healthy state for discharging the lightning current.
- Multi-function meter for measuring current, voltage, power, frequency, and harmonics shall be provided for all the incomers.
- Motor starter selection shall be done as follows:
 - Direct on Line (DOL) Starter – For motors rated up to 5.5 kW.
 - Star- Delta Starter - For motors rated above 5.5 kW & up to 75kW or as per local Electricity board requirements, whichever is more stringent.
 - Soft Starter – For Low voltage motors rated above 75kW.
 - DOL starter shall be provided for Fire Fighting Pumps irrespective of rating.
- Motor feeders shall have the following protection and components:
 - Motor Protection Circuit Breakers (MPCBs) with inbuilt thermal overload and air break contactors for motors up to and including 30kW rating suitable for type 2 co-ordination.
 - MCCB with separate thermal overload and air break contactors for motors above 30 kW up to and including 110 kW rating suitable for Type 2 co-ordination.
 - ACB/MCCB and Composite motor protection relay (a minimum of protections such as over current, short circuit, earth fault, locked rotor, Negative phase sequence, thermal alarm etc.) for motors above 110kW rating.
- The PCC shall have provision for addition of verticals for future loads.

5.5. Automatic Power Factor Improvement Panel

One(1) No. Automatic Power Factor Improvement/correction Panel shall be considered for reactive power compensations. The required kVAR rating shall be calculated based on the system power factor requirement for achieving 0.99 power factor, i.e., 0.80 to 0.99. APFC Panel shall be selected considering following design criteria:

- MCCB/ACB based on current requirement to be considered as Incomer Breaker for APFC Panel.
- Steps shall be selected for Capacitor Bank with combination of 5 kVAR, 10 kVAR, 25kVAR, 50 kVAR, 100 kVAR
- Capacitor of All Poly Propylene (APP) type (Double Layer).
- 7% Detuned Copper Reactor shall be considered to take care of inrush & harmonics.
- Contactor based capacitor switching needs to be adopted.
- 1 No. Selector Switch for Auto/Manual Operation needs to be considered at the Incomer Circuit Breaker.
- All switchgear sizing needs to be done considering current rating of 1.5 times of FLC.
- APFC relay needs to be considered with 2 spare steps for future requirement.

5.6. Cables

All power cables shall be selected to carry the corresponding full load current under site conditions. In addition, the following main aspects shall also be considered while deciding the final size.

- Maximum ambient design temperature 45degC.
- Supply Voltage & Frequency.
- Maximum allowable temperature rises under normal full load condition based on the material of cable insulation (XLPE/ PVC).
- Maximum short circuit current and its duration (fault clearing time).
- De-rating factors with respect to the Method of cable laying i.e. outdoor/ indoor in air; underground/ buried/ trench with removable cover; depth of burial/ duration for trenches, no. of cables in a group – touching each other or separated by a distance; no of tiers of tray/ no of cables in a tray.
- Voltage drop with reference to Length of the cable.
- The maximum cumulative voltage drop of the system from the distribution transformer to the load is within the limit of 5%.
- The total dip has been limited to max. of 15% during Motor starting & 3% during Motor running.
- De-rating factors, resistance and reactance values for cable sizing has been considered from the published data of the offered make.
- Standardization of cable sizes has been preferred.

5.7. Cable Routing

- (i) Cable Laying shall be considered underground outside the ICCC BUILDING & Cable Tray to be considered for laying the Cables inside the ICCC Building.
- (ii) The cable tray sizes need to be selected based on the numbers and sizes of cables to be carried with the due consideration to the following cable laying arrangements.
 - All HT Power Cables shall be laid in a single layer with 1D Spacing between each other.
 - All LT power cables are laid in a single layer touching each other.
 - All control cables are laid in three layers touching each other.
 - Power and control cables are laid in separate trays for segregation.
- (iii) All the cables outside the building premises has been considered to be laid in DWC HDPE pipes beneath the carriage way/landscape area. The pipe size determination shall be based on the table below:

Sl. No.	Voltage level (kV)	Occupancy (%)	Max. No. of Cables per pipe
1	33	40	1
2	0.415	40	As per occupancy requirement

- (iv) DWC HDPE pipes shall be buried beneath the footpath / carriage way (as per space availability in the same order of precedence) with different layers for each voltage level. The voltage grading shall be 1.1 kV (LT) on the top about 750mm below the Finished Road Level (FRL) followed by subsequent voltage level of 33 kV. The voltage grading shall be 33 kV (HT) on the top about 1050mm below the Finished Road Level (FRL).

- (v) Within buildings, the cables shall be laid in prefabricated galvanized steel, perforated type cable trays, race way suitably supported by painted steel cable tray supports supported from wall/ ceiling/ columns etc. as per site condition. Separate cable trays will be used for power cables and control cables.
- (vi) Bending radius of 12D and 15D shall be adopted for laying of LT and HT cables respectively where D is the outer diameter of the cable.

5.8. Motors

All LV Motors shall be 3 phase, 415 V, 50 Hz, Squirrel Cage, Premium Energy Efficient IE3 Induction type with TEFC IP55 enclosure with Class-F insulation limited to Class B temperature rise conforming to IS 12615.

5.9. Earthing & Lightning Protection System

The safety earthing and lightning protection system shall be designed on the basis of following codes and standards.

- (i) IS 3043: Code of practice for Safety Earthing
- (ii) IS/IEC 62305: Protection against lightning
- (iii) IEEE 80: IEEE Guide for Safety in Sub-station Earthing
- (iv) Central Electricity Authority (CEA) Regulations – 2010
- (v) IEEE 1100- Electronic Earthing

The galvanising of the earthing material will be done as per IS 2629.

Fault current for Grid Conductor sizing considered at 33 kV has been mentioned below:

Sl. No.	System	Fault Current & Duration
1	33 kV	25 kA for 1 s
2	415V	25 kA for 1 s (Minimum)

Following factors shall be considered for sizing the earthing conductor.

Design ambient temperature	45°C
Temperature rise for steel welded joints	500°C
Fault clearing time	1 second
Overall earthing resistance	less than 1 ohm

Buried earthing conductors around the periphery of each building shall be installed at a minimum depth of 600 mm at a distance of approximately 1500 mm from the building edge. For outlying areas, main earthing conductor will be installed around the building periphery in the form of a ring.

For equipment earthing, two earthing leads shall be provided if the rated voltage of the equipment is equal to or above 250V and one earthing lead shall be provided for equipment rated below 250V. The neutrals of star connected transformer windings, noncurrent carrying parts and enclosures of all electrical equipment such as LV

switchboards, transformers, motors, LDBs, local control stations, cable trays, socket outlets, transformer yard fences etc. will be connected to the earthing grid by two separate (one for each lead) or one earth conductors (one from one lead).

Following equipment shall have dedicated GI Pipe eathing as mentioned below;

- Transformer Body – 2 nos. per Transformer
- DG Set Body – 2 nos. per DG
- Lightning Protection – 1 no. per down comer
- CSS – 4 nos. per CSS
- 2 Nos Plate type Cu earthing shall be considered for Transformer & DG neutral respectively as per IS 3043.
- Separate earthing system shall be provided for UPS & SERVER.

Lightning protection system:

The function of the air-termination systems of a lightning protection system is to prevent that direct lightning strikes damage the volume to be protected. They must be designed to avoid uncontrolled lightning strikes to the building/structure to be protected. Air-termination systems can consist of the following components and can be combined with each other as required;

- Roof conductor / rods / Meshed conductors / Air termination
- Down conductors
- Earth termination

Mesh size of 5 mtr. x 5 mtr. (Level-1 Protection as per IS/IEC62305) consisting of 25 mm x 6 mm GI Strip as Air Termination & Down Conductor shall be considered on the terrace of the buildings. 1 No. Earthing Pit shall be considered for each downcomer.

All connection between the conductors shall be welded/brazed type. Metallic pipe, conduit, structures shall be bonded to lightning protection conductors to prevent the side flashover. But no metallic pipe, conduit, the structure shall be used as air termination conductor or down conductor. Earth pits provided for down comers of lightning protection will be connected with general earth pits through earth strips below ground to reduce the overall earthing resistance of the grid.

SL. NO.	EARTHING CONDUCTORS	MATERIAL USED
a.	Conductors above ground	Galvanized Iron (GI) flat strip capable of withstanding fault level for 1s
b.	Conductors buried in ground	Galvanized Iron (GI) flat strip capable of withstanding fault level for 1s
c.	Conductor connecting electrical equipment body to the Main Earth Grid or earth pit	Galvanized Iron (GI) flat strip capable of withstanding fault level for 1s
d.	Conductor connecting electrical equipment neutral to earth pit	Cu flat strip capable of withstanding fault level for 1 Sec
e.	Pipe electrodes for treated earth Pit	Galvanized iron (GI)
f.	Plate Electrode for treated earth pit	Copper (Cu)
g.	Lightning protection air termination and down conductor	GI flat strip of 25 X 6mm

5.10. Point Wiring

- (a) Point wiring from Lighting DB (LDB) to switchboards shall be done with 1.1 kV grade, FRLS PVC insulated multi-stranded copper conductor wires of area 2.5 sq mm for phase and neutral with 1.5sq.mm earthing wire laid in 20 mm dia steel conduit concealed in wall and supported above the false ceiling/ true ceiling.
- (b) Point wiring from switchboards to light point shall be done with 1.1 kV grade, FRLS PVC insulated multi-stranded copper conductor wires of area 1.5 sq mm for phase and neutral with 1.5sq.mm earthing wire laid in 20 mm dia steel conduit concealed in wall and supported above the false ceiling/ true ceiling.
- (c) Point wiring from raw power receptacle DB (RDB) to 6 A receptacle shall be done with 1.1 kV grade, FRLS PVC insulated multi-stranded copper conductor wires of area 2.5 sq mm for phase and neutral with 1.5sq.mm earthing wire laid in 20 mm dia steel conduit concealed in wall or supported above the false ceiling/ true ceiling.
- (d) Point wiring from raw power receptacle DB (RDB) to 16/20 A receptacle shall be done with 1.1 kV grade, FRLS PVC insulated multi-stranded copper conductor wires of area 4 sq mm for phase and neutral with 2.5sq.mm earthing wire laid in 20 mm dia steel conduit concealed in wall or supported above the false ceiling/ true ceiling.
- (e) Point wiring from emergency lighting DB to emergency light point shall be done with 1.1 kV grade, FRLS PVC insulated multi-stranded copper conductor wires of area 1.5 sq mm for phase and neutral with 1.5sq.mm earthing wire laid in 20 mm dia steel conduit concealed in wall or supported above the false ceiling/ true ceiling.
- (f) Point wiring from workstation DB (WSDB) to workstations point shall be done with 1.1 kV grade, FRLS PVC insulated multi-stranded copper conductor wires of area 4 sq mm for phase and neutral with 2.5sq.mm earthing wire laid in raceway embedded in the floor.

5.11. Illumination System

Illumination is required to obtain the sufficient and required Lux level for proper mobilization and working at workplace. The illumination levels for indoor areas shall be as per IS 3646 part 1, 1992 & outdoor areas as per IS 1944.

Latest version of related IS standards, NBC and National Lighting Code (NLC) shall be referred for designing illumination for different areas. All lighting design shall be carried out on Dialux latest version or equivalent.

The basis of design is based on the following lighting engineering criteria:

- Lighting lux level.
- Luminance distribution.
- Glare restriction.
- Direction of incidence of light and shadow effect.
- Colour appearance and colour rendering of the light source.
- Uniformity.

The illumination level for different areas are chosen as per recommendation of IS, NBC and other governing bodies. Following table indicates the proposed illumination levels for various proposed services:

Area Description	Lux Level	Model No. / Equivalent
PARKING	100	PHILIPS TMC501 WITH TLED 4FT OR EQUIVALENT
LOBBY	200	Philips DN296B LED15S PSU WH OR EQUIVALENT
STAIRS	200	PHILIPS TMC501 WITH TLED 4FT OR EQUIVALENT
SERVICES	250	PHILIPS TMC501 WITH TLED 4FT OR EQUIVALENT
TOILET	150	Philips DN296B LED12S PSU WH OR EQUIVALENT
DIRECTOR ROOM	300	Philips DN296B LED12S PSU WH OR EQUIVALENT
		Philips RC480B LED30S/840 W60L60 PSUW OR EQUIVALENT
MANAGER ROOM	300	Philips DN296B LED12S PSU WH OR EQUIVALENT
		Philips RC480B LED30S/840 W60L60 PSUW OR EQUIVALENT
PA ROOM	300	Philips RC480B LED30S/840 W60L60 PSUW OR EQUIVALENT
CONFERENCE ROOM	350	Philips RC480B LED30S/840 W60L60 PSUW OR EQUIVALENT
MEETING ROOM	300	Philips DN296B LED15S PSU WH OR EQUIVALENT
WORKSTATIONS	300	Philips RC480B LED30S/840 W60L60 PSUW OR EQUIVALENT
RECEPTIONS	250	Philips DN296B LED12S PSU WH OR EQUIVALENT
RECORD ROOM	200	Philips DN296B LED 20S PSU WH OR EQUIVALENT
BMS ROOM	300	Philips RC480B LED30S/840 W60L60 PSUW OR EQUIVALENT
ELECTRICAL ROOM	200	Philips DN296B LED 20S PSU WH OR EQUIVALENT
CANTEEN	300	Philips DN296B LED 20S PSU WH OR EQUIVALENT

Area Description	Lux Level	Model No. / Equivalent
DATA CENTRE	500	Philips RC480B LED30S/840 W60L60 PSUW OR EQUIVALENT
NETWORK ROOM	300	Philips RC480B LED30S/840 W60L60 PSUW OR EQUIVALENT
AHU ROOM	300	Philips DN296B LED 20S PSU WH OR EQUIVALENT
CONTROL COMMAND CENTRE	500	Philips RC480B LED30S/840 W60L60 PSU WH OR EQUIVALENT
HUB ROOM	300	Philips DN296B LED 20S PSU WH OR EQUIVALENT

5.12. PROVISION OF GENERAL RECEPTACLES AND OTHER SERVICE OUTLETS

Details of the receptacles considered for various services has been indicated below:

These are the minimum requirement, Bidder to access the actual requirement.

Sl. No.	Location Description	Workstation UPS Power Point			Raw Power Point (6A)		Raw Power Point(16A)		
		6/16A (1000W)	6A (350W)	6A (200A)	Exhaust (100W)	General (100W)	General (500W)	Fridge (1000)	Microwave/Oven (110)
GROUND FLOOR									
1	Services Room				1	1	1		
2	Toilet					1			
3	Staircase Lobby						1		
4	Front Car Parking & Open Space						1		
FIRST FLOOR									
1	Director Room			2		1			
2	Manager Room			1		1			
3	Conference Room			3		2	1		
4	Meeting Room			2		1			
5	PA Room			1		1			
6	Workstation Area			14		7			
7	Lobby	1				1			

Sl. No.	Location Description	Workstation UPS Power Point			Raw Power Point (6A)		Raw Power Point(16A)		
8	Tiolet					1			
9	Electrical Room	1				1			
10	BMS Room			1					
11	Record Room			1					
12	Staircase Lobby						1		
SECOND FLOOR									
1	Conference Room			6		3	1		
2	Lobby	1				1			
3	Tiolet					1			
4	Hub Room			1					
5	Electrical Room	1				1			
6	Staircase Lobby						1		
7	Canteen				1	1	1	1	1
8	UPS/Battery Room			2		1	1		
THIRD FLOOR									
1	AHU Room			1		1			
2	Lobby	1				1			
3	Tiolet					1			
4	Hub Room			1					
5	Electrical Room	1				1			
6	Staircase Lobby						1		
7	Network Room			2		1			
8	Data Centre			3		2			
FOURTH FLOOR									
1	Electrical Room	1				1			
2	Lobby	1				1			
3	Staircase Lobby						1		
4	Command Control Centre	30				5	3		

Sl. No.	Location Description	Workstation UPS Power Point			Raw Power Point (6A)		Raw Power Point(16A)		
5	Conference Room			8		4	2		
TERRACE									
1	Staircase Lobby						1		

5.13. Lighting Power Distribution

- a. For indoor area, lighting power distribution should be through 415V, 3 phase, and 4 wire lighting distribution boards.
- b. The lighting system which will essentially comprise the following two (2) categories:
 - Normal 240V AC Lighting System.
 - Normal-cum- emergency 240V AC Lighting System.
- c. Normal 240V A.C. Lighting
 - This will be provided by A.C. lighting fixtures proposed for various buildings and common area. These lights can be switched ON as long as the A.C. supply is available.
 - A.C. lighting fixtures will be fed from respective area lighting panels, which in turn will be fed from Main Lighting Distribution Board. Normal A.C. supply thus made available by the MLDB. Lighting panels will be provided with at least 20% spare outlets.
- d. Normal cum Emergency AC Lighting
 - On failure of normal A.C. supply as well as D.G. supply, A.C. lighting will be provided in critical accessing areas for general visibility, safe movements.
 - At least 15% of the fixtures will be fed from this Normal cum Emergency AC Lighting Boards.
 - Emergency lights shall be envisaged at strategic points viz., near entrances, staircases, control rooms, passage / corridor etc. These would be fed from UPS systems. UPS of adequate kVA rating with 30 min Battery Backup shall be considered for emergency lighting for ICC Building.

5.14. Elevator

- (a) The lift and selection shall be as per NBC and IS 14665.
One (1) No. Lift approximately 8 Nos. of passenger's capacity are proposed
- (b) Speed of Passenger elevators / lifts shall be generally 1.0 m/sec.
- (c) The lifts shall be suitable to operate on 415 Volts 3 phase, 4 wires, 50 Hz. A.C. supply with a variation of +10% in Volts and +5% in frequency respectively. The supply for illumination and single-phase equipment shall be 230 Volts A.C.
- (d) Earthing shall be provided to Lift / Elevator panel, further all cabling, wiring and earthing work shall be in elevator VENDOR scope.
- (e) All lifts shall be provided with following minimum features:

- (f) VVVF drive
- (g) Stainless steel rope
- (h) Automatic operations
- (i) Fire rated doors
- (j) Provision of fireman drive
- (k) Automatic self-levelling feature
- (l) Photo electric device/ infrared safety curtain
- (m) Automatic rescue device

Above mentioned requirement is the minimum requirement, bidder to assess the actual requirement with respect to the statutory regulations laid down by State or any other implementing authority & provide the same.

5.15. ELECTRIC VEHICLE CHARGER

One no. EV Charger shall be considered for ICCB Building as per Bharat DC standard, details for the same are as follows:

a)EV Charger shall be suitable to operate on 415 Volts 3 phase, 4 wires, 50 Hz. A.C. supply with a variation of +10% in Volts and +5% in frequency respectively.

b)General Technical Particulars of the EV Charger shall be as follows:

AC Input	
Line Voltage	415V
Frequency	50 Hz

DC Input	
Nominal Output Voltage	40-100V
Output Current	150 A
Output Power	15 kW

1.11 ICT SYSTEM – SCOPE OF WORKS

This specification covers specific requirements of design, preparation of detailed drawings, manufacture, testing at manufacturer's works, supply, inspection at Vendor's/Sub-Vendor's works, packing, forwarding, transportation, transit insurance, delivery at site, installation, testing at site and commissioning, Handing over, performance monitoring of the system and operation & maintenance for five year after acceptance testing and handing over.

The tender consists of the following sections:

- a) Structured Cabling System (Data & Voice Network)
- b) Fire Detections & Alarm System (FDAS)
- c) CCTV Camera Surveillance System (CCTV)
- d) Public Address System (PAS) for the Building
- e) Access Control System (ACS)
- f) Audio & Video Equipment's for the Conference Room
- g) Integrated Building Management System (I-BMS)

This tender shall act as a guide to the type of system desired for the project. The specifications described in this tender are as per the 'Design Project Report' and are the minimum required from the contractor.

The basic architecture of the system shall be as described herein the tender and the detail engineering based on this shall be carried out by the ICT Contractor after the award of work. The contractor shall work out the number of system panels required and mark their tentative position on the drawings along with their model numbers, at the time of submission of tender. The final number of system panels and their relative position shall be decided in consultation with the Architect / Consultant / Owner's site representative and their decision in this regard shall be final and binding.

The minimum required general character and the scope of work to be carried out under this contract is illustrated in Specifications. The Contractor shall execute the said work as per the terms & condition set out in the tender documents and in conformity with the specifications laid down. The contractor shall furnish all labour, materials and equipment, transportation and incidentals necessary for design, supply, installation, testing and commissioning of the complete above-mentioned system and Integrated Building Management System as described in the tender document. 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 complete the installation.

1.11.1 STRUCTURE CABLING SYSTEM

General Summary

The scope of this project is to provide (Design, Supply, Installation, Testing & Commissioning and Final Handover to client) the hardware, infrastructure, cabling and terminations and associated components, trim, sealant, firestopping and accessories for complete and operational telecommunications system (Data & Voice

both) at the ICCB Building at Guwahati and as defined in the following project components:

- Voice Cabling system for Normal Telephone/Trunk System
- Data Cabling network for the all Data Touch Points in the Buildings

The following sub-systems and peripheral components should be considered in conjunction with the design and implementation of the cabling system:

- a) False floor or Raised Floor in server/communications rooms to facilitate cable routing to floor mounted racks and cabinets.
- b) Smoke detection in server and communications rooms
- c) UPS system capacity requirements, accommodation, battery maintenance and life span
- d) Wireless LAN / Access Points
- e) IP Telephone Systems
- f) Normal Telephone Trunk Lines.
- g) Video Conferencing System
- h) IP cameras (CCTV Surveillance) using existing switching (not on separate security network)
- i) Network for Data Communication (DCN) terminations and associated equipment. The SCS provides the physical media for the Project's Local Area Network (LAN) port and Wireless LAN and as such, provides connectivity for:
 - Data and voice devices
 - Wireless Local Area Network (WLAN)
 - Wireless Internet
 - IP Video Surveillance Cameras

The conceptual arrangement of a generic cabling system is illustrated below:

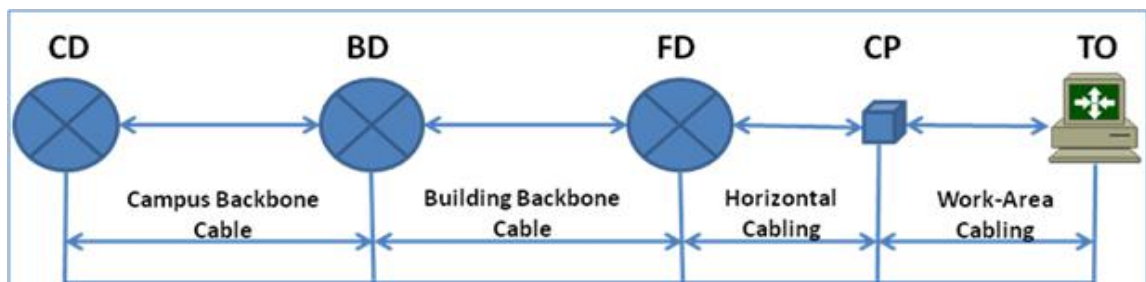


Figure 1: Cable Distribution System (Data NW)

The distributors (Campus Distributer-CD, Building Distributer-BD, and Floor Distributer-FD) provide the means to construct different cabling system topologies such as bus, star and ring, or a combination of these. Furthermore, the distributor functions may be combined, and the Consolidation Point (CP) may or may not be included in the cabling between the Telecommunications Outlet (TO) and the distributor.

1.11.2 FIRE DETECTION & ALARM SYSTEM

The work covered by this specification comprises all design, supply, materials, installation, labour, services and all equipment and materials necessary to install, operate, test, and commission, including, but not limited to, the under-mentioned items:

- a) Addressable Multi Criteria detectors
- b) Addressable Heat detectors
- c) Flush Mount Detectors
- d) Loop Powered Sounders cum strobe
- e) Addressable Manual call points
- f) Addressable Conventional Zone Module
- g) Addressable Control module
- h) Beam Detector
- i) Aspiration Detector
- j) FDAS panel
- k) Cabling for FDAS
- l) I/O Modules
- m) Auto-Dialer
- n) Telephone Jack/Handset

The fire detection and alarm system may comprise of main fire alarm control panels, optical smoke/heat sensors, heat sensors, and optical smoke/heat sensor with integral sounder units, manual call points, electronic sounders, repeat panels, and interface units, each with its own short circuit built-in isolators. All loop cabling and any other components and accessories deemed necessary for a safe, reliable and satisfactory system will conform to the relevant and applicable requirements and recommendations. The fire alarm system shall comply with requirements of NFPA standard No. 72 for protected premises signalling systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.

- Contractor will train and instruct client's personnel in the correct use, operation and supervision of the system, prior to the handing over of the project.
- The system will be fully programmed to accommodate at least 4 fire zones. The system will 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.

1.11.3 PUBLIC ADDRESS SYSTEM

- Design, Supply, installation, testing and commissioning high quality fast-acting IP CCTV surveillance system along with power supply, power distribution and required

accessories in different blocks of Integrated Command Control Centre (ICCC), Guwahati (Assam).

- The CCTV surveillance system should consist of IP Fixed cameras (indoor type), Dome Camera, Software, Server, Power Supply and Cables.
- Video management software shall offer both video stream management and video stream storage management. Recording frame rate and resolution in respect of individual channel shall be programmable.
- Cat-6/6e Cable/Fibre cable connectivity with all required hardware up to ICT control Room or networking switch room,

EXCLUSION:

- PAN city storage infrastructure (under System Integrator Project) shall be used for ICCC video camera video footage.

1.11.4 PUBLIC ADDRESS SYSTEM

- a) This scope of work covers specific requirements of design, preparation of Design, Detailed Drawings, Supply, Installation, Packing, Transportation, Transit Insurance, Delivery at site and Testing & Commissioning of the PA System at ICCC Building at Guwahati.
- b) Public Address System (PAS) for the ICCC building. The main purpose of the Public Address system (PAS) shall be to inform ICCC personnel of an emergency situation by:
 - Sounding audible alarm signals.
 - Allowing emergency verbal announcements to be made in all areas of the campus where personnel may be present during normal operations.
- c) The Public Address System (PAS) shall be monitored and controlled from IBMS room located at ICCC Building.
- d) Supplier shall note that in the event of conflict between standard requirements and project specific requirement in specifications & other terms and conditions.
- e) It is not the intent to specify completely herein all details of design and construction of equipment or materials to be supplied or of services to be rendered. However, the equipment, materials and services shall conform in all respects to high standards of engineering design, workmanship and be capable of performing in continuous commercial operation in a manner acceptable to PURCHASER who will interpret the meaning of drawings and specifications and shall have the power to reject any work or material which in his judgments are not in full accordance therewith.

1.11.5 ACCESS CONTROL SYSTEM

- a) The contractor shall design, supply, install, test, commission and maintain the Security equipment including provision of all necessary hardware, software and relevant spares.

- b) The ICT Contractor shall provide all interface components to interface with other mechanical & electrical equipment unless specified otherwise in this contract. Normally, the dry contacts shall be made available, but in the event of these not being available, the contractor may be required to provide the necessary paraphernalia. The terminations in the other services panels shall be in scope of respective services contractors.
- f) It shall be the responsibility of ICT contractor to perform all checks on wiring, for trouble-free operation of the System.
- g) It shall be responsibility of ICT contractor to in close coordination with services contractor so that desired results are obtained along with complete monitoring of various systems.
- h) Proper operation and maintenance for 5 years after 60 months of DLP of the system shall be responsibility of the contractor and shall include debugging and proper calibration of each component in the entire system.
- i) No claim for extra items shall be entertained for installation / commissioning of the system. All works in connection with completion of the system shall be in scope of this tender. The Bidder shall take into its scope, price for all works and approvals in connection with installation of the CCTV System from government as well as statutory bodies.

1.11.6 **AUDIO & VIDEO EQUIPMENT IN CONFERENCE ROOM**

This scope of work covers specific requirements of design, preparation of Design, Detailed Drawings, Supply, Installation, Packing, Transportation, Transit Insurance, Delivery at site and Testing & Commissioning of the Audio & Video Equipment's in Conference Rooms at ICCC Building at Guwahati.

- Wireless Table Top Digital Chairman Unit with Super Cardioid Microphone (Detachable)
- Digital Audio Conference Control Unit with Antenna Module for conference system controls Minimum 350 discussion units
- Delegate charging case, charging time 4 Hrs. or less
- Wireless digital Handheld Microphone with 18 or more channel, RF output 100mW or more,
- 8" thin edge ceiling speaker, 24W
- Digital power amplifier, RMS Power
- 7 input and 4 output digital signal processor, all input should have AEC and Dante connectivity, expandable up to 62 inputs
- Projector
- Projector Board/Screen
- White-board

- Require Cables and connector Lot for above Audio-visual system. XLR, Speaker Cables, Touch USB cable & Connectors.

1.11.7 **BUILDING MANAGEMENT SYSTEM**

In general, the work to be performed under this contract shall comprise/include the following:

- a) This specification covers the supply, installation, testing & commissioning of BMS including performance testing at the manufacturer's and / his System Integrator / Bidder/Contractors works, delivery/Supply to site, storing and handling at site, training of personnel at site for operation and maintenance and carrying out performance tests at site to the satisfaction of the GSCL.
- b) The Bidder/Contractor shall supply, install, testing, commissioning and maintain the Building Automation System (BAS) including provision of all necessary hardware, software and relevant spares.
- c) The Bidder/Contractor shall provide all interface components for automation system including, sensors, transducers etc. to interface with other mechanical & electrical equipment unless specified otherwise in this contract. Normally, the dry contacts shall be made available, but in the event of these not being available, the Bidder/Contractor may be required to provide the necessary paraphernalia. The terminations in the other services panels shall be in scope of respective Bidder/Contractor.
- d) It shall be the responsibility of Bidder/Contractor to perform all checks on wiring, sensor and actuator mounting for trouble-free operation of the equipment.
- e) It shall be responsibility of Bidder/Contractor to in close coordination with services Bidder/Contractor so that desired results are obtained along with complete monitoring of various systems.
- f) Cables for the integration of the system shall run in separate (MS/GI) conduits/raceway to be provided and installed by the Bidder/Contractor.
- g) Proper operation and maintenance of the system shall be responsibility of the Bidder/Contractor and shall include debugging and calibration of each component in the entire system. Maintenance Software package also should be included in the scope.
- h) Bidder/Contractor should obtain all technical details of each equipment which are being controlled / monitored and program the maintenance software as per the manufacturer's recommendations.
- i) No claim for extra items shall be entertained for installation / commissioning of the system. All works in connection with completion of the system shall be in scope of this tender. The tenderer shall take into its scope, price for all works and approvals in connection with installation of the BAS System from government as well as statutory bodies.

Besides the above, general scope of work shall also include the following:

- j) Supply & installation of all necessary BAS control and monitoring outstations.

- k) Supply and installation of all BAS field controls cabling including local area networks.
- l) Supply and installation of field interface cabling between all equipment and the BAS System.
- m) Identification of all field cabling from the motor control panels at both ends of each core, and in junction boxes using the same numbering as used for associated outgoing enclosure terminal.
- n) Supply and installation of controls for temperature, humidity and pressure detectors, thermostats, flow switches and differential pressure switches, etc. associated with the BMS.
- o) Ensure all control devices are positioned such that maximum stability of control for each system can be achieved.
- p) Supply and fitting of necessary clips, hangers and supports for all averaging element detectors and for serpentine them across the ducts.
- q) GI trunking/ GI Trays with GI supports wherever more than 6 Nos. conduits/cables are to be terminated at any point. More than 6 Nos. Armoured cables should not be saddled directly in to wall /ceiling and cable tray/trunking should be used for the same.

Detailed Design Submittals:

- a) Literature to be furnished by the successful tenderer.
- b) Besides furnishing the information called for in Technical data, tenderers shall submit literature with specifications and all relevant data. Bidder shall submit system configuration drawing, write-up on the system and its features, clause by clause confirmation to the specification and data sheets and catalogues for the proposed make and models of all the components of the system. The UPS load corresponding to the BMS equipment shall be indicated in the bid. All BMS equipment is to be covered by the UPS.
- c) On the Award of Contract, the manufacturer shall submit the following for approval.
 - i) Shop drawing on each piece of equipment provided in accordance with the specification. – Dimensional data sheet, wiring diagram, foundation detailed drawings etc.
 - ii) Brief description of the system/equipment offered.
 - iii) Installation, Operation and Maintenance data sheet/manuals.
 - iv) Compliance statement with Tender requirements.
- d) Drawings and Documents: All works shall be carried out on the basis of approved drawings. Drawings furnished shall include, but not be limited to
 - i) Schematic diagram
 - ii) Layout Diagrams
 - iii) Drawings for control panels.

1.11.8 ACCESSIBILITY

The contractor shall confirm adequacy of the size of the openings and clearances for proper installation of his equipment. The contractor shall locate all equipment's which must be serviced, operated or maintained, in fully accessible positions. The exact location and size of all access panels, required for each concealed control equipment, valve or other devices, shall be finalized and got approved from PMC well in advance of the site installation.

1.11.9 ELECTRICAL INSTALLATION:

The electrical work related to Integrated Building Management System works in various panels, shall be carried out in full knowledge of, and with the complete co-ordination of the respective services contractor. Such electrical work shall be in total conformity with the control wiring drawings prepared by the respective contractor and approved by the Architect / Consultant / Owner's site representative. All equipment other than those in the scope of this tender shall be connected and tested in the presence of an authorized representative of the respective contractor, whose equipment is being tested. The Architect / Consultant / Owner's site representative decision shall be binding on all parties in case of any dispute.

1.11.10 MATERIAL AND EQUIPMENT

All materials and equipment shall conform to the relevant Standards and shall be of the approved make list. Deviation, if any will be highlighted by the Bidder at the time of submission of tenders.

1.11.11 MANUFACTURERS INSTRUCTIONS :

Specific instructions, from manufacturers of the materials and equipment used in this project, and not specifically mentioned in these documents, shall be followed in all cases.

1.11.12 COMPLETION CERTIFICATES

On completion of the installation, a certificate shall be furnished by the contractor, counter signed by the licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local authority.

The contractor shall be responsible for getting the entire installation duly approved by the authorities concerned as required and shall bear all expenses in connection with the same. However, any receipted fees paid shall be reimbursed by the Owner on production of proof of payment.

1.11.13 UPTIME GUARANTEE

The contractor shall guarantee for the installed system an uptime of 99%. In case of shortfall in any month during the defects liability period, the Defects Liability Period shall get extended by a month for every month having shortfall. In case of shortfall beyond the defects liability period, the contract for Operation and Maintenance shall get extended by a month for every month having the shortfall and no reimbursement shall be made for the extended period.

The Bidder shall include a list of other projects where such an Operation Assistance

has been provided.

1.11.14 COMPLIANCE LIST AND TECHNICAL DATA:

The contractor shall submit paragraph-by-paragraph listing of strict word-for-word compliance or non-compliance of specifications. In case of any item of conditional compliance or non-compliance, the Bidder shall spell out the substitute to the feature.

At the time of tender, all Bidders shall include a detailed compliance statement, listing each clause of the specifications and highlighting:

- a. Exceed specification requirements (explanation required)
- b. Meet specification requirements
- c. Meet intent of specification (explanation required)
- d. Deviation from specification

Each Bidder must also submit along with his tender the technical data for all items listed in schedule of quantities. Failure to furnish technical data with tenders may result in summary rejection of the tender.

The contractor shall also submit the following documents and details at the time of submission of the tender. These shall be from the system which contractor is offering for this project.

- i. Available services for full system maintenance, software updates and modifications, hardware spare parts, adds and changes, system changes and training classes.
- ii. Technical data for all hardware components as asked for in the tender as per Appendix. III.
- iii. Manufacturers, Test Certificate for each device/ sensor / equipment, clearly highlighting the conforming standards.

2.0 SCHEDULE A – PART B – SCOPE OF OPERATION & MAINTENANCE SERVICES

The contractor shall be responsible for Comprehensive Operation and Maintenance of the facility designed and built by him including works executed by other Contractors, elsewhere in the building (Except for any specialized equipment supplied and installed by other contractors, which has separate O&M with the OEM) for five years after completion of works, running concurrently with stipulated Defect liability periods of 5 years.

2.1 Service & maintenance requirements

- i. The Contractor shall, at all times, operate and maintain the Project in accordance with the provisions of the Contract, Applicable Laws and permits. In particular, the Contractor shall, at all times during the Maintenance Period, conform to the service and maintenance requirements set forth in this Schedule
- ii. The Contractor shall repair or rectify any defect or deficiency set forth in this Schedule within the time limit specified therein and any failure in this behalf shall constitute a breach of the Contract. Upon occurrence of any breach hereunder, the Authority shall be entitled to recover Damages as set forth in relevant section of the Contract, without prejudice to the rights of the Authority under the Contract, including Termination thereof.
- iii. General ambience and upkeep
 - a. The general ambience and upkeep shall be of high standards to maintain clean, comfortable, informative, and welcoming surroundings and interiors.
 - b. The Contractor shall be responsible for cleanliness, maintenance, upkeep of premises and facilities and provide a clean, comfortable, safe and aesthetically appealing environment.
 - c. The Contractor shall arrange for dustbins in all common areas inside the building and outside the building within the campus, to minimize littering from users of the Project Facility.
 - d. While cleaning the ICCC building, the Contractor shall make sure that the dump shall not be thrown in the adjoining areas, except any area which is designated by the Authority for such purpose.
 - e. The Contractor shall follow adequate waste management and disposal methods for waste generated from Project Facility operations.
 - f. The Contractor shall ensure collection, screening and segregation of dry and wet garbage area. The Contractor shall also ensure the segregation of bio-degradable, non-bio degradable and hazardous waste. Appropriate disposal as approved by applicable authority shall be the responsibility of the Contractor. The Contractor shall in no way harm the environment of the place.
 - g. The Contractor shall undertake clearing of any choking in the drainages, manholes, etc. removal of beehives and cobwebs/ honey webs from the property and its premises, cleaning and sweeping of rooftops with brooms/ mechanized sweeping, cleaning of signage. All dustbins shall be properly cleaned from in and outside and shall be emptied at the end of the shifts on regular basis.
 - h. The Contractor shall not damage, destruct or demolish any structure, area or asset, which is owned by Authority, inside or outside Project Facility areas without prior instructions and / or approval of Authority.

- iv. Toilet/ wash rooms and shower areas
 - a. There shall be a regular maintenance program in place for toilet/washroom and shower area cleaning to maintain the facilities in a clean, working condition.
 - b. The housekeeping staff of the contractor shall be responsible for daily cleaning disinfection of toilet/washrooms and shower areas in the project facility as per the following check list.
 - c. Appropriate cleaning mechanism must be employed.

v. Schedule of Maintenance

The Contractor shall follow the following timetable for routine cleaning of the Project Facility:

Periodic cleaning schedule

Activity	Frequency
Toilets cleaning and sweeping	Continuous (3 times a day)
Washfloors, dust, clean (open) drains, empty dustbins, scrub pantry/ kitchen, tables/chairs, other furniture and accessories, furniture, shelters, etc.	Once a day
Clean cobwebs, clean doors, windows, kitchen walls, weeding the plants, etc.	Once a week
Cleaning of Glass/ Façade, any other external features, etc.	Once in 6 months
Repairs, Fumigation, Wash Curtains, Cushion Covers, water tanks, filter solution, pest eradication, clean air conditioning system etc.	Once a year
Whitewash/ External painting, contract renewals, etc.	3 years

Periodic maintenance schedule

Item	Activity	Frequency
Floor	Machine scrub to ensure removal of soil from grouting	Fortnightly
Walls	Hand scrub to ensure removal of soil from grouting	Monthly
Bins	Hand scrub to ensure removal of soil from grouting	Fortnightly

Item	Activity	Frequency
Basins	Scrub with scrubbing pad to remove stubborn stains	Weekly
Bowls / Urinals	Scrub with scrubbing pad to remove stubborn stains Scrub beneath rim to ensure removal of yellow stains	Weekly
Soap Dispenses	Dismantle and check / clean chokes	Weekly
Exhaust Fans	Wipe clean to remove dust	Weekly

Equipment and Supplies List for Cleaning and/or Operations

- a. Service tray or cart
- b. Premixed glass cleaner (with spray bottle)
- c. Premixed disinfectant cleaner (with spray bottle)
- d. Disinfectant cleaner concentrate
- e. Scouring power
- f. Stainless steel cleaner (if necessary)
- g. Toilet bowl swab and container
- h. Putty knife
- i. Broom
- j. Dust-pan corner brush
- k. Mop / Bucket / Wringer
- l. Signages such as 'wet floor' and 'closed for cleaning'
- m. Duster (feather / lamp's wool)
- n. Clean cloth
- o. Paper towels / Toilet paper / Soap
- p. Gloves

Cleaning Agent for Different Finishes

1. Wall/ Floor (cleaning granite)	Use neutral-based cleaners or disinfectants. Do not use acid- based cleaner on marble
2. Glass / Mirror	Use ammonia or neutral based cleaners
3. Sanitary Wares	Use disinfectant cleaners
4. Stainless Steel /Chrome	Use stainless steel / chrome polish
5. Plastic / PVC	Use neutral based cleaners

6. Toilet Bowls	Use disinfectant or mild abrasive liquid cleaners
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Washroom Inspection Card

Location Month

Date	Time	Defects	Checkers	Remarks

vi. Preventive maintenance

- a) The outlets and drainpipes of the urinals shall be kept clog free and fixed in proper place.
- b) The clogged drain pipes are to be de-clogged immediately and drain chambers cleaned thoroughly once a week as part of preventive maintenance and also one register to be maintained for all the drainages of the Gallery.
- c) Regular monitoring to be done by the housekeeping supervisor for the cleaning by maintaining and filling the checklist.

vii. Maintenance of horticulture and landscaping

- a) The Contractor shall be responsible for the maintenance of horticulture and landscape areas in the Project Facility which includes, watering, fertilizing the plants, protection from pests and diseases, sweeping, weeding, mowing and disposal of garden refuse, cultivation and cutting of hedges, pruning and clipping of hedges roses. etc and stacking, preparation and planting of seasonal flowers, minor repair works and all other landscape operations necessary for the proper growth of garden features and proper standard of maintenance.
- b) The Contractor must engage experienced staff for the supervision of these works, which shall be familiar with the landscape operation in the area/region.
- c) The staff shall ensure regular weeding, cutting grass of lawns and flower beds, ground covers, making basins of tree pits and hoeing to be done periodically.
- d) The Contractor shall ensure adequate watering of all garden /landscape features, trees, hedges, shrubs with hose pipes in different area shall be done regularly. The Contractor shall ensure that unnecessary wastage of water

does not occur at any time and must protect the irrigation fittings / hydrant etc. fixed at site and existing irrigation system due to negligence of his staff will have be made good by the Contractor at his cost.

- e) The Contractor shall ensure that manure and fertilizers as required shall be applied under the directions of the experienced Gardner/Mali. Periodic checks to be carried out for pests and diseases.
- f) The Contractor shall ensure that sweeping, removal and disposal of garden refuse and cut grass to approved dumping ground. No grass/refuse to be left over night in the garden area/landscaped area.
- g) The Contractor shall ensure that lawn mowing to take place at regular intervals of 10-15 days in a month or as per direction of the experienced Gardner/mali.
- h) The Contractor shall ensure that clipping and trimming of hedges, edges and trimming of shrubs, plants, trees, creepers and bougainvilleas etc. to be carried out at regular intervals.
- i) The Contractor shall ensure safety of all goods and equipment, tools/ hose pipes etc. at the project facility site.
- j) The Contractor shall take all necessary precautions for carrying out the above operations. In the case of any injury/accident to any person, the responsibility and liability will be entirely on the Contractor.

viii. Signage and information board maintenance

- a) The Contractor shall provide sufficient and elaborate signage, both symbolic / directional as well as descriptive throughout the site. The signage shall be well lit, readable and located at strategic locations.
- b) The Contractor shall provide Internal directional signs which may be required in large the Project.
- c) Information signages and display boards shall be visible, legible and functional. These shall be cleaned once in a week. Damaged signages and boards shall be replaced, repaired within seven days of detection.
- d) The Contractor shall provide controlled Entrance (access) and Exit (egress) to be suitably manned by security personnel.

ix. Other Maintenance Requirements

S.No.	Activity	Description
a)	Electric Meter	The Contractor shall check all meters once in a month time to ensure that they are functioning and are showing correct readings.
b)	Standby Power Supply	The Contractor shall have arrangement of standby power supply by DG sets which shall be available 24 hours.
c)	Safety	Any fault in the electrical equipments like switches, receptacles, wiring etc. shall be identified, tested and repaired within 24 hours of detection to prevent accidents.

d)	Fire Fighting Facilities	The Contractor shall provide the required firefighting equipment and facilities including fire exits, fire proof doors, etc conforming to relevant standards and the applicable rules and regulations.
e)	Facilities for Physically Challenged Persons	The Contractor shall provide all the necessary facilities to the entry/exit seating and movement of physically challenged persons including wheel chairs, ramps etc.
f)	Equipment	The Contractor shall ensure the equipment and component parts shall conform to the relevant standards by (BIS) wherever available.

2.2 Repair / rectification of defects and deficiencies

- i. The obligations of the Contractor in respect of Maintenance Requirements shall include repair and rectification of the defects and deficiencies specified in Annexure – I of this Schedule within the time limit set forth therein.
- ii. Other defects and deficiencies
- iii. In respect of any defect or deficiency not specified in Annex - I of this Schedule the Contractor shall undertake repair or rectification in accordance with Good Industry Practice and within the time limit specified by the PMC/Authority.
- iv. In respect of any defect or deficiency not specified in Annex - I of this Schedule,
- v. the Authority/PMC may, in conformity with Good Industry Practice, specify the permissible limit of deviation or deterioration with reference to the Specifications and Standards, and any deviation or deterioration beyond the permissible limit shall be repaired or rectified by the Contractor in accordance with Good Industry Practice and within the time limit specified by the Authority

2.3 Extension of time limit

Notwithstanding anything to the contrary specified in this Schedule, if the nature and extent of any defect or deficiency justifies more time for its repair or rectification than the time specified herein, the Contractor shall be entitled to additional time in conformity with Good Industry Practice. Such additional time shall be determined by the Authority and conveyed to the Contractor and the Authority with reasons thereof.

2.4 Emergency repairs / restoration

Notwithstanding anything to the contrary contained in this Schedule, if any defect, deficiency or deterioration in the Project poses a hazard to safety or risk of damage to property, the Contractor shall promptly take all reasonable measures for eliminating or minimizing such danger.

2.5 Daily Inspection by the Contractor

The Contractor shall, through its engineer, undertake a daily visual inspection of the Project and maintain a record thereof in a register to be kept in such form and manner as the Authority/PMC may specify. Such record shall be kept in safe custody of the Contractor and shall be open to inspection by the Authority/PMC.

Annexure-I

	Nature of defect or deficiency	Time limit for repairs/rectification
(i)	Breach or blockade of the pavement/walkways/ within ICCC building and the utility building.	Temporary restoration within 24 hours; permanent restoration within 15 days.
(ii)	Damage to or silting of culverts and side drains during and immediately preceding the rainy season	7 days
(iii)	Desilting of drains	48 hours
(iv)	Damages in retaining wall, weep holes, culverts, cover slabs etc.	7 days
(v)	Damage to shape or position; poor visibility or loss of retro-reflectivity/electrical service to signages/ information boards	48 hours
(vi)	Damages to signages/information boards	7 days
(vii)	Any major failure of the exterior lighting (including stree lighting) and telecom/Wi-Fi system	24 hours
(viii)	Faults and minor failures of the exterior lighting (including street lighting) and telecom/Wi-Fi system	8 hours
(ix)	Deterioration in health of trees and bushes, lawn and other landscaping features	Timely watering and treatment
(x)	Replacement of trees and bushes	30 days
(xi)	Removal of vegetation affecting sight line and road structures	15 days
(xii)	Defects in electrical/ AC/ mechanical/ water and sanitary installations/all internal and external service lines	24 hours
(xiii)	Cracks / gaps	7 days
(xiv)	Exterior painting	Once in 3 Years

(xv)	Internal white washing / painting in service areas / toilets	Every year for 5 years
(xvi)	Damages in joineries / flooring, walls etc.	15 days
(xvii)	Firefighting / operation of extinguishers	24 hours
(xviii)	Damages to furniture, fixtures, curtains, internal signages etc.	7 days
(xix)	Damages to RO water plant (if applicable)	24 hours
(xx)	Damages to rainwater harvesting	30 days
	Nature of defect or deficiency	Time limit for repairs/rectification
(xxi)	Damages to septic tank	24 hours
(xxii)	Damages to tube wells & pumps including water tank	24 hours
(xxiii)	Damages to CCTV & security system	7 days
(xxiv)	Damages to electrical substation / transformer	24 hours
(xxv)	Damages to trenches / ducts for UG cables / Pipeline	30 days
(xxvi)	Damages to DG set	24 hours
(xxvii)	Damages to Entertainment - Satellite TV & Wi- Fi	7 days
(xxviii)	Damages to shading devices	7 days
(xxix)	Damages to outdoor furniture	7 days
(xxx)	Damages to indoor furniture	5 days

2.6 Damages for breach of operation and maintenance service obligations

In mutual consultation with the Authority, the Contractor shall provide a maintenance schedule with an agreed time for rectifying any maintenance related damages/repair for each maintenance type.

In the event that the Contractor fails to repair or rectify any defect or deficiency set forth in the maintenance requirements within the period specified therein, it shall be deemed to be in breach of the Contract and the Authority shall be entitled to recover Damages, to be calculated and paid for every minor breach as 0.25% of the Monthly Maintenance Fee amount calculated pro rata with reference to actual quarterly payment in terms hereof, for each instance of breach; and for every major breach as 1% of the Monthly Maintenance Fee amount calculated pro rata with reference to actual quarterly payment in terms hereof, for each instance of breach. Repair / Replacement of any damage to be made good by the Contractor.

The Damages set forth may be assessed and specified forthwith by the Authority. The Contractor shall pay such Damages forthwith and in the event that it contests such Damages, the dispute resolution procedure shall apply.

If the Contractor fails to pay the amount of Damages within the said period of 7 (seven) days of its demand, the Authority shall be entitled to recover the said amount of the liquidated damages by invoking the Performance Guarantee. If the then Contract Performance Guarantee is for an amount which is less than the amount of the liquidated damages payable by the Contractor to the Authority under this Clause 90.4, the Contractor shall be liable to forthwith pay the balance amount. For avoidance of doubt it is clarified that this clause will survive the termination or expiry of the Contract.

2.7 SCOPE OF MAINTENANCE-GENERAL

- a. The general scope of work includes operations, monitoring team and maintenance related works. The manpower deployments considered are to carry out equipment operations & maintenance works and attend to breakdowns as and when required. Also the maintenance schedules shall be prepared by Contractor and site based team shall carry out the equipment related works as per schedules & instructions.
- b. The basic tools required for maintenance, access ladders including special tools & tackles, measuring instruments, access ladders beyond 6 feet, scissor lift / boom lift for high access...etc and PPE's are included in the scope of Contractor and this is included as part of operation cost.
- c. All necessary log books, computers, office space, tables, chairs, registers & stationeries for report generation shall be arranged and provided by Contractor
- d. High access ladders (above 10 feet), scaffolding, boom lift / scissor lift etc shall be provided by Contractor as and when required.
- e. Storage space / Cupboards shall be provided by Contractor for keeping the tools and tackles and other instruments.
- f. All equipment spares shall be provided by Contractor and has to monitor the spares & if stock of spares is less, the same should be arranged and provided by the contractor.
- g. Contractor has to ensure the Tools & PPE's quantity as much as sufficient for the

trouble free service.

- h. In case of any defect in materials, workmanship or structural defects (strength and serviceability) of any element or the building, the Contractor shall make good, rectify or replace the element/structure at no extra cost to GSCL. Contractor should ensure warranty and support for all equipment from OEMs/ Suppliers during the contract period. Any cost for extension of warranty if required, shall be borne by the Contractor and GSCL shall make no extra payment for this.
- i. Maintenance person should be qualified (B.E / Diploma / ITI) and experience in the related field. Persons deployed should be approved / confirmed by Authority, if persons deployed are found unsatisfied by Authority after necessary communication to Contractor, they have to replace the person immediately.
- j. Any increase on the manpower employed shall be communicated by Authority in writing.
- k. Helper person should be (8th /10th STD) having relevant experience in the field (Persons deployed should be approved / confirmed by Authority, if persons deployed are found unsatisfied by Authority after necessary communication to Contractor, they have to replace the person immediately.
- l. Contractor has to prepare / follow standard operating sheet / operation control procedure for all Maintenance work – should get approval from Authority.
- m. All the personnel should undergo regular training for the operation and maintenance of the plant & safety measure. The same shall be arranged and ensured by Contractor.
- n. Contractor has to submit manpower detail and shift wise details & get approval from Authority.
- o. Contractor has to supply sufficient manpower after considering weekly off's and statutory leaves in a month.
- p. Electrical supervisor should have valid license –C license & electrical technician should have a valid B license.
- q. Housekeeping in a good manner at maintenance work spot and in the event of waste Generated from maintenance activity, same shall be collected properly and sent to storage location by Contractor employees as per hazardous & non hazardous waste segregation process and as instructed by the Authority.
- r. All safety measures to be taken care during operation & maintenance of the plant. (In case any safety deviation Authority can enforce % of penalty or Contractor has to replace the person violated safety)
- s. Contractor should maintain all necessary documentation and records such as log book / sheets, inventory registers, daily report, weekly report, monthly report, performance reports all such other related documentation as per Authority requirement.
- t. Contractor should maintain accounts for receipts, consumption and inventory of all consumables & spares as per the consumption pattern.
- u. Contractor should prepare / adhere to the Authority maintenance schedule for mechanical, electrical & instrumentation should be approved by Authority.
- v. Carrying out routine, preventive and break down maintenance in mechanical, electrical and instruments category and record to be maintained and submitted to Authority periodically.
- w. Before taking up major maintenance, Contractor should inform and obtain

permission from Authority and proper approval shall be obtained and further approvals in the form of Electrical clearance / LOTO procedures shall be adopted.

- x. Spares shall be procured and supplied by Contractor as per requirement.
- y. The damaged / repaired equipments (Mechanical / Electrical / Instrument equipment/exhibits or its parts) which are coming under warranty & guarantee, the Contractor has to co – ordinate with supplier and get it replaced / serviced at free of cost from the equipment manufacture / supplier.
- z. Contractor should periodically check equipment, lubrication, adjustments etc. to ensure proper performance as per Project Manager check sheet.
- aa. Contractor has to follow getting safety & security permit from Authority safety for necessary job.
- bb. Contractor should ensure that the Maintenance activities are conducted without affecting the daily operations of the building.
- cc. Environmental best practices to be followed as required by the Authority. Best environmental practice like Energy conservation, advance methodology in Pollution prevention etc., will be given appreciation to the Contractor.
- dd. All Engineering spares, consumables like bulbs, fuses, contactors, chemicals, other materials etc, shall be provided by Contractor.
- ee. Cost of food for personnel deployed by Contractor has to be arranged and provided by the Contractor. Providing drinking water and tea for Contractor employees shall be in the account of Contractor.
- ff. All costs related to testing of equipment as per statutory requirements and obtaining statutory clearances etc. shall be in the scope of Contractor.
- gg. Prompt repair of leaking joints in plumbing works
- hh. Ensure any ingress of moisture or seepages in roof or through walls is addressed with a permanent solution
- ii. Keep the equipment maintenance staff to follow the manufacturer's recommended maintenance schedule and keep a proper record of the same, ensure all manufacturers' warranties are kept secure
- jj. All Equipment & vehicle insurances of equipment both movable & immovable against various kind of damage are always maintained
- kk. All staff have covered under group medical insurance of at least Rs 1 lakh as well as life insurance covers are maintained
- ll. Train staff and carry out regular fire drills to take care of any emergency
- mm. Dispose off old and unusable materials so as not to block the space within the premises, in case the contractors wishes to use them for repairs, etc the same should be kept by him in a separate storage and details of any material sent disposed off / stored having a value more than Rs 10,000/- be recorded in a register / recorded electronically
- nn. The Contractor has to train the staff of the Authority before he hands over the facility to the Authority on completion of the O&M contract duration
- oo. The Contractor shall also hand over all the documents regarding maintenance schedule, A Consolidated O&M manual of the complete facility along the inventory of the spares (at least for next 2 years) to the Authority officials

2.8 Manpower estimation for Maintenance Period

Area	Number of Persons	Responsibility	Authority ship
Operation & Maintenance Manager	1	Overall in-charge of Operation and management of the ICCC building campus	Contractor
Housekeeping and upkeep Management	8	Housekeeping, cleaning, garbage disposal etc.	Contractor
Technicians/ Supervisors/Operators for IBMS systems/BMS Expert	1	Overall in charge of all Electrical & BMS Systems & PA system	Contractor
Operator for all Mechanical systems – Pumps, Chillers, Cooling towers, etc.	1	Overall in charge of all Mechanical Systems	Contractor
Technicians/ Supervisors/Operator/ Electrician for Electrcrical, etc.	1	For all MEP systems in the building	Contractor
Plumber	1	All Internal & External Water supply works	Contractor
Total	13		

2.9 Landscape Manpower Estimation for maintenance period:

Area	Number of Persons	Responsibility	Duration	Authoritys hip
Gardener	1	Planting, weeding, watering, fertilizing, pest control and supervision	6 days per week	Contractor
Total	1			

Note: Manpower refers to Indicative Minimum Manpower required to be deployed by Contractor

3.0 SCHEDULE 2 – PART-C SITE INFORMATION

1.0	Authority	Guwahati Smart City Development Limited
2.0	Project Title	Design, Construction, Testing, Commissioning, Facility Management and Operation & Maintenance for 5 years for Integrated Command & Control Centre at at Panjabari, Guwahati.
3.0	Location	ICCC Guwahati – Near Vopanan Kendra, Panjabari, Guwahati
4.0	Nearest Air Port	Guwahati Airport
5.0	Nearest Railway Station	Guwahati Railway Station
6.0	Temperature	
a)	Average Maximum Temperature	35°C
b)	Average Minimum Temperature	10°C
7.0	Seismic Data	
a)	Earthquake Zone	Zone V as per IS 1893 – 2016.

SCHEDULE B – TECHNICAL SPECIFICATIONS

ARCHITECTURAL WORKS – TECHNICAL SPECIFICATION

1.0 ARCHITECTURAL DESIGN CONCEPT – PART A

1.1 STATUTORY REQUIREMENT & GUIDELINES

The proposed building shall be designed and constructed strictly as per General Development Control Regulations, applicable for Guwahati. For Fire and Safety requirement the **National Building Code 2016** (NBC) shall be followed.

Site Area (as per parcel of plot considered for designing)	534.6 sq.m.
Proposed Ground Coverage @50%	255.5 sq.m.
Proposed FAR	1131.5sq.m.
Proposed FAR	2.1

Some assumptions are being followed, it is assumed that the land parcel is assumed as "Public-Institutional".

1.2 SITE PLANNING

The Plot of land identified for the ICCC building is part of a larger plot of land on which the Collector Office building is also located. The part of the site identified for locating the ICCC building is fairly rectangular in shape, the entire plot abuts 6.6 mt road and entry to the plot is also from this road. It is a fairly leveled land, but undulations exist on part of the plot. As per the requirement the ground floor is advised to be reserved for parking and for locating some of the utilities. Minimum 3.5m wide drive way has been kept all around the building for easy movement of vehicles. The entry and exit for cars to be planned through same gate located at the center of the plot. The gate to be provided with security gate posts for control and monitoring of both vehicular and pedestrian movement. The main entry to the building should preferably be from the side which allows ease of movement within and to the outside of the plot. Dedicated open spaces have to be kept for plantation for site beautification.

Provision for DG set to be suitably arranged at outside open space without creating any hindrance to the driveway.

1.2.1 Consolidated Built-Up Area Statement:

	DESCRIPTION	AREA	TOTAL BUILT UP AREA (SQMT)	FUNCTIONS
1	GROUND FLOOR PLAN	235.53	235.53	Entry Lobby, Stilt area for services & parking Toilets,

				Staircase, Space for Services
2	FIRST FLOOR PLAN	235.53	235.53	Reception Lobby, Director room, Space for PA, Manager Room, Work stations, conference rooms, Toilets, Staircase, Space for Services
3	SECOND FLOOR PLAN	235.53	235.53	Conference room, UPS/ Elect. Room, Canteen, Toilets, Staircase, Space for Services
4	THIRD FLOOR PLAN	235.53	235.53	Network room, Data Centre, Toilets, Staircase, Space for Services
5	FOURTH FLOOR PLAN	244.85	244.85	Command Control Centre (for 30 people) Conference room, Staircase, Space for Services
	GRAND TOTAL	1186.97	1186.97	

BUA of utility structures, if any, e.g. U.G. Tank, Pump room, Security cabin, etc are not separately counted, their cost shall be built in, into the above BUAs.

1.2.2 Facilities at Ground floor:

The ground floor of the building shall be used as car/ two- wheeler parking space and Utility space. Few car parks have been identified in this plot. For each car 2.5m x 5.5 space is earmarked. The parking spaces have been so arranged that the each individual parking space can be easily accessible through clear drive way. The employees can park their vehicles and access the staircase and lift lobby to reach the upper floors. Beside the parking space ground floor shall also be housing miscellaneous utilities, like electrical room, pump room and other utilities, as will be required. Staircase and lift shall be provided with access to each of the floors & pump room. Capacity of all the lifts should comply with National Building Code (NBC) 2016. All the floors are accessed by staircase, as per NBC norms. Space on the plot also provided for locating the U.G. water storage tanks and D.G. sets.

1.2.3 Facilities at First Floor:

The first floor shall house the following:

Cabins for director, along with other required cabins for their separate personal Assistants shall be provided. There will be a good space to provide for seating for Staff. The entrance lobby should be spacious enough to accommodate the inflow and out flow of the occupants during the office hours. Lift and staircase access shall be through the entrance lobby The rooms

catering to essential utilities like Electrical room, AHU room, Pantry and toilets are located in a service core area.

1.2.3 Facilities at Second Floor:

It is proposed that the Second floor shall predominantly be used as a Service floor, housing the following services:

Shafts for HVAC, Electrical cum UPS room, etc. One room is proposed for meeting room. A small cafeteria shall also be proposed here. Other common utilities like toilet etc. are also located on this floor.

1.2.4 Facilities at Third Floor:

It is proposed that the Third floor shall also be predominantly used as a Service floor, housing the following services:

Shafts for HVAC, AHU Room, Network room & Data Centre etc shall be provided on this floor. Other common utilities like toilet etc. are also located on this floor.

1.2.5 Facilities at Fourth Floor:

The fourth floor would be having the important City Operation Room, with the video wall and the representatives of various city functions manning the monitors which would be accessing data. This would normally be a double heighted space and the representatives would be seated on stepped platforms for better visibility of the screen.

A glass fronted conference room/ war room would be located behind the representatives, where the City's important officers/ administrators would be putting their heads together for solutions to the emerging crisis. There would also be a Lounge adjacent to the War room.

Common utilities like Pantry and toilets are also located on this floor.

1.3 BUILDING EXTERIOR AND FACADE:

This building is going to be an important public building of the proposed smart city, hence need to have an identifiable and approachable appearance, for the general public. The facade treatment should satisfy the functional requirement of the inside spaces as well as the aesthetic need. The use of material and design of the building should reflect stark modernism with a subtle blend of heritage. Being an office building structural glazing, aluminium composite panel (ACP), Aluminium louvers etc may be used on facade. The service and utility lines should be suitably camouflaged within building elements. Use of glass should be so planned that the heat gain from sun light is minimized.

1.4 SAFETY REQUIREMENTS:

The building shall be designed and provided with all safety features as recommended by NBC. Staircase proposed shall be enclosed within two hours fire rated walls. Fire rated doors with panic exit device shall be provided at each floor level to access the staircase. Both the staircases shall have doors at the ground floor to give access to an open space at ground level. A dedicated space at ground level shall be earmarked as the refuge area for emergency situation. The entrance gates to site and driveways shall be so designed that the movement of the fire tenders are not hindered at any case. Use of external glazing work, if any, should also satisfy the standard safety norms. All gaps between structural glazing and floor slab or beam or any other floor opening through which fire can spread to upward direction shall be suitably sealed with compatible material. All vertical shafts shall also be sealed at every floor level by means of steel plate, suitable fire-resistant mortar or foam concrete application.

1.5 BUILDING MAINTENANCE:

The building shall be provided with all necessary fittings and fixtures for cleaning and maintenance. Roof or parapet mounted "I" bolts shall be provided along the periphery of the building so that any point of the facade can be accessed or maintained by "Spider man" method. Each duct should be accessible from the floor level for maintenance. Separate store

room shall be provided to keep all the tools and tackles required for maintenance work. All the utilities shall be so designed that the same shall be easy to maintain.

1.6 TOILETS & PANTRY:

All toilets shall be provided with adequate number of fixtures like wash basin, WC , etc. Number of toilet fixtures shall be provided considering the occupancy load of each floor satisfying the guideline provided by NBC. All wash basins to be provided with sensor operated taps to avoid wastage of water. Basins shall be "under counter top" type, mounted on counter finished with granite. Each basin shall be fitted with all necessary fittings and fixtures like bottle trap, stop cock, pvc connector pipe etc. For fixing mirror in toilets specialized mirror mounting tape shall be used. One SS towel ring and SS soap dispenser to be provided for each basin.

Being an office building all the urinals shall be provided with sensor operated flushing system. For water closets dual mode water saving flush valves shall be provided in place of conventional cistern. All water closets shall be wall mounting type and necessary ledge walls to be kept for fixing the same.

Cafeteria shall be equipped with SS sink (with drain board) in cooking counter finished with black granite. Provision for placing Tea- coffee vending machine, Water dispenser, microwave oven, refrigerator, dish washer shall be kept. Adequate number of below counter floor cabinets and wall cabinets shall be provided with all necessary modular type SS wire baskets, cutlery tray, bottle pull out etc, for keeping utensils

All the vertical pipes for toilet should run through one single duct or enclosure with adequate internal space for maintenance. The pipe duct should have door access from each floor for inspection and maintenance. All wet areas like toilet, pantry etc shall have elastomeric membrane type waterproofing treatment on floor slab (and up to 450mm on dado walls) prior to application of flooring. Special care shall be taken on slab openings where floor traps or other pipe connectors are fixed.

1.7 STAIRCASES:

The design of staircase should satisfy the guideline provided in NBC. The staircase shall be provided with SS hand railing (SS-304 grade) on the free end. On wall side one SS pipe grab rail shall be provided along the staircase flight and landing areas. External window to come at each landing level for keeping the staircase lit with natural light in day time. For all fire doors provided with panic bars, at staircase locations, external trim to be provided to keep the provision of opening the doors from the staircase side. All such doors shall be provided with fire rated aluminium alloy hydraulic door closure so that in no case the door remains open. Skid resistant safety strips to be fixed at each tread of staircase to avoid accident due to slippage.

1.8 CEILING TREATMENT:

As all the floors shall be air conditioned there is a need to reduce the AC load by providing false ceiling. Being an office building there shall be a number of ceiling mounted utility lines like AC ducts, fire hydrant and sprinkler pipes, electrical conduits etc. The purpose of providing false ceiling will be to cover these utility lines with an easy provision for maintenance of the same. Hence removable panel type false ceiling of Hunter Douglas or approved equivalent shall be provided in all the AC areas. Lighting fixtures shall be ceiling mounted recessed type. Design of False ceiling shall be aesthetically pleasing.

1.9 INTERNAL PARTITIONS:

For larger rooms or compartments full height brick walls shall be provided as per functional requirement. For cabins, meeting rooms, conference rooms partitions in between rooms shall be provided with gypsum board wall. The external or front walls for those rooms shall be provided with seamless transparent toughened glass panels fitted with SS patch fittings. All such glass walls shall be finished with translucent (patterned) glass film of 3M or approved equivalent. Full-glass doors shall be fitted with floor spring (with hold open facility), SS "D" handle and patch lock. In City Operation Centre the interior surfaces of all walls shall be provided with acoustic treatment with suitable material as per specific requirement.

1.10 FURNITURE:

Each room shall be furnished with state of the art modular furniture of reputed brand as per the functional requirement.

Workstation shall be made of pre laminated particle board top with powder coated metal support structure. Modesty partition shall be made of powder coated aluminium framing and modular aluminium panels. The hollow space inside modesty partition shall provide suitable wire management provision for both data and power. Privacy panel shall be provided with coloured lacquered glass. Pedestal unit with three numbers drawers and cushion on top shall come with each workstation.

For conference room, meeting room etc modular conference tables shall be provided with provision for adequate number of power and data point for fixing laptops and other related accessories required for modern day conferencing.

All chairs shall be ergonomically designed. Back rest shall be made of mesh type fabric. Seats shall have fabric finish with CM foam and arm rests shall be with polypropylene. Base shall be "5- star" type in black nylon.

All chairs shall have adjustment facilities for height, back rest, lumbar support, tilting, hand rest support etc.

1.11 MISCELLANEOUS FINISHES :

	S.NO	AREA	FLOORING	SKIRTING/ THRESHOLD/ CILL STONE	WALLS	CEILING	DOORS WINDOWS AND VENTILATION	RAILING
GROUND FLOOR	1	PARKING AREA	HARD FLOOR	HARD FLOOR	PLASTIC EMULSION PAINT, TEXTURE PAINT ON EXTERIOR WALLS	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	FLUSH DOOR, ROLLING SHUTTER	-
	2	LIFT LOBBY	VITRIFIED TILE	VITRIFIED TILE	PLASTIC EMULSION PAINT	MINERAL FIBRE GRID CEILING	ALUMINUM TOUGHENED GLAZED DOOR	
	3	TOILET	ANTI SKID VITRIFIED TILE	CERAMIC TILES	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER AND CERAMIC DADO UPTO 2100MM HIGH. POLISHED GRANITE ON COUNTER TOP & FASCIA AND LEDGE WALL	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	FRP DOOR VENTILATOR- ALUMINUM FRAME WITH 6.0 mm THICK TOUGHENED GLASS	
	4	SERVICE ROOM	KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	METAL FIRE RATED DOOR WINDOW- ALUMINUM WINDOW WITH 6MM HIGH PERFORMANCE TOUGHENED GLASS	
	5	STAIRCASE	TREAD - KOTA RISER - KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	2HR FIRE RATED DOOR	SS RAILING
FIRST FLOOR	1	RECEPTION	VITRIFIED TILE	VITRIFIED TILE	PLASTIC EMULSION PAINT	MINERAL FIBRE GRID CEILING/ GYPSUM CEILING	ALUMINUM TOUGHENED GLAZED DOOR, FLUSH DOOR	
	2	MEETING ROOM	VITRIFIED TILE	VITRIFIED TILE	PLASTIC EMULSION PAINT	MINERAL FIBRE GRID CEILING/ GYPSUM CEILING	12MM FRAMELESS GLASS DOOR	
	3	CONFERENCE ROOM	VITRIFIED TILE	VITRIFIED TILE	PLASTIC EMULSION PAINT	MINERAL FIBRE GRID CEILING/ GYPSUM CEILING	12MM FRAMELESS GLASS DOOR	
	4	PA ROOM	VITRIFIED TILE	VITRIFIED TILE	PLASTIC EMULSION PAINT	MINERAL FIBRE GRID CEILING/ GYPSUM CEILING	N/A	
	5	DERECTOR'S ROOM	VITRIFIED TILE	VITRIFIED TILE	PLASTIC EMULSION PAINT	MINERAL FIBRE GRID CEILING/ GYPSUM CEILING	12MM FRAMELESS GLASS DOOR	
	6	MANAGER ROOM	VITRIFIED TILE	VITRIFIED TILE	PLASTIC EMULSION PAINT	MINERAL FIBRE GRID CEILING/ GYPSUM CEILING	12MM FRAMELESS GLASS DOOR	
	7	LIFT LOBBY	VITRIFIED TILE	VITRIFIED TILE	PLASTIC EMULSION PAINT	MINERAL FIBRE GRID CEILING	ALUMINUM TOUGHENED GLAZED DOOR	
	8	LOBBY	VITRIFIED TILE	VITRIFIED TILE	PLASTIC EMULSION PAINT	MINERAL FIBRE GRID CEILING	ALUMINUM TOUGHENED GLAZED DOOR, FLUSH DOOR	
	9	TOILET	ANTI SKID VITRIFIED TILE	CERAMIC TILES	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER AND CERAMIC DADO UPTO 2100MM HIGH. POLISHED GRANITE ON COUNTER TOP & FASCIA AND LEDGE WALL	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	FRP DOOR VENTILATOR- ALUMINUM FRAME WITH 6.0 mm THICK TOUGHENED GLASS	
	10	ELECTRICAL ROOM	KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	2HR FIRE RATED DOOR WINDOW- ALUMINUM WINDOW WITH 6MM HIGH PERFORMANCE TOUGHENED GLASS	
	11	HUB ROOM	KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	FLUSH DOOR WINDOW- ALUMINUM WINDOW WITH 6MM HIGH PERFORMANCE TOUGHENED GLASS	
	12	BMS	KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	2HR FIRE RATED DOOR WINDOW- ALUMINUM WINDOW WITH 6MM HIGH PERFORMANCE TOUGHENED GLASS	
	13	RECORD ROOM	KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	FLUSH DOOR	
	14	STAIRCASE	TREAD - KOTA RISER - KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	2HR FIRE RATED DOOR	SS RAILING
SECOND FLOOR	1	CANTEEN	VITRIFIED TILE	VITRIFIED TILE	PLASTIC EMULSION PAINT	MINERAL FIBRE GRID CEILING/ GYPSUM CEILING	12MM FRAMELESS GLASS DOOR	
	2	CONFERENCE ROOM	VITRIFIED TILE	VITRIFIED TILE	PLASTIC EMULSION PAINT	MINERAL FIBRE GRID CEILING/ GYPSUM CEILING	12MM FRAMELESS GLASS DOOR	
	3	LOBBY	VITRIFIED TILE	VITRIFIED TILE	PLASTIC EMULSION PAINT	MINERAL FIBRE GRID CEILING	ALUMINUM TOUGHENED GLAZED DOOR	
	4	LIFT LOBBY	VITRIFIED TILE	VITRIFIED TILE	PLASTIC EMULSION PAINT	MINERAL FIBRE GRID CEILING	ALUMINUM TOUGHENED GLAZED DOOR, FLUSH DOOR	
	5	TOILET	ANTI SKID VITRIFIED TILE	CERAMIC TILES	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER AND CERAMIC DADO UPTO 2100MM HIGH. POLISHED GRANITE ON COUNTER TOP & FASCIA AND LEDGE WALL	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	FRP DOOR VENTILATOR- ALUMINUM FRAME WITH 6.0 mm THICK TOUGHENED GLASS	
	7	ELECTRICAL ROOM	KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	2HR FIRE RATED DOOR WINDOW- ALUMINUM WINDOW WITH 6MM HIGH PERFORMANCE TOUGHENED GLASS	
	8	HUB ROOM	KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	FLUSH DOOR WINDOW- ALUMINUM WINDOW WITH 6MM HIGH PERFORMANCE TOUGHENED GLASS	
	9	UPS/ELEC. ROOM	KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	2HR FIRE RATED DOOR WINDOW- ALUMINUM WINDOW WITH 6MM HIGH PERFORMANCE TOUGHENED GLASS	
	14	STAIRCASE	TREAD - KOTA RISER - KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	METAL FIRE RATED DOOR	SS RAILING
THIRD FLOOR	1	LOBBY	VITRIFIED TILE	VITRIFIED TILE	PLASTIC EMULSION PAINT	MINERAL FIBRE GRID CEILING	ALUMINUM TOUGHENED GLAZED DOOR	
	2	LIFT LOBBY	VITRIFIED TILE	VITRIFIED TILE	PLASTIC EMULSION PAINT	MINERAL FIBRE GRID CEILING	ALUMINUM TOUGHENED GLAZED DOOR	
	3	TOILET	ANTI SKID VITRIFIED TILE	CERAMIC TILES	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER AND CERAMIC DADO UPTO 2200MM HIGH. POLISHED GRANITE ON COUNTER TOP & FASCIA AND LEDGE WALL	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	FLUSH DOOR VENTILATOR- ALUMINUM FRAME WITH 6.0 mm THICK TOUGHENED GLASS	
	4	ELECTRICAL ROOM	KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	2HR FIRE RATED DOOR WINDOW- ALUMINUM WINDOW WITH 6MM HIGH PERFORMANCE TOUGHENED GLASS	
	5	HUB ROOM	KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	FLUSH DOOR WINDOW- ALUMINUM WINDOW WITH 6MM HIGH PERFORMANCE TOUGHENED GLASS	
	6	AHU ROOM	KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	2HR FIRE RATED DOOR WINDOW- ALUMINUM WINDOW WITH 6MM HIGH PERFORMANCE TOUGHENED GLASS	
	7	NETWORK ROOM	KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	FLUSH DOOR WINDOW- ALUMINUM WINDOW WITH 6MM HIGH PERFORMANCE TOUGHENED GLASS	
	8	DATA CENTER	KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	FLUSH DOOR WINDOW- ALUMINUM WINDOW WITH 6MM HIGH PERFORMANCE TOUGHENED GLASS	
	9	STAIRCASE	TREAD - KOTA RISER - KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	2HR FIRE RATED DOOR	SS RAILING
FOURTH FLOOR	1	LOBBY	VITRIFIED TILE	VITRIFIED TILE	PLASTIC EMULSION PAINT	MINERAL FIBRE GRID CEILING	ALUMINUM TOUGHENED GLAZED DOOR	
	2	LIFT LOBBY	VITRIFIED TILE	VITRIFIED TILE	PLASTIC EMULSION PAINT	MINERAL FIBRE GRID CEILING	ALUMINUM TOUGHENED GLAZED DOOR	
	3	TOILET	ANTI SKID VITRIFIED TILE	CERAMIC TILES	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER AND CERAMIC DADO UPTO 2200MM HIGH. POLISHED GRANITE ON COUNTER TOP & FASCIA AND LEDGE WALL	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	FLUSH DOOR VENTILATOR- ALUMINUM FRAME WITH 6.0 mm THICK TOUGHENED GLASS	
	4	ELECTRICAL ROOM	KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	2HR FIRE RATED DOOR WINDOW- ALUMINUM WINDOW WITH 6MM HIGH PERFORMANCE TOUGHENED GLASS	
	5	CONFERENCE ROOM	WOODEN FLOORING	WOODEN	ACOUSTICAL GYPSUM BOARD PANEL	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	FLUSH DOOR WINDOW- ALUMINUM WINDOW WITH 6MM HIGH PERFORMANCE TOUGHENED GLASS	
	6	COMMAND CONTROL CENTER	VINYL FLOORING	VINYL	ACOUSTICAL GYPSUM BOARD PANEL	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	2HR FIRE RATED DOOR WINDOW- ALUMINUM WINDOW WITH 6MM HIGH PERFORMANCE TOUGHENED GLASS	
	7	STAIRCASE	TREAD - KOTA RISER - KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	2HR FIRE RATED DOOR	SS RAILING
TERRACE	56	MUMPTY	KOTA	KOTA	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	DISTEMPERING WITH 1st QUALITY ACRYLIC DISTEMPER	2HR FIRE RATED DOOR	
	57	TERRACE AREA	HEAT RESISTANT TILES				NA	
EXTERIOR FINISH	58	EXTERNAL WALL	TEXTURE EXTERIOR PAINT/ ACP CLADDING					

EXTERNAL FINISHES:



1.12 GREEN BUILDING

A green building is an environment friendly building. Hence Command Control Centre can be planned as Green Building following IGBC rules and regulation. A gold rating can be targeted for this building.

1.13 IMPLEMENTATION PLAN

The activities can be carried out in following order

- Architectural design – Alternative proposals
- Approval of Architectural design
- Civil, MEP, Building security and surveillance design based on approved Architectural design
- Excavation
- Procurement of Construction material for foundation
Construction of foundation
- Construction of skeletal structure for superstructure
- Construction of building envelope at superstructure
- Installation of routing for Electrical, plumbing, Sanitary, HVAC, Fire fighting and other utilities and building automation system.
- Implementation of finishing materials
- Fittings and fixture for Electrical, plumbing, Sanitary, HVAC, fire detection and protection system, Building security and Surveillance system etc
- Finishing of parking under the building
- Construction of Security Post and automated Gate Installation
- Peripheral Building services around the building
- Development of Campus with landscape, illuminations, pathways, driveways etc.

1.14 SIGNAGE

External and internal signage as per norms, of suitable size and material shall be provided at appropriate locations.

ARCHITECTURAL TECHNICAL SPECIFICATIONS – PART B

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PART 01 : FLOORING AND ALLIED WORKS

1.0 SCOPE

These specifications cover flooring, skirting, dado or cladding works using different types of stone / slabs / tiles as detailed hereunder.

2.0 GENERAL & CODES

The provision of the latest revisions of the following IS Codes shall form a part of this specification to the extent they are relevant.

IS 269	Specification for ordinary, rapid hardening and low heat Portland cement.
IS 383	Specification for coarse and fine aggregate from natural sources for concrete
IS 777	Specification for glazed earthenware tiles
IS 1200 Part XI	Method of measurements for Building and Civil Engg. Works, paving, floor finishes, dado & skirting.
IS 1237	Specification for cement concrete flooring tiles
IS 1443	Code of practice for laying and finishing of cement concrete flooring tiles.
IS 2541	Code of practice for use of lime concrete in buildings
IS 2571	Code of practice of laying in situ cement concrete flooring
IS 10067	Material Constants in Building work

Other IS Codes not specifically mentioned here, but pertaining to floor finishes form part of these specifications.

2.1 Sustainability

- 2.1.1 It is recommended that the tiles shall have at least 15% recycled content by cost.
- 2.1.2 The tiles / stones used shall be procured from the manufacturing plants / quarries located within 400 Km from the project site.

2.2 Finishes for stones

Following are the different finishes for stone surfaces. All other specifications shall remain same, irrespective of the finish unless specifically indicated.

- 2.2.1 **Sawn:** A finish is not applied to the stone; the appearance of the surface is a result of blade or wire used to cut it. A sawn finish will produce a flat but raw stone. Primarily used on curbing.
- 2.2.2 **Honed:** A honed finish is smooth and shows the full color of the stone without reflection. This is the same procedure used to polish, but the honing process ends before the buffing stage.
- 2.2.3 **Polished:** Polished granite is highly reflective and all of the color, depth, and crystal structure is brought out. By polishing granite, the surface pores become sealed, making the stone nearly impervious to weather and chemical wear.
- 2.2.4 **Machine Tooled – (4-cut/6-cut/8-cut):** This bush-hammered finish consists of parallel, concave grooves in the stone. A heavy duty, surface pneumatic tool

produces 4, 6, and 8 bats (grooves) to the inch. The depth of the groove varies with the number of bats used but will range from 1/32" to 1/16" deep and from 3/32" to 7/32" apart.

- 2.2.5 Thermal/Flamed: This finish is achieved by applying a high temperature flame and cool water to the surface of the stone simultaneously. The flame fractures the crystals on the face while the water prevents splitting, leaving a rough-textured finish. The thermal finish is commonly used on exterior paving applications since it is highly slip resistant.
- 2.2.6 Sandblasted – (Fine – Coarse Stippled): Powered by compressed air, the sandblast machine forces 20, 40, or 60 grade sand directly onto the stone. This leaves a fine to coarse planed surface on the stone.
- 2.2.7 Split Face: A rugged, uneven, concave-convex finish that reveals reflections from the crystal is produced by the splitting action of a guillotine. Detail character ranges from low to high for fine grain through coarse grain stones, respectively. The stones are split to the specified wall thickness but will have a random tolerance.
- 2.2.8 Rock Face: Done by hand with a chipping tool, rock face stone is chipped around the perimeter to produce a bold, convex projection along its face. This finish creates a more massive appearance than split face. Detail character ranges from low to high for fine grain through coarse grain stones, respectively.
- 2.2.9 Pointed: A rough and uneven surface resulting from splitting, pointing and/or rough cutting the granite.
- 2.2.10 Diamond 4/6/8 – Water Jet: Because thermal and honed finishes do not maximize the color of the stone, a diamond finish can be applied to enhance it. The diamond finish is achieved by water jetting stone with 4, 6, or 8 heads by either hand or machine.
- 2.2.11 Sculptured: Expert stonecutters hand-carve any type of stone similar to the traditional Roman methods.

3.0 INDIAN PATENT STONE FLOORING

3.1 MATERIALS

Cement concrete. The cement concrete shall generally conform to specifications for ordinary concrete. The coarse aggregates shall be carefully selected. Sufficiently tough and hard stone pieces broken in a manner that will provide particles of approximately cubical shape affording good interlocking. The maximum size of coarse aggregate shall be 12 mm. The fine aggregate shall consist of properly graded particles. The proportion of mix shall be M20 (1:1.5:3). The least amount of mixing water that will produce a workable mix and will allow finishing without excessive troweling shall be used. Generally a water cement ratio of 0.5 should suffice.

3.2 WORKMANSHIP

- 3.2.1 The sub-grade in all cases shall be formed to proper levels and slopes, well compacted and cured. The top surface shall be kept slightly rough.
- 3.2.2 The surface of the sub-grade shall be cleaned off all loose material and moistened immediately before laying the concrete floor. The concrete flooring shall be laid in alternate bays not exceeding 6.25 sq.m. (about 67 sf.ft.) each. The edge of each panel into which the floor is divided should be separated by flat bars of Glass. Their depth shall be the same as that proposed for the finished floor as mentioned in the item.

- 3.2.3 The concrete shall be laid immediately after mixing. While being placed the concrete shall be vigorously sliced and spaded with suitable tools to prevent formation of voids or honey comb pockets. The concrete shall be brought to the specified levels by means of a heavy straight edge resting in the side forms and drawn ahead with a sawing motion in combination with a series of lifts and drops alternating with small lateral shifts. While concreting the adjacent bays care shall be taken to ensure that the edges of previously laid bays are not broken by careless or hard tamping.
- 3.2.4 Immediately after laying the concrete, the surface shall be inspected for high or low spots and any needed correction made up by adding or removing the concrete. After striking off the surfaces to the required grade concrete shall be compacted with a wooden float. The blows shall be fairly heavy in the beginning but as consolidation takes place, light rapid strokes shall be given to complete the ramming. The floating shall be followed by steel trowel after the concrete has hardened sufficiently to prevent excess of fine material from working to the surface. The finish shall be brought to a smooth and even surface free from defect and blemishes and tested with straight edges. No dry cement or mixture of dry cement and sand shall be sprinkled directly on the surface of the concrete to absorb moisture or to stiffen the mix. After the concrete has been rammed and has dried sufficiently, the surface shall be rendered with a thin coat of 1:1 cement mortar with fine sand and uniformly floated. If so directed by the ER/PMC, approved mineral colour pigment conforming to appendix-B of IS 657 shall be added to the cement mortar to give the required colour and shade to the flooring. The junctions of floor and walls shall be rounded off if so directed, without any extra payment.

3.3 FINISHING

- 3.3.1 When the rendering is somewhat stiff, neat cement may be sprinkled sparingly through a paper pot on the surface and rubbed lightly to give smooth polished ordinary cement coloured surface.
- 3.3.2 If coloured flooring is required by the PMC the approved coloured cement shall be used. Surface shall be protected from direct sun when it is green.

3.4 CURING

Curing shall start on the next day after finishing and shall be continued for 14 days.

4.0 MARBLE STONE SLAB/GRANITE STONE SLAB FLOORING

4.1 MATERIAL

- 4.1.1 Machine cut marble stone / granite stone slabs shall be of 18 - 20 MM thickness Size, Colour & Pattern as specified in the items description & Approved Sample. Colour shall be uniform and the slabs free from all defects. Tiles used at site shall be machine-cut.
- 4.1.2 In machine-cut tiles, edges shall be protected from any damage in transit. No breakage shall be permitted. All edges shall be sharp, perfectly rectangular. Edges shall be polished for exposed corners faces as per the drawing and specifications.
- 4.1.3 At its thinnest part, no stone shall be thinner than 18 mm. The flagstones shall be hard, sound, durable and wear resistant. Uniformity of size shall generally be maintained for the flags used in any one room. The stones flags shall be without any soft veins cracks or flaws and shall have a uniform colour. They shall have even natural surfaces free from broken flakes on top and shall be true and square to ensure uniform width of joint.

- 4.1.4 Samples of stone slabs to be used shall be got approved by the PMC and the slabs to be used shall conform to the approved sample.

4.2 BEDDING

- 4.2.1 Bedding shall be of cement-sand-mortar mix in a ratio of 1:4. The base of cement or lime concrete shall be laid and compacted to a reasonable true plain surface and to the required slopes and level.
- 4.2.2 The amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and satisfactory bedding.
- 4.2.3 Before spreading mortar, the sub-floor or base shall be cleaned off all dirt, scum or laitance and of loose material and then well wetted without forming any pools of water on the surface. In case of RCC floors, the top shall be left a little rough. The mortar shall then be evenly and smoothly spread over so much area will be covered with slabs then be evenly and smoothly spread over so much area as will be covered within slabs within half an hour.
- 4.2.4 The thickness of the mortar bedding shall be provided as required as per the site condition, on an average 20mm, but in no case shall be less than 12 mm.

4.3 LAYING

- 4.3.1 Laying of marble / granite stone slab flooring shall be as follows
Before laying, the stone slab shall be thoroughly wetted with clean water. Neat cement grout (pigmented to match the shade of the stone slab) of honey like consistency shall be spread on the mortar bed over as much areas could be covered with the slabs within 15 to 20 minutes. Each stone slab shall be gently tapped with a wooden mallet till it is firmly and properly bedded. If there is a hollow sound on gentle tapping of the slabs shall be removed and reset properly. The joints shall be as thin as possible and limited to 2 mm at the maximum. The stone slab shall be laid so as to give continuous parallel long joints with cross joints at right angles to them. The edges of the adjoining slabs shall be in one plane. Where the slabs cover open edges of floor or window sills the edges shall be nearly rounded off.
- 4.3.2 Laying shall start after due consideration is given to following points and approved by the PMC.
- a) Datum levels of floors in rooms, adjacent rooms, passages, etc.
 - b) Slopes, if provided, , the flooring should be given by adjusting thickness of mortar.
 - c) Tiles in openings and doors are equally placed.
 - d) Passage may be laid first to achieve evenness in doors.
 - e) Tiles in rooms shall be symmetrical and equal cut tiles shall be around the edges.
 - f) In case of differently coloured titles in passages and rooms, a dividing strip shall be provided and changes over of colour shall be under the shutter.
 - g) In case there in any other architectural or structural features, the same shall be considered and the pattern adjusted accordingly.
 - h) Titles may be allowed to go under plaster or dado about 10 mm. after the tiles are laid, surplus cement\ slurry from the joints shall be cleaned. The following day the joints shall again be cleaned, washed and wire brushed.
- 4.3.3 Grouting of joints shall be carried out with coloured (pigmented cement) cement or gray cement that matches the colour of tiles. Grout shall be worked into joint. Excessive grouts shall be cleaned off.

- 4.3.4 The floor shall be kept wet for a period of 7 days No traffic shall be allowed on the bedding and bedded tiles for at least 2 days.

4.4 POLISHING

- 4.4.1 Polishing and grind shall be done only after 14 days. Machine cutting or grinding shall be carried out. At first the grinding shall be with rough stone of grade 48 to 60. All chips shall be visible and grinding shall be uniform. It shall be cleaned with water. All pin-holes and opened out joints shall be grouted with matching coloured cement grouts supplied by the tile manufactured. It shall be cured for a period of 7 days by keeping its moist.
- 4.4.2 Second coat/grinding shall be done with carborundum stone of grade 120. The same procedure as for the first coat shall be repeated till curing is completed.
- 4.4.3 The final cutting/grinding shall be with a fine stone of 220-320 grade and shall be done with sample water.
- 4.4.4 Tin oxide powder shall be spread 33 gm/sq.m and polished by machine fitted with hessain bobs. The floor shall be washed, cleaned and dried with a soft cloth or linen. Wherever corner of tiles are slightly low and remain unpolished, they should be hand polished by using rubbing stone.
- 4.4.5 In case of wax polishing, wax polish shall be applied to the surface. It shall be rubbed with machine. Then clean saw-dust shall be speared over the floor and rubbed with polishing machine. This will remove wax, leaving a glossy surface underneath. The granite slabs shall be delivered in pre-polished and /or flamed finish state.

5.0 MARBLE STONE SLAB/GRANITE STONE SLAB LIFT CAR FLOORING

5.1 MATERIAL

- 5.1.1 Machine cut marble stone / granite stone slabs shall be of 18- 20 MM thickness, Size, Colour & Pattern as per approved sample. Colour shall be uniform and the slabs free from all defects. Tiles used at site shall be machine-cut.
- 5.1.2 In machine-cut tiles, edges shall be protected from any damage in transit. No breakage shall be permitted. All edges shall be sharp, perfectly rectangular. Edges shall be polished for exposed corners faces as per the drawing and specifications.
- 5.1.3 At its thinnest part, no stone shall be thinner than 18mm. The flagstones shall be hard, sound, durable and wear resistant. Uniformity of size shall generally be maintained for the flags used in any one room. The stones flags shall be without any soft veins cracks or flows and shall have a uniform colour. They shall have even natural surfaces free from broken flakes on top and shall be true and square to ensure uniform width of joint. Samples of stone slabs to be used shall be got approved by the PMC and the slabs to be used shall conform to the approved sample.

5.2 LAYING

Laying of marble / granite stone slab flooring shall be as follows:

Before laying, the stone slab shall be thoroughly dried with blower. Neat Adhesive (pigmented to match the shade of the stone slab) to be spread on the laying surface & to be covered with the slabs within 2 to 5 minutes. Each stone slab shall be gently tapped with a wooden mallet till it is firmly and properly bedded. If there is a hollow sound on gentle tapping of the slabs shall be removed and reset properly. The joints shall be as thin as possible and limited to 2 mm at the maximum. The stone slab shall be laid so as to give continuous parallel long joints with cross joints at right

angles to them. The edges of the adjoining slabs shall be in one plane. Where the slabs cover open edges of floor or window sills the edges shall be nearly rounded off.

6.0 MARBLE STONE/ OTHER STONE SLAB FLOORING FOR TREADS

The method of laying, bedding etc. for marble / other stone flooring in treads shall be similar to that for marble stone slab / granite stone slab flooring as specified in 4.0 above. Nosing of the treads shall be rounded or as directed, final polishing may be done by hand. The item to include rounding, nosing, groove cutting.

7.0 SKIRTING / DADO OR CLADDING OF POLISHED STONE SLAB

The backing for skirting / dado or cladding shall be cement plastered mentioned in the item, 12 mm to 20 thick and this plastering shall be done in a single coat. Thickness of joints shall not exceed 1.5 mm. Final polishing may be done by rubbing. The top of skirting or dado shall be jointed neatly with the plaster above as directed. The joints between the two slabs shall be filled with neat white cement and matching coloured grout of appropriate consistency. In case if the skirting is flushed with the wall powder coated aluminium U Chanel to be provided in between the skirting & wall as per the drawing. Mention for groove between wall finish & skirting.

8.0 GLAZED TILES

8.0.1 The tiles shall be of first quality and shall generally conform to IS : 777. These shall be flat, and true to shape and free from cracks, crazing, spots, chipped edges and corners. The glazing shall be of uniform shade and shall be provided in Dado of kitchen and toilets. The tiles shall be set over screed/ plaster 12mm thick with cement mortar 1:3 (1 cement: 3 coarse sand) to all surface, set and jointed with neat white cement slurry. The joints shall be neat and fine. Tiles face shall be kept flush with the skirting below.

8.0.2 Size of glazed tiles both for toilets, Baths, WC and kitchen shall be as shown on drawings.

8.0.3 The colour of tiles shall be white/coloured as approved by ER/PMC

8.0.4 Height of glazed tiles dado above skirting in toilets and in kitchen, above kitchen platform shall be as shown on the drawings.

9.0 FINISH OF WORKING PLAT FORMS IN KITCHENS/PANTRY

9.1 GRANITE PANTRY COUNTERS ON CUDDAPAH BACKING

Providing and fixing 600mm wide pantry counter with top made of 18-20 mm thick pre-polished granite slab top of approved shade laid on 25mm thick one side polished Cuddapah on a bed of cement mortar 1:4, 20 mm thick, supported on 20mm thick both sides polished Cuddapah verticals as directed. Providing, 100mm high front facia and 150mm high band above the counter top of same shade granite. All exposed surfaces of platform to be finished in same granite slab. Necessary cut-outs for sink to be provided and all cut-outs, exposed edges to be half round bull nosed with mirror polished. Cost to also include making necessary cut-outs for taking pipes through counter top. Cost of Pre-Polished Granite Rs. 1800/Sqm. Mode of measurement to be in Running Meter.

9.2 GRANITE PANTRY COUNTER ON MARINE BACKING

Providing and fixing 600mm wide pantry counter with top made of 18-20 mm thick pre-polished granite slab top of approved shade laid on 20mm thick marine ply

backing, supported on 19mm thick marine ply verticals as directed. Providing, 100mm high front fascia and 150mm high band above the counter top of same shade granite. All exposed surfaces of platform to be finished in same granite slab. Necessary cut-outs for sink to be provided and all cut-outs, exposed edges to be half round bull nosed with mirror polished. Item to include making necessary cut-outs for taking pipes through counter top.

9.3 GRANITE PANTRY COUNTERS ON MARINE BACKING WITH SS SUPPORTS

Providing and fixing 600mm wide pantry counter with top made of 18-20mm thick pre-polished granite slab top of approved shade laid on 19mm thick marine ply backing, supported on SS legs 50mm dia, 3mm thick as directed. Providing, 100mm high front fascia and 150mm high band above the counter top of same shade granite. All exposed surfaces of platform to be finished in same granite slab. Necessary cut-outs for sink to be provided and all cut-outs, exposed edges to be half round bull nosed with mirror polished. Item to also include making necessary cut-outs for taking pipes through counter top.

10.0 POLISHED KOTA STONE FLOORING

10.1 GENERAL & CODES

The Kota stone slabs shall be machine polished and of selected quality, hard, sound, dense and homogeneous texture, free from cracks decay watering and flaws. They shall be machine cut to the requisite thickness. The edges shall truly vertical. The colour of the slabs will be approved by the ER/PMC, before starting of work. The slabs shall have the top (exposed) face polished before being brought to site. The slabs shall conform to the size required. The thickness of the slabs shall be 20 - 25mm.

10.2 DRESSING

Every slab shall be cut to the required size and shape and fine chisel dressed in the edges to the full depth. The edges shall be table rubbed with coarse sand or machine rubbed before paving. All angles and edges shall be true and square and the surface shall be true and plane.

10.3 PREPARATION OF SURFACE AND LAYING

The sub grade concrete or RCC slab on which the kota stone slabs are to be laid shall be cleaned, wetted and mopped. The bedding shall be with cement mortar of an average thickness of 20mm and mix 1:4 (1 cement: 4 coarse sand) over this bedding, neat grey cement slurry of honey lie consistency shall be spread. The edges shall be pasted with cement slurry @ 4.4 Kgs. of cement per sqm. mixed with pigment to match the shade of the slabs. The joints shall be kept as thin as possible.

10.4 POLISHING AND FINISHING

The floor shall then be kept wet for a minimum period of seven days. The surface thereafter shall be grounded with machine fitted with grit block No. 60, then No. 120 and finally with No. 320. Between every two successive grindings the surface shall be washed, cleaned and covered with a thin coat of grey cement in order to fill any pin hole that appear. 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 mamdah block (pad 7% woolen rags) the following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

11.0 POLISHED KOTA STONE IN RISERS, TREADS AND SKIRTING

- 11.0.1 The kota stone slabs for skirting shall be as specified in clause 10 above and of thickness 20 - 25 mm for risers & treads. The height of skirting shall be 100mm high.
- 11.0.2 Preparation of surface and laying: The surface shall be chipped off the projections/productions if any cleaned and wetted. 12-20 mm thick plaster of cement mortar 1:3 (1 cement: 3 coarse sand) for risers & dado and 1:4 (1 cement: 4 coarse sand) for treads shall be applied and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonal lines 2mm deep at approximately 7.5 cms. centre both ways. The back and edges of the stone slabs shall be buttered with a coat of grey cement slurry and set in the bedding mortar.
- 11.0.3 Cutting, Polishing and finishing : Cutting, grinding and polishing of skirting shall be done in the same manner as of flooring but by hand.

12.0 CERAMIC TILES (ANTI SKID OR GLAZED)/ VITRIFIED / INDUSTRIAL TILES

12.1 GENERAL & CODES

Ceramic tiles (Anti Skid/Glazed) shall be 300mm x 300mm x 8/10 mm thick in size, Vitrified tiles to be 600 mm x 600 mm x 8/10 mm / 1000 mm x 1000 mm x 10/12 mm thick or as specified in the Item and of best quality, Indian make obtained from approved manufacturer. The tiles shall be sound, hard, well and evenly treated, free from twist, with fine and sharp edges. Sample of the tiles shall be first got approved by the ER/PMC and all the tiles which shall be used in the work shall strictly conform to the approved sample otherwise all the tiles will be rejected. The surface to be laid for the flooring or dado shall be thoroughly hacked, joints of masonry raked, cleaned of all mortar scales, concrete lumps, loose materials, etc. and washed to remove mud, dirt, etc. from the surface. Unless and until the surface is approved by the PMC the flooring and dado shall not be started. The prepared surface shall be thoroughly drenched with water.

12.2 FLOORING

- 12.2.1 A bedding 20 mm thick (unless otherwise specified) of cement mortar 1:4 shall be laid evenly to levels or slope as directed, The tiles shall then be laid on the bedding with a backing of thin cement paste. All tiles shall be truly and evenly set and pressed in position to obtain a uniform plane surface. The tiles shall be closed jointed and all joints shall be uniform and run in perfect straight lines. Joints shall be filled with matching cement paste. Entire finished surface shall be thoroughly cleaned to remove all cement stains, etc. The joints shall be kept wet for 7 days. Size of Vitrified tiles both for toilets, Baths, WC and kitchen shall be as shown on drawings.
- 12.2.2 The colour of tiles shall be white/coloured as approved by ER/PMC.

12.3 CERAMIC /VITRIFIED TILE SKIRTING

- 12.3.1 Where shown/indicated in the drawing/ schedule of finishes shall be provided 100mm high over 10mm thick cement mortar 1:3 (1 cement : 3 coarse sand) and jointed with white cement paste pigmented to the tile shade.
- 12.3.2 The tile to be protected with plastic & POP board/ PVC bubble sheet as specified by the ER/PMC.

12.4 DADO

- 12.4.1 The prepared surface shall be plastered with cement mortar 1:3 to get a bedding of 12mm thick. The plastered surface shall be even, uniform and true to plumb. The tiles shall be fixed in position with a backing of cement paste or water proof adhesive of

approved manufacturer as specified in the item. All tiles shall be evenly set and pressed in position to a true plane surface. The specifications for workmanship shall be exactly similar to tile flooring. The tiles shall be closed jointed and all joints shall be uniform and run in perfect straight lines. Joints shall be filled with matching cement paste. Entire finished surface shall be thoroughly cleaned to remove all cement stains, etc.

13.0 EPOXY COATING

13.1 GENERAL & CODES

- 13.1.1 Epoxy coating should be based on carefully selected solvent less Epoxy resin composition. It should be a 3 component system consisting of base, hardener and hard wearing quartz fillers. It should be self levelling composition and forms a very smooth, attractive hygienic, hard wearing and chemical resistant floor topping.
- 13.1.2 It should provides a joint less flooring making it dust free and is easy to clean because of smooth surface.
- 13.1.3 Chemical Resistant – It should have excellent chemical resistance to most chemicals
- 13.1.4 Wear Resistant – It should provide a tough floor topping to withstand foot and light vehicular traffic.

13.2 SURFACE PREPARATION

- 13.2.1 The long term durability of the applied Epoxy topping is dependent upon the adhesive bond achieved between the flooring material and substrate. It is most important therefore, that substrate surface is correctly prepared prior to application.
- 13.2.2 Substrate must be of sufficient strength to support loads applied through the topping. New concrete or cementations substrates should have been placed for at least 28 days and have a moisture content of less than 5% before topping. Before application, the surface to be coated should be free from loose particles, rust, oils, grease or earlier coatings and should be thoroughly dry. After surface is dry, all repair work like sealing of joints, cracks filling of cavities and crevices should be carried out. 5. The self levelling action is very localized and does not eradicate irregularities of level present in the original substrate. It is most important, therefore, that adequate surface preparation and repair is undertaken prior to application of flooring systems.

13.3 PRIMING

To be as per manufacturer's specifications.

13.4 MIXING

To be as per manufacturer's specifications.

13.5 LAYING

Spread the mixture on the floor immediately to the required thickness by means of rollers and serrated trowels. The floor should be rolled by a spike roller to remove trapped air. The floor shall self level to uniform colour and smoothness.

14.0 VDF FLOORING ('TREMIX' OR EQUIVALENT)

Providing & laying in position and compaction as specified machine mixed, plain cement concrete of grade M20 using maximum 20 mm downgraded coarse aggregate using Vacuum Dewatering procedure "TREMIX or Equivalent" including all necessary dewatering, form work, casting in panels of specified size and

thickness, wherever necessary, to shape and depth as specified curing, etc., complete for any specified thickness, cutting grooves, filling joints etc

Specification to be inclusive of

- a) Steel form work with steel channel sections as approved by ER/PMC, mechanical vibration using needle and screed vibrators.
- b) Vacuum dewatering and Curing
- c) Cutting mechanically the dummy joints of 6mm wide and up to 0.33 times depth within 24hours - 36 hrs after casting the slab. The dummy joints are at approx 4m x 4m grids.
- d) Filling the grooves for joints with approved primer and approved joint sealing compound. The joint sealant will be filed flush with PCC surface.
- e) The joints will be kept filled with thermocol immediately after cutting and before filling, the same shall be removed & joints cleaned thoroughly with compressed air etc as directed.
- f) The acceptable level difference of VDF shall be only maximum 5mm at entire length.

15.0 CHINA MOSAIC FLOORING

15.1 GENERAL & CODES

The item refers to the provision of china mosaic surface (broken glazed tile pieces) set in cement mortar over waterproofing treatment well compacted and finished and laid in the required positions with white cement float as mentioned in the item.

15.2 MATERIALS

15.2.1 Broken glazed tile pieces

These shall be obtained from broken glazed tiles of approved shade and manufacture and conforming to I.S. 777, the sizes of pieces should be suitable to obtain the correct pattern of flooring as shown on the drawings or as directed by the ER/PMC

15.2.2 Cement

Cement in cement float shall be white cement or coloured as specified in the item.

15.3 WORKMANSHIP

15.3.1 Mortar bedding : Cement mortar bedding shall be laid as described in the item description, the thickness of bedding being about 20mm laid to the required slopes shown on the drawings or directed by the ER/PMC.

15.3.2 Broken glazed tile pieces : These pieces shall be thoroughly wetted before fixing them. White cement grout as required of honey like consistency shall be spread over the mortar bedding when the mortar is still plastic. In this cement float glazed tile pieces shall be fixed piece by piece to the pattern as required. The fixing shall be done by keeping the joints between the pieces as thin as possible. The flooring shall be laid to correct level and slopes and compacted by striking the surface with hand thappies and straight screed tamper. The grout shall cream up to the surface. The junctions of the flooring and the parapet wall shall be rounded and the flooring shall be extended up the wall for 15cm or as specified. After the flooring has been laid or the day's fixing work is completed, surplus cement grout that may have come out of the joints on compacting shall be cleaned off. The flooring laid shall be kept moist and allowed to mature undisturbed for 10 days to allow the bedding and flooring to set properly.

15.4 CLEANING

Once the floor has set, it shall be carefully washed clean and dried. When dry, the floor shall be covered with oil free dry sawdust, which shall be removed only after the construction work is completed.

15.4.1 Scope shall include all labour, materials, tools and equipment required for the following operations to carry out the item as specified above.

(a) Fixing the broken glazed tile pieces in white cement float on the bedding to the required pattern and compacting.

(b) Curing

(c) Cleaning the floor

16.0 TWIN GRANITE/MARBLE STONE FRAMES

16.1 GENERAL & CODES

16.1.1 Bedding shall be of grey cement-paste with minimum cement consumption of 0.21 bags per smt. Of applied area, unless specified otherwise in the BOQ/drawings. The base of cement shall be compacted to a reasonably true plain surface and to the required and level. The amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and satisfactory bedding. Before spreading paste, the sub- base shall be cleaned off all dirt, scum or laitance and of loose material and then well wetted without forming any pools of water on the surface. The paste shall then be evenly and smoothly spread over so much area as will be covered with slabs within half an hour. The thickness of the paste shall not be less than 6 mm and not more than 12 mm.

16.1.2 The joints shall be cleaned & properly grouted with a neat paste of white cement with minimum cement consumption of 0.55 kg per smt

16.1.3 The proportion of mortar bedding shall be 1:3 , unless & otherwise prescribed any other proportion and shall be as per IS 2116-1965 , as applicable to non-reinforced masonry work.

16.1.4 The adhesion of two slab frames overlay shall be ensured with approved adhesive.

16.2 LAYING

Laying of marble /granite stone slab frame shall be as follows :-

16.2.1 Before laying, the stone slab shall be thoroughly wetted with clean water. 20 / 25 mm thick stone slab (as per the detail drawing) / tiles shall be fixed with approved polymer modified cement adhesive forming 3 to 6mm of adhesive bed , rendering absolute minimum , uniform joints between stone slab/tiles. Joints to be grouted with approved grout.

16.2.2 Each stone slab then shall be gently tapped with a wooden mallet till it is firmly and properly bedded. If there is a hollow sound on gentle tapping of the slabs such slabs shall be removed and reset properly. The joints shall be as thin as possible and limited to 2mm at the maximum. Unless & until detailed in the BOQ or Drg, exposed edges of window sills/door frames , the edges shall be neatly rounded off.

16.2.3 Laying shall start after due consideration is given to following points and approved by the PMC.

16.2.4 The vertical surface for frame cladding work should be rough, fairly in plumb & in right angles with each other,

16.2.5 Concealed plumbing & electric conducting shall be complete before the execution of frame cladding work.

- 16.2.6 Check all the right angles of the corners of bath/W.C. /toilet or pantry area. Please ensure that the plaster is in plumb.
- 16.2.7 Check the level of the wooden Patti with spirit level before commencing the cladding work.
- 16.2.8 After the frames are laid, surplus cement slurry from the joints shall be cleaned. The following day the joints shall again be cleaned, washed and wire brushed.
- 16.2.9 In case not specified in the Drg or BOQ, and if the projection is not recommended, 6mm groove to be provided at the junction of the wall & stone frame.
- 16.2.10 Polishing and grinding shall be completed on the surfaces & edges before the laying of the stone frames. At first the grinding shall be with rough stone of grade 48 to 60. All chips shall be visible and grinding shall be uniform. It shall be cleaned with water. All pin-holes and opened out joints shall be grouted with matching coloured cement grouts supplied by the tile manufacturer. It shall be cured for a period of 7 days by keeping it moist.
- 16.2.11 Second coat cutting/grinding shall be done with carboundum stone of grade 120. The same procedure as for the first coat shall be repeated till curing is completed.
- 16.2.12 The final cutting/grinding shall be with a fine stone of 220-320 grade and shall be done with ample water.
- 16.2.13 Oxalic acid powder shall be spread 33 gm/sqm. and polished by machine fitted with Hessian bobs. The floor shall then be washed, cleaned and dried with a soft cloth or linen. they should be hand polished by using rubbing stone.
- 16.2.14 In case of wax polishing, wax polish shall be applied to the surface. It shall be rubbed with machine. Then clean saw-dust shall be spread over the slab and rubbed with polishing machine. This will remove wax, leaving a glossy surface under-neath.

17.0 SCREED AS BASE FLOOR IN OFFICE AREAS

The entire office areas inclusive of passages, Stair Landings to be provided with average 62mm thick Cement Concrete with cement concrete 1:1.5:3 laid in alternate panels of sizes 3m x 3m etc., all materials and labour complete. Surface to leveled uniformly and roughened to receive the top finished surface.

18.0 HEAT RESISTANT TERRACE TILES

- 18.1 Base preparation to be done and ensure that the substrate is waterproof with adequate slope provided for quick water discharge. Prepare bed mortar mixture in the ratio of 1:4, cement to sand. Do not use very fine sand. The mixture should have some coarse grains also. Care should be taken to ensure that the bed mortar is properly mixed without lumps. Improper mixing leads to voids in the bed mortar, which might lead to cracking. The sand used should be free from silt and mud. The bed mortar should be compacted properly before tiles are laid. Improper compacting also leaves voids in the layer and is a cause for cracking of tiles. The thickness of the bed mortar should be 20 mm not less than 18 mm.
- 18.2 Heat Resistant terrace tiles should be fixed on bed mortar just like mosaic tiles. Tiles may be laid with a gap of 2 mm between each other by using spacers. This gap will ensure proper filling of grout. Finely sieved sand to be mixed in the slurry used for fixing the tiles. (Sand: Cement: 1:5) The mixture should not be very rich i.e. the proportion of cement should not be increased. The tile joints should be grouted with white cement and white marble Powder

mixed in the ratio 1:2. One hand polish to be provided on the tiles for evening out the surface and proper sealing of tile joints. Polishing the surface will prevent dust collection and algae formation.

- 18.2.1 For skirting purpose, each tile must be cut into two and the edges chamfered using diamond cutting machine. The tile should be embedded in the parapet wall at the brick level and finished off with proper plastering. Or proper cover (wata) should be prepared at the sides.
- 18.2.2 Since the heat resistant terrace tiles are multi-layered tile, instruction to be issued to handle it properly while laying. Hammering of tiles for levelling purpose should be done carefully. In case a tile cracks while levelling, the tile should be removed and used for skirting. Do not use cracked tiles while fixing. After completion of tiling (before polishing) cure the entire area by ponding water for one hour (twice a day) for at least 4 days. Ideally one week curing is recommended. Make sure the tiles do not dry up. Some of the tiles are likely to crack after fixing due to the inherent property of cement structures and heat generated by the bed mortar and cement slurry used for fixing the tiles. This is a normal occurrence and does not affect the performance and life of the tiles. Fill up any cracks appearing on tiles with Heat Reflective paint paste and polish the surface as mentioned above. It is recommended not to use soft and porous materials as substrate. The compaction and air voids in these materials can cause cracks in the future.

19 IORNITE / HARDENED FLOOR TOPPING

19.1 Materials and Workmanship

- 19.1.1 Floor hardener topping shall be provided either as integrally finished over the structural slab/ grade slab or laid monolithically with the concrete/ granolithic floor finish on top of hardened concrete base.
- 19.1.2 Floor hardener of the metallic or non-metallic type suitable for the performance of normal/ medium/ heavy duty function of the floor, the quantum of ingredients and the thickness of topping shall be as specified in the respective items of work.
- 19.1.3 For monolithic application with the floor finish/ slab the thickness of the layer shall be 15 mm. The topping shall be laid within 2 to 3 hours after concrete is laid when it is still plastic, but stiffened enough for the workmen to tread over it by placing planks. The surface of the concrete layer shall be kept rough for providing adequate bond for the topping. Laitance shall be removed before placing the topping. The topping shall be screened and thoroughly compacted to the finished level. Trowelling to a smooth finish shall be carried out. After the surface has hardened sufficiently, it shall be kept continuously moist for at least 10 days.
- 19.1.4 The procedure for mixing the floor hardener topping shall be as per manufacturer's instructions.

PART 02 : PAINTING

1.0 SCOPE

These specifications cover the use of paints for the plastered and concrete surfaces. It also includes the painting of wood and metal surfaces.

2.0 GENERAL & CODES

The provisions of the latest revisions of the following IS : Codes shall form a part of this specification.

IS: 63	Whiting for Painting Ready mixed paint, brushing, grey filler, for Enamels, for use over primers.
IS: 426	Specification for paste filler for colour coats.
IS : 428	Specification for Distemper, Oil Emulsion, colour as required.
IS : 710	Marine Plywood
IS : 1200 (Part XIII)	Method of Measurement of Building & Civil Engg. Works - White Washing colour washing, distempering & other finishes.
IS : 1477 (Part I)	Code of practice for painting for ferrous metals in buildings Pretreatment.
IS : 1477 (Part II)	Code of practice for finishing of ferrous metals in building. Painting
IS : 2338 (Part I)	Code of practice for finishing of wood and wood based materials Operations and workmanship for finishing.
IS : 2338 (Part II)	Code of practice for finishing of wood and wood based materials, Schedule.
IS : 2395 (Part I)	Code of practice for painting concrete masonry and plaster surfaces. Operation & workmanship
IS : 2395 (Part II)	Code of practice for painting concrete, masonry and plaster surfaces. Schedule.
IS : 159	Specification for ready mixed paint, brushing, acid resistant.
IS : 2524 (Part I)	Code of practice for painting of non-ferrous metal in building Pre-treatment.
IS : 2524 (Part III)	Code of practice for painting of non-ferrous metal in building Painting.
IS : 3140	Code of practice for painting asbestos cement buildings.
IS : 5410	Specification for cement paints, colour as required.IS:15489-04 Specification for External Paint

Other IS Codes not specifically mentioned here, but pertaining to painting form part of these specifications.

3.0 MATERIALS

Materials shall strictly conform to the relevant IS: Specifications.

3.1 PLASTERED OR CONCRETE SURFACES

3.1.1 General

- a) 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..
- b) For painting on external surfaces secured double scaffolding to be used.
- c) Where ladders are used, pieces of old gunny bags shall be tied at top and cotton to prevent scratches to the walls and floors. For painting of ceilings, proper stage scaffolding shall be erected, where necessary.

3.1.2 Preparation of surfaces

- a) The surface shall be thoroughly cleaned off all dirt, dust, mortar dropping and other foreign matter, before paint is to be applied. New plaster surfaces shall be allowed to dry for at least 2 months, before applying paint. All unnecessary nails shall be removed. Pitting in plaster shall be made good with putty. The surface shall then be rubbed down again with a fine grade sand paper and made smooth.
- b) The surface shall be allowed to dry thoroughly before the regular cost of paint is allowed.
- c) The surface affected by mounds moss, fungi, algae lichens, efflorescence shall be treated in accordance with IS 2395 (Part I) before applying paint. The Adjoining surfaces/finishes shall be protected with either masking tape / plastic to avoid damages to other finishes.
- d) The masking tape / plastic shall be removed without damaging the finishes.

4.0 POP / GYPSUM PLASTER

4.1 Preparation of Surfaces

- 4.1.1 Any smooth surface shall be hacked in order to make the surface rough as POP is always required to be applied on a rough surface for better strength and bonding.
- 4.1.2 All the back boxes, conduits etc. to be protected well in order to avoid damages to other services.

4.2 Leveling of the surface

All the surface of the wall / ceiling shall be leveled by maintaining a uniform surface with a tolerance level as per IS codes and corners to be 90 degree.

4.3 Application

- 4.3.1 POP / Gypsum plaster as per the approved list of make specified by the ER/PMC shall be mixed with water as per the approved technical specification and applied with a straight, clean, dry and smooth aluminum box section on clean and dry surface. Horizontal grid shall be given first and vertical grid shall be applied immediately afterwards. This entire operation will checked by the EIC.
- 4.3.2 The surface shall be finished as uniformly as possible leaving without undulation. It shall be allowed to dry for at least 48 hours, the moisture content should be completely dried and if any tracks are developed shall be repaired and finished.

5.0 OIL-BOND DISTEMPERING

5.1 PREPARATION OF SURFACES

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 undulation and then sand papering the same after it is dry.

5.2 PRIMER COAT

The primer where used as an undercoated surfaces shall be alkali resistance primer or distemper primer as specified in the item. These shall be of the same manufacture as of out bound distemper. If the wall surface plaster has not dried completely alkali resistance primer shall be applied before distempering the walls. But if the distempering is done after the wall surface is dried completely, distemper primer shall be applied.

5.3 APPLICATION

Primer shall be applied with a brush on the clean dry 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. It shall be allowed to dry for at least 48 hours, before oil bound distemper or paint is applied.

5.4 PREPARATION OF OIL BOUND DISTEMPER WITH LOW VOC AS PER IGBC RATING

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 days work shall be prepared.

5.5 APPLICATION OF DISTEMPER COAT

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 printing coat. All loose particles shall be dusted off after rubbing. Minimum two coats of distemper shall be applied with brushes in horizontal strokes followed to immediately by vertical, which together shall constitute one coat. The subsequent coats shall be applied after a time interval of at least 24 hours between consecutive coats to permit the proper drying of the preceding coat.

5.6 The finished surface shall be even and uniform without patches, brush marks, distemper, drops, etc.

5.7 Sufficiently quantity of distemper shall be mixed to finish one room at a time. The application of a coat in each room shall be finished in one operation and no work shall be started in any room, which cannot be completed the same day.

5.8 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 that are dirty and caked with distemper shall not be used on the work.

6.0 WATER PROOF CEMENT PAINT

6.1 PREPARATION OF SURFACES

The surfaces shall be thoroughly wetted with clean water before the waterproof cement paint is applied.

6.2 PREPARATION OF PAINT

6.2.1 Portland cement paints are made readily by adding paint power to water and stirring to obtain a thick paste, which shall then be diluted to a brushable consistency. Generally equal volumes of paint powder and water make a satisfactory paint. In all cases the manufacturer's instructions shall be followed. The paint shall be mixed in such quantities as can be used up within an hour of mixing as otherwise the mixture will set and thicken, affecting flow and finish.

6.2.2 The lids of cement paint drums shall be kept tightly closed when not in use, as by exposure to atmosphere the cement paint rapidly air set due to its hygroscopic qualities.

6.3 APPLICATION OF PAINT

6.3.1 No painting shall be done when the paint is likely to be exposed to a temperature of below 7 degree within 48 hours after application.

- 6.3.2 When weather conditions are such as to cause the paint to dry rapidly, work shall be carried out in the shed as far as possible. This helps the proper hardening of the paint film by keeping the surface moist for a longer period.
- 6.3.3 To maintain a uniform mixture and to prevent segregation the paint shall be stirred frequently in the bucket.
- 6.3.4 For undercoated surfaces, the surface shall be treated with minimum two coats of water-proof cement paint. Not less than 24 hours shall be allowed between two coats and the second or subsequent coat shall not be started until the preceding coat has become sufficiently hard to resist marking by the brush being used. In hot dry weather the preceding coat shall be slightly moistened before applying the subsequent coat.
- 6.3.5 The finished surface shall be even and uniform in shade without patches, brush marks, paint drops, etc.
- 6.3.6 Cement paints shall be applied with a brush with relatively short stiff hog or fibre bristles. The paint shall be brushed in uniform thickness and shall be free of excessively heavy brush marks. The laps shall be well brushed out.

6.4 CURING

Painted surfaces shall be sprinkled with water two or three times a day. This shall do between coats and for at least two days following the final coat. The curing shall be started as soon as the paint has hardened so as not to be damaged by the sprinkling of water, say about 12 hours after its application.

7.0 SYNTHETIC ENAMEL PAINT

7.1 GENERAL REQUIREMENT

- 7.1.1 The material required for the execution of painting work shall be obtained directly from approved manufacturers and brought to the site in maker's drums, with seals unbroken. All paints of low VOC as per IGBC rating shall conform to relevant Indian Standards as mentioned under sub-head "Material".
- 7.1.2 All materials not in actual use shall be kept properly protected. Lids of containers shall be kept closed and surface of paint in open or partially open containers covered with a thin layer of turpentine to prevent formation of skin. Materials, which have become stale or fat due to improper and long storage shall not be used. The paint shall be stirred thoroughly in its container before pouring into small containers. While applying also, the paint shall be continuously stirred in the smaller container. No left over paint shall be put back into stock tins. When not in use, the containers shall be kept properly closed.
- 7.1.3 If for any reason thinning is necessary, in case of ready mixed paint, the brand of thinner recommended by manufacturer shall be used.
- 7.1.4 Painting except the priming coat shall generally be taken in hand after all other builder's work is practically finished. The rooms shall be thoroughly swept out and the entire building cleaned up at least one day in advance of the paintwork being started. The surface to be painted shall be thoroughly cleaned and dusted. All rust, dirt scales, smoke and grease shall be thoroughly removed before painting is started.
- 7.1.5 No painting on exterior or other exposed parts of the work shall be carried out in wet, humid or otherwise unfavorable weather and all the surfaces must be thoroughly dry before painting work is started.

7.2 BRUSHING OF PAINT

- 7.2.1 The brushing operations are to be adjusted to the spreading capacity advised by the manufacturers of the particular paint. The painting shall be applied evenly and smoothly by means of crossing and laying off, the later in the direction of the grain of wood. 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 the opposite directions two to three times and then finally brushing lightly in a direction at

right angles 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 out coat.

- 7.2.2 During painting, every time after the paint has been worked out of the brush bristles or after the brush has been unloaded, the bristles of the brush. (Which are drawn together due to the high surface tension) shall be opened up by striking the brush against a portion of the unpainted surface with the end of the bristles held at right angles to the surface, so that bristles thereafter will collect the correct amount of paint when dipped again into the paint container.

7.3 SPRAYING

- 7.3.1 Where so stipulated, the painting shall be done with spray. Spray machine used may be (a) high pressure (small air aperture) type or (b) a low-pressure (large air gap) type, depending on the nature and location of work to be carried out. Skilled and experienced workmen shall be employed for this class of work. Paints used shall be brought to the requisite consistency by adding a suitable thinner.
- 7.3.2 Spraying should be done only when dry conditions prevail. During spraying the spray gun shall be held perpendicular to the surface to be coated and shall be passed over the surface in a uniform sweeping motion. Different air pressures and fan adjustment shall be tried so as to obtain the best application with the minimum wastage of paint. The air pressure shall not be kept too high as otherwise the paint will clog up and will be wasted.
- 7.3.3 Spots that are inaccessible to the spray pattern shall be touched up by brush after spraying.
- 7.3.4 At the end of the job, the spray gun shall be cleaned thoroughly so as to be free from dirt. Incorrect adjustments shall be set right, as otherwise they will result in variable spray patterns, runs, sags and uneven coats.
- 7.3.5 Each coat shall be allowed to dry completely and lightly rubbed with very fine grade of sand paper and loose particles brushed off before next coat is applied. Each coat shall vary slightly in shade and shall be got approved from the PMC before next coat is started.
- 7.3.6 Each coat except the last coat shall be lightly rubbed down with sand paper or fine pumice stone and cleaned off dust before the next coat is applied.
- 7.3.7 No hair marks from the brush or clogging of paint puddles in the corner panels, angles of moldings, etc. shall be left on the works. In painting doors and windows, the putty round the glass panes shall also be painted but care shall be taken to see that no paint stains etc. are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out in painting.
- 7.3.8 In painting steel work, special care shall be taken while painting over bolts, nuts, rivets, overlaps etc.
- 7.3.9 The additional specifications for primer and other coats of paints shall be according to the detailed specifications under the respective headings.

7.4 BRUSHES AND CONTAINERS

- 7.4.1 After work, the brushes shall be completely cleaned off paint and linseed oil by rinsing with turpentine. After cleaning, brushes are wrapped in heavy paper or waterproof paper for storage. It is to be used the next day; it shall be hung in a thinner or linseed oil in a container. On no account shall brushes to be made to stand on bristles. A brush in which paint has dried up in ruined and shall on no account be used for painting work.
- 7.4.2 The containers, when not in use, shall be kept closed and free from air so that paint does not thicken and also shall be kept guarded from dust. When the paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, before they can be used again.

8.0 STEEL AND OTHER METAL SURFACES

8.1 PREPARATION OF SURFACES

The surface before painting shall be cleaned of all rust, scale, dirt and other foreign matter sticking to it with wire brushes, steel wool, scrappers, sand papers etc. The surfaces shall then be wiped finely with mineral turpentine, which shall also remove grease and perspiration of hand marks. The surface shall then be allowed to dry.

8.2 PREPARATION OF SURFACES

The surface shall be treated with Mordant Solution (5 liters for about 190 sq.m.) by rubbing the solution generously, with a brush or bundle of rags on a stick. After about half an hour, the surface will turn gray and parts remaining bright shall be retouched and the extra surface washed down thoroughly with clean cold water and allowed to dry.

8.3 APPLICATION OF PRIMERS AND PAINTS

After preparation of the surface, the priming coat shall be applied immediately.

9.0 WHITE WASHING

9.1 GENERAL

9.1.1 The item refers to whitewashing over old and new concrete, stone masonry brick plastered surfaces and asbestos cement sheets.

9.1.2 White wash shall be prepared from fresh burnt white stone lime or shell lime. This lime shall be of class type as per IS: 712. shell lime or fat lime of equivalent quality may be used. The lime shall be dissolved in a tub with sufficient quantity of water (about 4.5 liters/Kg. Of lime) and the whole shall be thoroughly mixed and stirred until it attains the consistency of thin cream. The white wash shall be taken out in small quantities and strained through a clear course cloth. Alternatively with IS : 63 may also be used. Clean gum dissolved in hot water shall then be added in suitable proportion of 2 gm of gum Arabic to a little of lime or whiting to prevent the white-wash coming off easily when rubbed. Rice may be used instead of gum.

9.2 SCAFFOLDING

This may be double or single according to requirements. If ladders are used, pieces of old gunny bags or cloth rags shall be tied on their tops to avoid damage or scratches to the wall. Proper stage scaffolding shall be created when whitewashing ceiling. The contract shall be responsible for accidents if any taken place.

9.3 PREPARATION OF SURFACE

9.3.1 The surface shall be prepared by removing all mortar dropping and foreign matter and thoroughly cleaned with wire or fiber brush or other means as may be ordered by the PMC to produce an approved clean and even surface. All loose pieces and the scales shall be scraped off and holes stopped with mortar. In case where the surface has been previously colour washed, the old colour wash must be entirely removed before the white-wash is applied. In the case of surface, which has once been white-washed, the old loose white-wash shall be broomed down. In case, the loose whitewash cannot be removed by brooming, the PMC may order scraping of the surface.

9.3.2 After cleaning the surface as specified above, the unwanted nails shall be removed and all nail holes, cracks and crevices stopped with mortar similar in composition to the surface to be stopped. The mortar should be cured.

9.4 APPLICATION OF WHITE-WASH

9.4.1 On the surface so prepared, the whitewash shall be laid. Each coat shall be laid on with a brush. The first stroke of the brush shall be from the top downward, another

from bottom upwards over the first stroke, and similarly, one stroke from the right and another from the left over the first brush before it dries. This will form one coat. Each coat must be allowed to dry and shall be subject to inspection before the next coat is applied. When dry, the surface shall show no signs of cracking. It shall present a smooth and uniform finish free from brush marks and it should not come off easily when rubbed with a finger.

9.4.2 No portion in the surface shall be left out initially, to be patched up later on. For new work, the white washed surface shall present a smooth and uniform finish.

9.4.3 For old work, patches and repairs shall be white washed first. Thereafter, the whole surface shall be white washed with the required number of coats.

9.4.4 Doors, windows, floors and other articles of furniture, etc. shall be protected from being splashed upon. Splashing and droppings, if any, shall be removed and the surfaces cleaned.

9.5 PREPARING THE SURFACE FOR WHITE WASH INCLUDING THE SCAFFOLDING

Applying the white wash in required number of coats as specified above and prior white washing of repaired patches.

10.0 ACRYLIC EMULSION PAINTING ON WALL & CEILING

10.1 GENERAL

Acrylic emulsion paint are not suitable for application on external wood and iron surfaces and surfaces which are liable to heavy condensation and are to be used generally on masonry or plastered surfaces. Suitable primer as per manufacturer shall be provided.

10.2 PAINT

Acrylic emulsion paint of approved brand and manufacture with low VOC as per IGBC rating and of the required shade shall be used.

10.3 PREPARATION OF SURFACE

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 undulation and then sand papering the same after it is dry.

10.4 APPLICATION

- a) The number of coats shall be as stipulated in the item.
- b) The paint will be applied in the usual manner with brush or roller.
- c) The paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surfaces to 2 to 3 hours on non-absorbent surfaces.
- d) The thinning of emulsion is to be done with water and not with turpentine.
- e) Thinning with water will be particularly required for the undercoat, which is applied on the absorbent surface. The quantity of thinner to be added shall be as per manufacture's instructions.
- f) The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

10.5 PRECAUTIONS

10.5.1 Old brushes if they are to be used with emulsion paints, should be completely dried of turpentine or oil paints by washing in warm soap water.

- 10.5.2 Brushes should 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.
- 10.5.3 In the preparation of walls for plastic emulsion painting, no oil base putties shall be used in filling cracks, holes etc.
- 10.5.4 Splashes on floors etc. shall be cleaned out without delay, as they will be difficult to remove after hardening.
- 10.5.5 Washing of surfaces treated with emulsion paints shall not be done within 3 to 4 weeks of application.

10.6 OTHER DETAILS

These shall be as per specification for "Painting" as far as they are applicable.

11.0 EXTERIOR GRADE WEATHER PROOF PAINT

11.1 GENERAL

- 11.1.1 Acrylic weather shield paint of low VOC as per the IGBC rating from the approved brand shall be applied over plastered surfaces as directed by the EIC.
- 11.1.2 Other specifications including preparation of surfaces, application of paint etc. shall conform to section 7.0 above and as directed by EIC. The priming coat, anti-fungal treatment, preparation of paint etc. shall be carried out as per manufacturer's specification /as directed by EIC. General
- 11.1.3 Acrylic weather shield paint with IGBC rating of SEZ shall be applied on surfaces which are liable to external condensation and are to be used generally on masonry or plastered surfaces. Suitable primer as per manufacturer shall be provided.

11.2 PAINT

Acrylic weather shield paint with IGBC rating for SEZ of approved brand and manufacture as per the required shade shall be used.

11.3 PREPARATION OF SURFACE

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 external putty mixed with water on the entire surface including filling up the undulation and then sand papering the same after it is dry.

11.4 APPLICATION

- 11.4.1 The number of coats shall be as stipulated in the item.
- 11.4.2 The paint will be applied in the usual manner with brush or roller.
- 11.4.3 The paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surfaces to 2 to 3 hours on non-absorbent surfaces.
- 11.4.4 The thinning of paint is to be done with water and not with turpentine.
- 11.4.5 Thinning with water will be particularly required for the undercoat, which is applied on the absorbent surface. The quantity of thinner to be added shall be as per manufacturer's instructions.
- 11.4.6 The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

11.5 PRECAUTIONS

- 11.5.1 Old brushes if they are to be used with paints should be completely dried of turpentine or oil paints by washing in warm soap water.

- 11.5.2 Brushes should 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.
- 11.5.3 In the preparation of walls for painting, no oil base putties shall be used in filling cracks, holes etc it should be only the external putties.
- 11.5.4 Splashes on floors etc. shall be cleaned out without delay, as they will be difficult to remove after hardening.
- 11.5.5 Washing of surfaces treated with emulsion paints shall not be done within 3 to 4 weeks of application.

11.6 OTHER DETAILS

These shall be as per specification for "Painting" as far as they are applicable.

PART 03 : METAL FIRE DOORS

1.0 SCOPE

This specification covers the design, supply of materials, Manufacture and installation of factory made special type of approved make steel fire doors of 1 Hour, 2 Hrs. Fire Rating and General Purpose Doors of approved makes.

2.0 GENERAL

- 2.1 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.
- 2.2 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.
- 2.3 All fittings shall be of high quality and as specified and as per approval.
- 2.4 The Contractor shall strictly follow, at all stages of work, the stipulations contained in the Indian Standard Safety Code or its Equivalent British Standard 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.
- 2.5 Any approval, instructions, permission, checking, review, etc., whatsoever by the PMC/AEC, shall not relieve the Contractor of his responsibility and obligation regarding adequacy, correctness, completeness, safety, strength, quality, workmanship, etc.

3.0 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.

List of certain important Indian Standards, Acts and Codes applicable to this work is given below. However, the applicable standards and codes shall be as per but not limited to the list given below:

IS : 277 Galvanized steel sheet (plain and corrugated)

IS : 3614 Metallic and non-metallic fire check doors – Resistance test and Part – 2 performance criteria.

4.0 HOLLOW METAL FIRE DOOR (2 Hours Fire Rating) WITH HONEY COMB CORE

4.1. GENERAL

- 4.1.1. Fire door shall be 2 hour fire rated and door quality shall be approved by TAC/CBRI and tested conformed to IS : 3614 Code or its Equivalent British Standard.

Unless otherwise specified, maximum size of door in this type:

Single shutter door : 1200 mm x 2200mm

Double shutter door : 2000 mm x 2400 mm

- 4.1.2. For doors above 2200 mm height (Single Doors) and 2400 mm height (Double Door) the options shall be:

A man operation door of size above 2049 mm height shall be provided with a removable panel / fixed panel on top.

The construction of above panel shall be designed similar to that of a shutter in case of flush panel to match the exteriors.

4.2. FRAME

4.2.1. Material

Frame to be manufactured from 1.60 mm (16 gauge) galvanised steel sheets complying with latest IS 277 Code or its Equivalent British Standard coating class zinc coating mill phosphatized.

4.2.2. Profile

Door frame profile to be double rebated of dimensions 143 mm X 57 mm (+ / - 0.3) with bending radius of 1.4 mm.

4.2.3. 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.

4.2.4. 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.

4.2.5. Frames to have factory finish-pre-punched cut outs to receive specific hardware and iron mongery.

4.2.6. 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.

4.2.7. Frames to have rubber shutter silencer on strike jambs for single shutter frames and on the head jambs for double shutter frames.

4.2.8. 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.

4.3. FIRE DOOR SHUTTER

4.3.1. Material

Fire door shutter to be manufactured from 1.25 mm (18 gauge) galvanized sheets conforming to latest IS : 277 Code or its Equivalent British Standard coating class zinc coating, mill phosphatized.

4.3.2. 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.

4.3.3. Door Shutter Cores

Shutters to be provided with honeycomb kraft paper core to be bounded to the inner faces of the shutter.

4.3.4. Door shutter preparations

Shutters to be factory prepared with pre-punched cutouts and reinforcements to receive iron mongery as per final finish hardware schedule. The shutter should have an interlocking arrangement at this stile edges for flat surface on either side.

- 4.3.5. 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.
- 4.3.6. For shutter with door closer reinforcement pads to be provided at appropriate location as per manufacturer's design.
- 4.3.7. All iron mongery preparation to have adequate reinforcement for flushes fixing at site.
- 4.3.8. Vision panel for Fire rated door

Vision panel to be provided with Borosilicate clear toughened glass of the thickness 6 mm for up to 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 360 mm diameter.

- 4.3.9. 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.

4.4. **INSTALLATION**

- 4.4.1. Door frame fixing

- a) The door frames should be assembled adjacent to the place of installation as the frames are not designed for transporting in an assembled condition. After assembly it is to be ensured that all threaded preparations are covered from the back of the frame using self adhesive strip to prevent penetration of mortar back-fill into screw threads. The head member of assembled frame shall be positioned against jambs ensuring correct alignment and secured using M8 x 20 long plated bolts together with nuts spring and flat washers.
- b) The assembled frame shall be kept in position within the opening by means of bracing. In order to correctly position the frame against finished floor level or equalise on adjustable floor anchors where specified, shim shall be used under jambs. The frame shall be checked for square ness, alignment, twist etc. with carpenters bevel and plumb.
- c) A tie rod shall be fixed to the frame during installation to ensure the correct dimensions between the frame rebated and the same may be removed after installation.
- d) Where a 2nd fix application is required a shim detail is suggested to take up gap between frame and existing opening.

- 4.4.2. Existing masonry wall openings – Metal expansion shields

- a) Brace, position, level etc.
- b) Mark all positions of fixings on wall.
- c) Remove frame and drill wall to appropriate specified size.
- d) Fit rod anchor shells metal expansion bolts into the wall.
- e) Fit jamb spacer bracket into back of frame profile.
- f) Reposition frame back into opening and realign.
- g) Lightly screw CSK HD machine screws into shells, shim behind frame.

- h) Slowly tighten screws continually checking plumb, square etc. Finally ensure frames are not deformed as tightened.
- i) After fixing the frame shall be grouted with cement mortar 1:3 or Plaster of Paris or Gypsum powder as approved. Gap between frame and wall to be closed by cement pointing using cement mortar 1:3.
- j) Back full the frame through holes provided and insert nylon plugs.

4.4.3. Door shutter fixing

- a) Fix all the hardware to the door shutter like hinges, flush bolts, bolts, mortise locks, door closer, door stoppers, handles etc. with the appropriate screws and bolts supplied.
- b) The shutter is to be then fixed to the frame which is already installed. Align the shutter to match the hardware to the cutouts in the frame. Tighten the hinge screws.
- c) Application of Fire / Smoke UL 10 C / UL 1784 (2001) classified seal (for smoke check if specifically required)
- d) Clean door jamb rebate surfaces of all dust, oil etc. Affix self-adhesive Fire / Smoke seal on the door frame rebates as indicated by the manufacturer on hinge jambs, strike jambs, head member and sill.
- e) 2 Hours FIRE RATED DOOR – Hardware Schedule: All hardware to be in line with door schedule drawing.

5.0 HOLLOW METAL FIRE DOOR (1 HOUR FIRE RATING) WITH HONEY COMB CORE

5.1 GENERAL

5.1.1 Unless otherwise specified, maximum size of door in this type:

Single shutter door	:	1200 mm x 2200 mm
Double shutter door	:	2000 mm x 2200mm

5.1.2 For doors of size above 2200 mm height the options shall be:

A man operation door of size above 2049 mm height shall be provided with a removable panel / fixed panel on top with glazing or without glazing or without glazing as required.

The construction of above panel shall be designed similar to that of a shutter in case of flush panel to match the exteriors.

5.2 FRAME

- 5.2.1 Material : Frame to be manufactured from 1.25 mm (18 gauge) galvanized steel sheets complying with latest IS 277 Code or its Equivalent British Standard coating class zinc coating mill phosphatized
- 5.2.2 Profile : Door frame profile to be single rebated of dimensions 100 mm X 57 mm (+ / - 0.3) with bending radius of 1.2 mm
- 5.2.3 Manufacture : Frame to be manufactured from 1.25 mm thick galvanized 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.
- 5.2.4 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.
- 5.2.5 Frames to have factory finish-pre-punched cut outs to receive specific hardware and ironmongery.

- 5.2.6 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.
- 5.2.7 Frames to have rubber shutter silencer on strike jambs for single shutter frames and on the head jambs for double shutter frames.
- 5.2.8 Finish
 - a) Door frames to be suitably cleaned with solvents and etch primered for receiving primer and top coats.
 - b) Door frames to be primered in zinc phosphate stoving primer (35 microns DFT).
 - c) Door frames to be finished in thermo setting paint (35 microns DFT) of approved colour and make as specified.

5.3 DOOR SHUTTER

5.3.1 Material

General purpose door shutter to be manufactured from 0.80 mm (22 gauge) glavanised sheets conforming to latest IS : 277 Code or its Equivalent British Standard coating class zinc coating, mill phosphatized.

5.3.2 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.

5.3.3 Door shutter core

Shutters to be provided with honeycomb paper cored to be bounded to the inner faces of the shutter.

5.3.4 Door shutter preparations

- a) Shutters to be factory prepared with pre-punched cutouts and reinforcements to receive iron mongery as per final finish hardware schedule. The shutter should have an interlocking arrangement at this stile edges for flat surface on either side.
- b) 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.
- c) All iron mongery preparation to have adequate reinforcement for flush fixing at site.
- d) For shutter with door closer reinforcement pads to be provided at appropriate location as per manufacturer's design.

5.3.5 Vision panel

Vision panel to be provided with Borosilicate clear toughened glass of the thickness 6 mm for up to 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 360 mm diameter.

5.3.6 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.

All hardwares to be as per the detail drawing.

5.4 INSTALLATION

5.4.1 Door frame fixing

- a) The door frames should be assembled adjacent to the place of installation as the frames are not designed for transporting in an assembled condition. After assembly it is to be ensured that all threaded preparations are covered from the back of the frame using self adhesive strip to prevent penetration of mortar back-fill into screw threads. The head member of assembled frame shall be positioned against jambs ensuring correct alignment and secured using M8 x 20 long plated bolts together with nuts spring and flat washers.
- b) The assembled frame shall be kept in position within the opening by means of bracing. In order to correctly position the frame against finished floor level or equalise on adjustable floor anchors where specified, shim shall be used under jambs. The frame shall be checked for square ness, alignment, twist etc. with carpenters bevel and plumb.
- c) A tie rod shall be fixed to the frame during installation to ensure the correct dimensions between the frame rebated and the same may be removed after installation.
- d) Where a 2nd fix application is required a shim detail is suggested to take up gap between frame and existing opening.

5.4.2 Existing masonry wall openings – Metal expansion shields

- a) Brace, position, level etc.
- b) Mark all positions of fixings on wall.
- c) Remove frame and drill wall to appropriate specified size.
- d) Fit rod anchor shells metal expansion bolts into the wall.
- e) Fit jamb spacer bracket into back of frame profile.
- f) Reposition frame back into opening and realign.
- g) Lightly screw CSK HD machine screws into shells, shim behind frame.
- h) Slowly tighten screws continually checking plumb, square etc. Finally ensure frames are not deformed as tightened.
- i) After fixing the frame shall be grouted with cement mortar 1:3 or Plaster of Paris or Gypsum powder as approved. Gap between frame and wall to be closed by cement pointing using cement mortar 1:3.
- j) Back full the frame through holes provided and insert nylon plugs.

5.4.3 Door shutter fixing

- a) Fix all the hardware to the door shutter like hinges, flush bolts, bolts, mortise locks, door closer, door stoppers, handles etc. with the appropriate screws and bolts supplied.
- b) The shutter is to be then fixed to the frame which is already installed. Align the shutter to match the hardware to the cutouts in the frame. Tighten the hinge screws.
- c) Application of Fire / Smoke UL 10 C / UL 1784 (2001) classified seal (for smoke check if specifically required)
- d) Clean door jamb rebate surfaces of all dust, oil etc. Affix self-adhesive Fire / Smoke seal on the door frame rebates as indicated by the manufacturer on hinge jambs, strike jambs, head member and sill.

5.4.4 2 Hours FIRE RATED DOOR – Hardware Schedule

All hardware to be in line with door schedule drawings.

PART 04 : WOODWORK AND JOINERY

1.0 SCOPE

The specifications refer to woodwork in general including carpentry and joinery work in the building.

2.0 GENERAL & CODES

The provision of the latest revisions of the following I.S. codes shall form a part of these specifications.

IS205	Specifications for non-ferrous metal butt hinges.
IS287	Recommendation for maximum permissible moisture content of Timber used for different purposes
IS303	Specification for plywood for general purpose.
IS362	Specification for parliamentary hinges.
IS419	Specification for putty for the use on window frames.
IS883	Code of practice for design for structural timber in building.
IS1003	Specification for Timber paneled and glazed shutters part – II Window and ventilator shutters
IS1200	Method of measurement of building and Civil Part XXI Engineer Works – Wood Work and joinery
IS1341	Specification for steel butt hinges
IS1658	Specification for Fibre Hard Boards
IS1761	Specification for transparent sheet glass for glazing and framing purposes.
IS3087	Specification for wood particle boards (medium density for structural timber in building

Other I.S. codes not specifically mentioned here, but pertaining to woodwork and joinery form part of these specifications.

3.0 MATERIALS

3.1 SAWN TIMBER

First class Indian teak wood of class as specified in the time shall be used. The timber shall be of high quality and well seasoned. It shall have uniform colour free from defects such as cracks, dead knots, shakes, sapwood etc. no individual hard and would knot shall be more than 6 sq.cm. in size and the aggregate area of such knots shall not be more than 1% of the area of the piece. The timber shall be close grained having not less than 2 growth rings per cm. Width in cross section. The maximum permissible percentage of moisture content for well seasoned timber used in building work shall be as specified in the IS : 287.

3.2 GLAZING MATERIALS

3.2.1 Glass panels

- a) Unless otherwise specified, glass pane used in glazed or paneled and glazed shutters, shall be of good quality glass of thickness not less than 2 mm for pane up to 0.1 sq.m. in area not less than 3 mm for glass pane of area larger than 0.1

sq.m. with a tolerance of 0.2 mm in both cases. The glass shall be free from flaws such as speaks, bubbles, smoke waves, air holes, etc. and shall conform to the relevant IS: 1761.

- b) Unless otherwise specified, glass panes used in shutters of bath room and lavatories shall be frosted and of thickness as mentioned above and shall be free from any flaws.
- c) Where so specified, special quality glass such as plate glass, wired glass flat glass etc. shall be used. They shall conform to relevant IS standards as regards quality.

3.2.2 Putty for glazing in wooden frames of doors and windows

Putty shall be prepared by mixing one part of white lead with three parts so finely powdered chalk and then adding boiled linseed oil and mixing the whole thing into a homogeneous stiff paste. It shall be free from impurities like dust, grit, etc. and shall conform to IS: 419.

3.2.3 Fittings

The item of wood work of joinery generally includes fittings such as hinges and screws for fixing of door shutters and is explicitly so mentioned in the item.

3.2.4 Hinges

Hinges shall be of iron, brass, aluminum or any other material as specified they shall present a neat appearance and shall operate smoothly. All hinges shall be of steel and their riveted heads shall be well formed and smooth. Hinges shall be of the type specified and shall conform to the relevant Indian Standard Specifications.

4.0 WORKMANSHIP

4.1 Wood Work, Wrought, Framed and Fixed

4.1.1 General : The work shall be carried out as per detailed drawings and/or as directed by the PMC. The wooden members of the frame shall be planed smooth and accurate to the full dimensions. Rebates, rounding, mouldings, etc. as shown in the drawing shall be done before the members are joined into frames. Where wood work is not exposed to view as in the case of frames for false ceiling, however, no planning is required to be done unless specified expressly as rough timber work.

Note: The work wrought shall mean 'planed'

4.1.2 Jointing in timber frames must be made carefully and accurately. They shall be strong, neat and shall fit without edging or filling. The joints shall be pinned with hard wood or bamboo pins of 10 to 15-dia after the members of the frame are pressed together in a suitable vice-mechanism

4.1.3 The door and window frame shall have rebate to house the shutters and the depth of such rebate shall be 1.25 cm.

4.1.4 Wood work shall be painted, oiled, polished or otherwise treated as specified. All portions of timber abutting against masonry or concrete portion of building shall be coated with boiling coal tar or other type of approved wood preservatives primer, before placing them in final position.

4.1.5 Before any surface treatment is applied in the wood work shall be got approved by the PMC.

4.1.6 Fixing in Position

The frames shall be fixed only after acceptance by the PMC. In case of door frames without sills, the vertical members shall be buried in floor for the full thickness of the floor and the door frame shall be temporarily braced at the sill level so as to prevent warping or distortion of frame during construction.

4.2 Paneled, Glazed or Paneled and Glazed Shutters

4.2.1 General

The work shall be carried out as per detailed drawing. The wooden members shall be planed smooth and accurate. They shall be cut to the exact shape and sizes without patching or plugging of any kind. Mouldings, rebates, rounding, etc. shall be done, as shown in the drawing, before the pieces are assembled into the shutter.

4.2.2 Joinery work

- a) The thickness of the styles and rails shall be as specified in the item of work. The minimum thickness of panels shall normally be 15 mm where the clear width of panel is not more than 300mm and 20 mm where the clear width of the panel is more than 300 mm. However, where the PMC so considers lesser thickness up to 12 mm and 15 mm respectively may be allowed by him instead of 15 mm and 20 mm specified above. Solid wood panel for door and window shutters shall be made out of one or more strips of timber planks of not less than 125 mm width. It is preferable to use strips of not more than 200 mm width to reduce chances of warping, splitting or other defects. The timber strips shall be joined together with continuous tongued and grooved joints, glued together and reinforced with metal dowels. The grooving of the solid panel shall normally run along the longer dimensions of the panel unless otherwise directed. The corners and edges of panels shall be finished as shown in the drawing and these shall be feather tongued into styles and rails. Sash bars shall have mitres joints with the styles.
- b) Styles and rails of shutters shall be made out of single piece. Lock and intermediate rails exceeding 200 mm in width if permitted by the PMC may be made out of one or more pieces of timber but the width of each pieces shall not be less than 125 mm. where more than one piece of timber is used, they shall be joined with a continuous tongued and grooved joint glued together and reinforced with metal dowels (rust proof) at regular intervals of 20 cm or pinned with not less than three 40 mm rust proof pins of the lost head type.
- c) The tenons shall pass clear through styles. The styles and rails shall have a 12 mm groove to receive the panel.
- d) In case the double shutters the rebate at the closing junction of the two shutters shall be of depth not less than 2 cm.
- e) Shutter shall not be painted or otherwise treated before these are passed by the PMC and fixed in position.

4.2.3 Glazing

The glazing work shall be done in accordance with the specification given separately elsewhere.

4.2.4 Hold Fast

Hold fasts used for fixing doors and window frames shall be made of 40 x 3 mm flat iron and 40 cm long. It shall have two holes on one end for fixing to frame with long screws, and at the other end, the flat iron shall be split and bent at right angles in the opposite direction. The hold fast shall be tightly fixed to the frame by means of bolts, the bolt hole in frame being plugged suitably and finished neat. The hold fast shall be embedded into masonry by concrete block of 200 x 250 x 400 mm size.

5.0 FLUSH DOOR SHUTTERS

5.1 General : The door shall be of flush type solid core with single or double shutter as the case may be.

5.2 Shutters : The shutters shall be decorative or non-decorative type of the exterior or interior grade as described in the item and as shown in the drawings. It shall conform to the relevant specifications for the type and grade given in I.S. 2202/1983,

specifications for Wooden Flush door shutter (solid core type). The finished thickness shall be as mentioned in the item. Face veneers used shall be of the pattern and colour approved by the PMC.

5.3 Fixtures And Fastenings

- 5.3.1 These shall be as shown in table on the drawings or as indicated in the specifications. Where it is not specified they shall be oxidized brass and shall be of good workmanship. All fixtures and fastenings shall be sound and strong. They shall be sectional and of the best quality. The size, shape, design and finish shall be as shown on drawings and approved by the PMC.
- 5.3.2 Unless otherwise specified each leaf shall be hung with four hinges with screws. Each door shall be furnished with aldrop and latch, brass flush bolts, etc. the fixtures shall comply with the relevant Indian standards. Samples of all fixtures and fastening shall be got approved by the PMC and deposited in his office for reference.
- 5.3.3 All the fixtures shall be fixed to the joinery in a secure and efficient manner. Metal sockets shall be provided to all bolts where the shoots enter, stone, concrete

6.0 FIRE RATED WOODEN DOORS

- 6.1 Door Frame : Hard wood 120mm x 70mm with heat activated in tumescent fire seal strip of size 10mm x 4mm provided in grooves on all three sides with one coat of fire resistant primer.
- 6.2 Door : 50mm thick non –metallic Asbestos free Fire Resistant doors conforming to BS: 476 Part 20 , 22 / IS : 3614 Part 2 as per proto type tested and certified at CBRI Roorkee suitable for mounting on above door frame. The shutter shall be made of non combustible vermiculite board of 35mm thick sand witched with Fire resistant insulation material, faced with 3mm thick teak ply on both the faces and Hard wood lipping all around the shutter with heat activated in tumescent fire seal strip of size 10mm x 4mm mounted on the grooves in the shutter on all sides except bottom.
- 6.3 Hinges : Heavy duty & shall be fixed to each door shutter.
- 6.4 Door Handles & Hasp Bolts : Door Handle and Hasp Bolts shall be as per the approved list of make / approved sample by the ER/PMC
- 6.5 Vision Panel : Vision panels of size as per the detail drawing approved and two (1) hours fire rated doors shall be Borosilicate single clear toughened glass of as approved by the PMC or its equivalent make to the thickness of 6mm. to withstand one hours fire rating.
- 6.6 Door Hardware
 - 6.6.1 All door hardware shall be (1) hour fire rated. All fixtures and fastenings shall be sound and strong. They shall be sectional and of the best quality. The size, shape, design and finish shall be as shown on drawings and approved by the PMC.
 - 6.6.2 Unless otherwise specified each leaf shall be hung with four hinges with screws. Each door shall be furnished with aldrop and latch, brass flush bolts, etc. the fixtures shall comply with the relevant Indian standards. Samples of all fixtures and fastening shall be got approved by the PMC and deposited in his office for reference.
 - 6.6.3 All the fixtures shall be fixed to the joinery in a secure and efficient manner. Metal sockets shall be provided to all bolts where the shoots enter, stone, concrete etc.
- 6.7 Test : Proto type Test and certified at CBRI Roorkee meeting all criteria such as Stability, Integrity & Insulation
Size: 1100mm x 2100mm (Height) Approx. or As specified

PART 05 : GYPSUM CEILING

1.0 SCOPE

The specifications refer to gypsum ceiling work in the building. The work envisaged under these specifications refer to supplying and fixing in position false ceiling at any floor, any location and at any height.

- a) Providing and fixing suspended G.I. frame work
- b) Providing and fixing one layer of 12.5 mm Gypboard over this frame work.
- c) Jointing the board flush, applying two coats of primer suitable for Gypboard
- d) Making necessary cut out for light fitting, A.C. grills diffusers and other necessities. The work shall include horizontal, vertical and inclined surfaces depending upon the various requirements.

2.0 GENERAL & CODES

ASTM C1396

3.0 MATERIALS

3.1 G.I. FRAME WORK

3.1.1 The system consists of G.I. frame work suspended from the soffit of the RCC ceiling. The following G.I. components shall be used for grid work.

- a) Ceiling section which is the main supporting section to fix plasterboard 80 x 26 x 0.5 x 3660mm having ribbed surfaces
- b) 2. Perimeter Channel used to Fix around walls / partitions having Dimensions in (mm) as 20 x 27 x 30 x 3660mm
- c) 3. Intermediate Channel which is used to Primary section to support the ceiling section having Dimensions in (mm) as 15 x 45 x 15 x 3660
- d) 4. Ceiling Angle used to provide suspensions from the structural soffit having Dimensions in (mm) as 25 x 10 x 3660mm
- e) 5. Connecting clips of 2.64 mm dia.
- f) 6. Soffit cleat 22X37mm
- g) 7. Anchor fasteners 6 mm

3.1.2 All the G.I. components shall be of approved make. The G.I. grid work system shall be suspended from the soffit of RCC ceiling using anchor fasteners of 6mm of approved type and make and connected to soffit cleats and ceiling angle by means of necessary nuts, bolts and washers etc.

3.2 GYPSUM BOARD

3.2.1 Gypsum Board of plain series 12.5 mm manufactured by Saint Gobain India Gyproc or equivalent from the approved makes list shall be used. The Gyp board shall conform to IS 2095. The longitudinal edge of the Gyp board shall be of tapered / square edges, so as to have flush joints while fixing.

3.2.2 Handling and transporting of Gyp board shall be done carefully and as recommended by the manufacturers. The board should always be kept in a dry and covered place sheltered from rain and to avoid dampness from flow, they should be supported on wooden battens which should not be more than 45cm apart on a flat surface.

- 3.2.3 The material shall be stacked in piles of smaller heights and should not be stacked on edges. Gyp board which have deformed due to poor stacking should not be used. Cutting of board should be made in faced side of the board by means of retractable knife or by using a normal saw and the edges of the boards shall be planned using proper files.
- 3.2.4 Gypsum boards shall be of specified thickness and of specified finish shall be screw fixed to the underside of false ceiling grid system with 12.5 mm dia dry wall screw @ 230 mm C/C by drilling machine. Joints in the board shall be finished flush with fillers, finisher and primer as per manufactures recommendation to give a seamless finish.

4.0 INSTALLATION

4.1 SUSPENDED CEILING

- 4.1.1 M/F Suspended Ceiling includes G.I. perimeter channels of size 0.55mm thick having one flange of 20 mm and another flange of 30mm and a web of 27mm along with perimeter of ceiling.
- 4.1.2 It shall be screw fixed to brick wall / partition with the help of nylon sleeves and screws, at 610mm centers. G.I. intermediate channels of size 45mm [0.9 mm thick with two flanges of 15 mm each] shall be suspended from the soffit at 1220 mm centers with ceiling angle of width 25 x 10 x 0.55 mm thick, and fixed to the soffit with G.I cleat and steel expansion fasteners.
- 4.1.3 Ceiling section of 0.55 mm thickness having knurled web of 51.5 mm and two flanges of 26 mm each with lips of 10.5mm shall be fixed to the intermediate channel with the help of connecting clip and in direction perpendicular to the intermediate channel at 457mm centers.
- 4.1.4 9.5/12.5mm tapered edge Gypboard [conforming to IS: 2095- 1996 : Part - I] shall be screw fixed to ceiling section with 25 mm dry wall screws at 230mm centers. Screw fixing is done mechanically either with screwdriver or drilling machine with suitable attachment.
- 4.1.5 The boards are to be joined and finished so as shall have a flush look, which includes filling and finishing the tapered and square edges of the boards with Jointing compound, Joint paper tape and two coats of Drywall top coat suitable for Gypboard [as per recommended practices of BPB India Gypsum].
- 4.1.6 Alternatively, all square and tapered edge joints are to be filled with Universal Board finish plaster and joint paper tape embedded to complete the first application.
- 4.1.7 2 mm thick Board finished plaster shall be applied on the entire surface of Gypboard to achieve smooth and seamless finish. The plaster application shall be carried out with BPBT&T, as per the recommended specification of BPB India Gypsum.

PART 06 : MINERAL FIBER CEILING WORKS

1.0 SCOPE

The specifications refer to mineral fibre ceiling work in the building.

2.0 MATERIALS

2.1 TILES

- 2.1.1 Humidity Resistance (RH) 90%
- 2.1.2 NRC 70
- 2.1.3 Light Reflectance >85%
- 2.1.4 Thermal Conductivity $k = 0.052- 0.057$ w/m K,
- 2.1.5 Colour White
- 2.1.6 Fire Performance Class 0/Class1 (BS 476 Part 6&7)
- 2.1.7 size 600 X 600 mm or as per BOQ.

2.2 SUPPORTING GRID

- 2.2.1 The grid should be of approved make with 15mm wide T - section flanges colour white having rotary stitching on all T sections i.e. The Main Runner, 1200 mm & 600 mm Cross Tees . The T Sections have a Galvanizing of 120 grams per M2 & passed through 500 hrs of Salt test.
- 2.2.2 Perimeter trim shall be approved make wall angles of size 3000 x 19 x 19 mm, secured to walls at 450 mm maximum centres.
- 2.2.3 Suspension System accessories shall be of approved make and consisting of :
 - a) Anchor Fasteners with Vertical Hangers made of Galvanised steel of size 26 x 26 x 25 x 1.2mm with a Galvanised Thickness of 80gm/ sq.m
 - b) Pre Straightened Hanger wire of dia – 2.68 mm of 1.83 m length., thickness of 80 g/sq.m and a tensile strength of 344-413 MPa
 - c) Adjustable hook clips of 0.8mm thick, galvanised spring steel for 2.68 mm with a minimum pull strength of 110 kg
 - d) The adjustable clip also consists of a 3.5 mm aquiline wire to be used with the main runner.

3.0 WARRANTY

The Tile & Grid system used together should carry a 15 year warrantee.

4.0 INSTALLATION

- 4.1.1 Main runner spaced at 1200mm centres shall be securely fixed to the structural soffit using approved suspension system (specifications below) at 1200mm maximum centre. The First/Last suspension system at the end of each main runner should not be greater than 450mm from the adjacent wall.
- 4.1.2 Flush fitting 1200mm long cross tees shall be interlocked between main runners at 600mm centre to form 1200 x 600 mm module. Cross tees longer than 600mm that require independent support shall be cut.
- 4.1.3 600 x 600mm module shall be formed by fitting 600mm long flush fitting cross tees centrally between the 1200 mm cross tees.

PART 07 : STONE CLADDING WORKS

1.0 SCOPE OF WORK

1.1 Stone work shall include providing stone veneering or cladding to internal and external surfaces of the buildings including terraces, pergolas, posts and railings, chajjas, fascias, gargoyles, sides of beams/ columns, soffits of slabs/ beams, parapets, copings, etc. whether in RCC or concrete or brick masonry or steel/ metal all to patterns, shapes and thickness, all as shown on the "Construction" drawings or as specified or as directed by the PMC, complete in all respects to give the quality of finished work as desired by and to the entire satisfaction of the PMC.

2.0 Grid / Panel Size

2.1 For typical stone cladding pattern please refer Tender drawings.

2.1.1 The bidder can suggest and quote for an alternative Grid Size for the Glazing system, so as to optimize on the consumption and wastages of the materials involved. However Authoritys shall have the final authority to decide on the Grid size to be executed.

3.0 SAMPLES

3.1 Cladding Stone : The Contractor shall supply 02 nos of each of the 04 options of stone as specified. Separate set of samples shall be supplied for the same stone but with a different finish. The sample shall be 200 mm square. and 100 mm on bed with specified finish on one face and one return. 02 samples shall be approved and the same shall be installed in the True scale Mock up

3.2 Samples of all accessories, hardware, fixings, angels, cramps, etc, used in the installation of the stone cladding shall be provided and duly approved by the Authoritys.

4.0 TRUE SCALE MOCKUPS

4.1 As per tender drawings.

5.0 MATERIALS

5.1 Stone

5.1.1 The stone shall be of the type specified in the Schedule of Quantities and shall be obtained from the quarries, approved by the PMC.

5.1.2 Stone shall be hard, sound, durable and tough, free from cracks, decay and weathering and defects like cavities, cracks, flaws, sand holes, veins, patches of soft or loose materials, etc. and other similar defects that may adversely affect its strength and appearance.

5.1.3 Generally stone shall also not contain crypt, crystalline silica or chart mica and other deleterious materials like iron oxide organic impurities, etc.

5.1.4 All stones used on one face of the work shall be from one lot and shall be of uniform colour, quality, texture and grain.

5.1.5 The Contractor shall provide stones to match approved samples and they shall comply with the following:

5.1.6 The stone shall be cut into slabs of required thickness with the natural bed of stone at right angles to the exposed surface.

- 5.1.7 Stone shall be properly seasoned as recommended by the quarry and brought to the proper condition for use.
- 5.1.8 Each worked stone shall be marked with the natural or quarry bed.
- 5.1.9 Stone shall be supplied to the site with all shaping and machining completed at the masonry yard. The mortices, sinkings, perforations and notches for cramps, dowels and corbel plates for supporting nibs shall be carefully formed, to ensure alignment of adjacent stones, in accordance with approved working drawings.
- 5.1.10 Feature stones shall be marked for identification with drawings.
- 5.1.11 Stone shall be finished, as specified, for all faces and returns, etc. visible in the finished work.
- 5.1.12 Stone shall be worked truly square from all face lines for the full width and thickness.
- 5.1.13 The minimum thickness of stone behind a cramp mortice shall not be less than that specified.
- 5.2 Materials for mortar :
 - 5.2.1 Cement : Pozzolana Cement conforming to IS: 1489 shall be used. The cement shall be non-staining to the stone for cladding. The total chloride content of the cement shall not exceed 0.05%.
 - 5.2.2 White Cement: This shall conform to IS: 8042. The cement shall be non-staining to the stone for cladding.
 - 5.2.3 Sand: Crushed stone shall be used to match the stonework and shall be graded to comply with approved sample.
 - 5.2.4 Coarse Sand: This shall conform to IS: 383 and shall be used for grouting of the stonework.
 - 5.2.5 Pigment: This shall conform to BS: 1014 or as per approved sample.
 - 5.2.6 Water: Water shall conform to the requirements of IS: 456.
 - 5.2.7 Note: Calcium Chloride shall not be used.
- 5.3 Mix proportion & Process of mixing
 - 5.3.1 Mortar for the work shall be made of 1 cement : 2 Stone dust. Only one type of mortar shall be used for any one type of work. The proportions shall be adjusted to suit the stone dust and weather conditions.
 - 5.3.2 Mortar shall be mixed by machines.
- 5.4 Ancillary Materials:-
 - 5.4.1 Compressible joint filler: Rigid Polyethylene foam or Rigid Polystyrene of 30 kg/cum density filler sheet or strip.
- 5.5 Metal fixings:
 - 5.5.1 Dowels, cramps, ties and other metal fixings shall be fabricated from austenitic stainless steel sheet, strip or plate conforming to ASTM A240 Gr 304 or bar to ASTM A479 Gr 304.
 - 5.5.2 Overtightening and bending of fixings to accommodate inaccuracies shall not be allowed.
 - 5.5.3 Each vertical unit shall be secured with two support cum restraint purpose fixings and two restraint purpose fixings plus two pins. Each soffit unit shall be secured with four support cum restraint fixings.

- 5.5.4 The sectional size of a cramp be less than 25 mm x 6 mm and that of pins for securing adjacent stones shall not be less than 75 mm long and 6 mm diameter.
- 5.5.5 The minimum thickness of stone behind a cramp mortice shall be 37 mm and the minimum depth of slot for a corbel plate shall be also be 37 mm.

5.6 Expansion Bolts:

- 5.6.1 Expansion bolts/ fasteners shall be fabricated from austenitic stainless steel sheet, strip or plate conforming to ASTM A240 Gr 304 or bar to ASTM A479 Gr 304.or an approved material of approved make and design
- 5.6.2 For steel backings the fasteners shall be prevented from contact with other metals, which would lead to bimetallic corrosion.
- 5.6.3 For brick masonry backing the sleeves of the expansion bolts shall be fixed in wedge shaped pockets having an area of 75 mm x 75 mm at the surface and 100 mm x 100 mm at the inner surface and shall be 125 mm deep. The wedge could also be as a truncated cone of 75 mm dia/ 100 mm dia. The wedge shall be filled with PCC 1:1:2 (1 Cement, 1 Coarse Aggregate 12 mm and down and 2 coarse sand) mixed with non-shrink compound in the proportion as recommended by the manufacturer.
- 5.6.4 All vertical fasteners/ expansion bolts fixed into soffits shall be bonded to the backing with epoxy/ polyester resin of approved make.
- 5.6.5 All expansion bolt fixings shall be tightened in accordance with the recommended torque figures by the manufacturer. Where such values are not available the Contractor shall test at least 6 samples to determine the safe torque values. All bolts shall be tightened using torque spanner/ wrenches. All bolts shall be checked 24 hours (minimum) after installation and retightened if necessary.
- 5.6.6 The minimum depth of the expansion bolt to be considered for effective penetration shall be as given in the Table below.

Type of fixing	Structural backing material	
	Concrete	Brickwork
Load bearing	75 mm	100 mm
Soffit	75 mm	100 mm
Restraint	50 mm	75 mm

- 5.6.7 Joint Sealant : One part gun-grade polysulphide sealant conforming to BS: 5215 or silicone based sealant conforming to BS: 5889. The sealant shall be of an approved colour and shall be non-staining to the stone for cladding.
- 5.6.8 Backing to Sealants : An expanded polyethylene cord or strip as recommended by the sealant manufacturer.

5.7 Epoxy Grouts:

- 5.7.1 Laticrete 111 Crete Filler Powder and Laticrete 73 Latex thin set mortar additive of Laticrete System or approved equivalent for concrete or masonry surfaces.
- 5.7.2 Latapoxy 310 of Laticrete System or approved equivalent for stone surface.

6.0 HANDLING AND STORING MATERIALS

- 6.1.1 All stone shall be stacked on a clean dry free-draining surface, be prevented from contact with soil and shall be protected from extreme weather conditions. The stone shall be covered with non-staining tarpaulins and protected from rain.
- 6.1.2 The Contractor shall take steps to ensure that there is no danger of breaking and damage to the stone. The storage areas shall be clear of all other operations.
- 6.1.3 The Contractor shall prevent damage to the stones due to handling and transport. Handling shall be planned and reduced to a minimum.

7.0 DRESSING

- 7.1.1 The edge of all stones at corners or junctions, soffits, projections, etc. shall be fine chisel dressed with single or double rebate as directed.
- 7.1.2 The edges of stones shall be fine chisel dressed with chamfer to form V-groove.
- 7.1.3 Machine cutting shall be resorted to instead of hand cutting for all stone work.
- 7.1.4 All copings shall project 40 mm from the surface of the cladding with a continuous drip mould of 10 x 10 mm, 15 mm from the edge.

8.0 WORK PROCESS

8.1 Initial Suitability Check:-

- 8.1.1 The Contractor shall survey the structure and check that the backgrounds are suitable and fit to receive the specified stone cladding work with the specified backing, fixing and finishing and that they will enable the specified finished lines, levels, flatness and tolerances to be attained. Deficiencies, if any, shall be brought to the notice of the PMC.
- 8.1.2 The Contractor shall also submit the remedial measure that he proposes to undertake to make the background suitable and fit. Remedial measures shall be initiated only after they are approved by the PMC. Nothing extra shall be paid for executing the remedial measures.

8.2 Service & 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 PMC.

8.3 Setting out:-

- 8.3.1 The Contractor shall set out the stone cladding work so as to achieve the following:
- 8.3.2 Establish a bench mark or datum at each floor level for setting out.
- 8.3.3 Establish a vertical centre line in each plain area.
- 8.3.4 Establish the positions of movement joints.
- 8.3.5 Avoid or minimise unsightly cutting.
- 8.3.6 Obtain truly horizontal joint lines.
- 8.3.7 Where openings and other features occur the work shall be done as per the detailed drawings or as directed by the PMC.

8.4 Preliminary Surface Preparation:-

- 8.4.1 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:
- 8.4.2 Withholding application until curing and drying shrinkage of the structural backgrounds are achieved.
- 8.4.3 Fungicidal wash as approved to remove any organic growth.

- 8.4.4 Removal of any greasy deposits by scrubbing with water and approved detergent.
 - 8.4.5 Final brushing to remove laitance, efflorescence or loose material.
 - 8.4.6 Wetting to reduce suction or to obtain uniformity of suction.
 - 8.4.7 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 and 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.
- 8.5 Laying:-
- 8.5.1 The requirements given under clause 7.7.4 of CPWD specifications 91 – 92 shall be superceded by the requirements given below.
 - 8.5.2 The stone cladding shall be constructed as follows:
 - 8.5.3 All stones and all jointing surfaces shall be made perfectly clean and free of dirt, dust, grease or other deleterious material.
 - 8.5.4 The stones shall be soaked in clean water for at least 30 minutes.
 - 8.5.5 Stones shall be used with the natural bed at right angles to the exposed surface.
 - 8.5.6 The rendering shall be damped just sufficiently to prevent excessive water absorption from stones.
 - 8.5.7 The bedding surfaces of small units shall be well wetted and the units stood on a full bed of mortar and tapped home.
 - 8.5.8 For very large or heavy units, a mortar bed shall be screeded level and full but kept back 20 mm from the face, before the stone is lowered into place. All joints shall be as completely filled as possible.
- 8.6 Spacer Dabs:
- 8.6.1 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.
 - 8.6.2 In case of light coloured stones for linings the back of the stone shall be buttered with white cement so as to enhance its appearance aesthetically.
 - 8.6.3 It shall be ensured that stones are flat and true by means of a straight edge. Adjustments, if necessary, shall be made within 10 minutes of fixing.
- 8.7 Jointing:-
- 8.7.1 The requirements given under clause 7.7.5 of CPWD specifications 91 – 92 shall be superceded by the requirements given below.
 - 8.7.2 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.
 - 8.7.3 All joints shall be filled solid with 1 : 2 mortar (1 white cement with pigment : 2 stone dust) except for projecting members of overhanging cornices, which may be provided with hollow bedding where approved by the PMC. Excess mortar shall be cleaned off immediately so that no mortar is visible on the face of the stone cladding.
 - 8.7.4 All stones shall be secured to the backing by means of stainless steel cramps, pins, anchors, fasteners and expansion bolts as shown on the “Good for Construction” drawings and approved shop drawings and as approved by the PMC.

8.7.5 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.

8.7.6 No stone shall bridge the expansion/ separation gap provided in the structure.

8.8 Grouting:-

8.8.1 The stone joints shall be grouted using 1 : 3 mortar (1 cement (grey) : 3 stone dust) as follows:

8.8.2 Grouting shall be done at any time after the stones are firmly fixed, but before any dirt or contamination can enter the joints.

8.8.3 Grouting materials shall be mixed to correct consistency and applied to as large an area as can be worked before hardening commences.

8.8.4 The grout shall be worked well into the joints/ gaps between the stone and the backing until they are completely filled.

8.8.5 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.

8.8.6 If any hollow surroundings are detected by tapping the stones, these shall be taken out and relaid.

8.9 Scaffolding:-

8.9.1 Only steel tube scaffolding of approved design shall be used for all works. The scaffold structure shall comply with the requirements of IS: 4014 and IS: 3696.

8.9.2 An independent tied scaffold (double scaffold), which has two lines of standards, shall be provided with the inner line kept at least one board clear of the finished face with extended transoms, or hop up baskets to carry an inside board.

8.9.3 Diagonal braces shall not prevent the material being moved along the scaffold run.

8.9.4 The scaffolding shall be suitably packed at the ends to prevent damage to the finished work

8.9.5 Cleaning & Completion : On completion of the stone cladding all the works cleaned of all dust and other deposits by washing together with detergent or other admixtures, with the approval of the PMC.

9.0 MOVEMENT JOINTS

9.1.1 A clear 10 mm wide horizontal joint shall be provided at every floor level as shown on the "Construction" drawings.

9.1.2 The joints shall be formed using a shelf type stainless steel channel type or z-shaped load bearing fixing.

9.1.3 An approved sealant shall be provided in the movement joints.

9.1.4 The joint for sealants shall be clean, dry, rectangular and formed by means of a removable fillet (such as a premoulded joint filler) for the depth of the stone cladding and backing.

9.1.5 The joint must be later duly sealed after cleaning, drying and placing backing material.

9.1.6 The treatment for the horizontal and vertical separation/ expansion joints shall be done in a similar manner.

10.0 ANCILLARY WORK

10.1 The Contractor shall

10.1.1 Form all chases and fixings, etc. as the work proceeds.

- 10.1.2 Temporarily support or brace items liable to distortion.
- 10.1.3 Cut into masonry subject to the following:
- 10.1.4 Delay cutting until the mortar has hardened.
- 10.1.5 Perform cuttings in a manner that involves minimal vibration to the wall.
- 10.1.6 Sills, Copings, Chajjas, Projecting Units:-
- 10.1.7 All sills, copings, chajjas, projecting units and the like shall be provided with a rebate on the underside/ soffits so as to provide a clean fit joint with the vertical facing stone.
- 10.1.8 All sills, copings, chajjas, projecting units and the like shall be provided with a drip mould cut in chase on the underside.

11.0 TOLERANCE FOR FINISHED WORK

11.1 The finished work shall conform to the following tolerance:

11.1.1 All hairline joints shall be in perfect lines and levels.

11.1.2 Plumb:

In any 3 m	± 5 mm
Maximum per floor	± 10 mm
Maximum for total height	± 15 mm

11.1.3 Horizontal:

In any 3 m	± 5 mm
Maximum for total length	± 10 mm

12.0 ACCEPTANCE CRITERIA

12.1 Periodic acceptance of work:- The work executed on any day shall be checked at the end of that day or the next day before commencement of further work.

12.2 Final acceptance of work:-

12.2.1 Various stages of approval are required to be met by the Contractor. Regardless of the periodic acceptance of work, the final acceptance shall only be accorded once the entire work is complete in one area of the building, after all other works as per this Contract have also been duly completed and accepted.

12.2.2 The Contractor shall ensure that the stone work is so constructed that it prevents rainwater from reaching its inside surface and rainwater falling or running down its external surface does not cause permanent or significant temporary deterioration in its performance. All units and joints between units shall be designed to prevent ingress of water by capillarity.

12.2.3 The Contractor shall ensure that the risk of attack or infestation by micro-organisms, fungi, insects and other vermin is minimal and also that there is no ingress of vermin into the building.

13.0 PROTECTION

13.1 The Contractor shall protect all work until handing over.

13.2 The lower courses shall be protected with heavy polyethylene sheeting, not less than 1000 gm/sqm, while work is in progress at higher elevations.

PART 08 : AL GLAZING / DOORS / WINDOWS / SKYLIGHT / ATRIUM WORKS

1.0 SCOPE

The specifications refer to AL glazing / doors / windows / skylight / atrium works in the building.

2.0 GLASS

2.1 General

2.1.1 Provide glazing systems, glass and glazing accessories which comply with all performance requirements.

2.1.2 Glass thickness shall be designed by the Façade Subcontractor but shall not be not less than indicated in Appendix B of this Specification.

2.1.3 Glass type, color, shade, tint and physical / photometric properties shall comply or outperform the benchmarks as indicated in Appendix B of this Specification.

2.1.4 All glass in the same visual plane shall be of the same thickness unless otherwise Accepted and Endorsed.

a. In case the total Lite thickness varies in the same visual plane, the system shall include spacers to maintain projection standard / alignment on the external side.

b. The Façade *Subcontractor* shall consider all potential risk locations including but not limited to the following:

- i. Heat **build-up** at shadow boxes and other non-vented spaces/zones.
- ii. Make provision for internal curtains or blinds within the building envelope framework which may temporarily create non vented spaces prone to heat build-up adjacent to the vision section of the building envelope system.
- iii. Shadowing effects.
- iv. Probability of breakage of glass due to anticipated thermal stress in glass shall not exceed 8/1000).

2.2 It is the responsibility of the contractor to determine the maximum design wind pressure and lateral forces applicable for that particular building. Negative pressures if determined using the wind code and Lateral forces using the Seismic code will make allowances for corner effects as described in the code.

2.3 Relevant Standards:

2.3.1 ASTM C1036 - Standard specification for flat glass.

2.3.2 ASTM C1048 - Standard specification for heat-treated flat glass – Kind HS, kind FT, coated and uncoated glass.

2.3.3 FGMA - Glazing Manual.

2.4 Annealed Glass

2.4.1 All glass shall be free from cracks, scratches, bubbles, blisters, all inclusions of deleterious matter including nickel sulphide and other defects, which detract from appearance or interfere with performance.

2.4.2 All glass shall have clean, wheel cut edges with minimum feather, free from vents, notches, or shells.

- 2.4.3 Products shall be reputable proprietary products, factory manufactured under ISO 9002.
- 2.4.4 Products which may be Accepted include those manufactured by:
 - a. Pilkington Glass
 - b. Asahi Glass
 - c. Saint Gobain
 - d. Sejal Glass
 - e. Glaverbel
 - f. Emirates Glass
- 2.4.5 Edge quality criteria for annealed and heat strengthened glass are as follows:
 - a. Shark teeth shall not penetrate more than half of glass thickness.
 - b. Serration hackle may occur only within 150 mm of corners.
 - c. Flare shall not exceed 1 mm measured perpendicular to glass surface across the edge. Flare shall not occur at setting blocks.
 - d. Bevel shall not exceed 1.5 mm.
 - e. Flake chips may occur only within 200 mm of corners. Depth shall not exceed 1 mm and length or diameter shall not exceed 6 mm.
 - f. Rough chips which exceed any of the dimensional limits for flake chips are not permitted.
- 2.4.6 Relevant Standards:
 - a. ASTM C1036 - Standard specification for flat glass.
 - b. FGMA - Glazing Manual.
- 2.5 Heat-Strengthened and Fully Tempered Glass:-
 - 2.5.1 Provide Accepted heat strengthened glass and fully tempered glass, manufactured using the "roller hearth", or an equivalent Accepted process in accordance with AS 2208, ASTM 1048 and/or ANSI Z97.1.
 - 2.5.2 Base material shall be an Accepted selected quality float glass.
 - 2.5.3 Edge quality:
 - a. All toughened glass shall have bevel edged edges.
 - b. All heat strengthened glass shall have clean cut edges.
 - c. Do not cut, work, or permanently mark after toughening. Use installation methods which prevent the glass making direct contact with metals or other non-resilient materials.
 - 2.5.4 Relevant Standards:
 - a. ASTM C1048 - Standard specification for heat-treated flat glass - Kind HS, kind FT coated and uncoated glass.
 - b. ASTM C1087 - Standard test method for determining compatibility of liquid-applied sealants with accessories used in structural glazing techniques.
 - 2.5.5 Heat strengthened and Tempered / Toughened glass shall be examined by the glass manufacturer to detect and discard any lights, which exceed the following tolerances:
 - a. Where the strengthening process results in essentially parallel ripples or waves, the deviation from flatness at any peak shall not exceed 0.230 mm

with in the 265 mm of a leading or trailing edge and the difference between adjacent peaks shall not exceed 0.076mm within the main body or size of the sheet.

- b. Where bow tolerance and wave tolerance differ, the stricter requirement shall govern. Direction of ripples shall be consistent and in conformance with Architectural design intent. The specification defines nickel sulphide stones as a glass material defect.
- c. It is recommended that an inspection procedure be used to eliminate the incidence of Nickel Sulphide (NiS) inclusions in all Heat strengthened / Tempered glass.

2.6 Laminated Glass

- 2.6.1 Provide all required laminated glass in accordance with AS 2208 and FGMA Glazing Manual.
- 2.6.2 The base material shall be an Accepted selected quality float glass.
- 2.6.3 Provide an Accepted polyvinylbutyral (PVB) interlayer.
- 2.6.4 Products which may be Accepted include DuPont "Butacite", or Accepted equivalent.
- 2.6.5 Edge quality:
 - a. All laminated glass shall have clean cut edges, or polished edges if required to eliminate thermal stress breakage risk.
 - b. Use glazing materials which do not cause deterioration or discoloration of the interlayer.
- 2.6.6 Heat soak procedure shall be followed to minimize the incidence of NiS induced failures if specified in any particular item of work like Entrance glazing fixed in spider fittings and the door (Open able/sliding) with patch/Manet fittings, on prior approval by Authority/PMC/Architect.
- 2.6.7 Relevant Standards:
 - a. FGMA - Glazing Manual
 - b. ANSI Z97.1- Glazing materials used in building – Safety performance specifications and methods of testing.

2.7 Insulating Glass Units:-

- 2.7.1 Provide Insulating Glass Units (IGUs) (also known as double-glazed units) of Accepted types in accordance with ASTM E774, AS 2208, and the recommendations of SIGMA using Heat Strengthened Glass.
- 2.7.2 Seal performance : Insulated glass shall have double edge seals.
 - a. The primary seal between spacer and glass shall be a continuous butyl tape with no skips or voids. IGUs shall incorporate accepted polyisobutylene primary(vapour) seals continuously bonded to glass, and two-part silicone secondary (structural) seals. Primary seal shall be not less than 3 mm deep.
 - b. Spacer bar shall be an proprietary aluminium type, desiccant filled, anodised in a color compatible with seals. The spacer shall be of Black color and the same shall be bent to shape of glazed unit profile and the bent black spacer shall be filled with desiccant drying agent of Molecular sieve or silica gel or blend of both.

- c. The secondary seal shall completely cover the spacer with no voids or gaps, and shall be continuously bonded on both plates of glass. The secondary seal shall be Structural Sealant of Dow corning or GE Bayer silicones Single / Two part silicon sealant – DC 983 or DC 995 of Dow corning or ultra glaze SSG 4000/4400 of GE Bayer silicones or approved equivalent.
 - d. The required thickness of the secondary seal shall be determined by calculation and verified by testing of samples as specified.
 - e. The Glass panel shall be separated by a de-hydrated air space specified.
 - f. Edge seal construction of the insulated unit shall be able to withstand at least three times the stress caused by the design wind pressures.
 - g. Edge seal construction of the insulated unit will be tooled to a smooth clean surface between the interior and exterior glass edges. Samples shall be submitted to Authority/PMC/Architect for approval. The approved sample shall be retained at the job site and Structural Glazing Panel / Window manufacturer's assembly facility for ready reference.
- 2.7.3 For a period not less than the warranty period, all IGUs shall be free from evidence of manufacturing defects and shall be free from:
- a. Intrusion of moisture or dirt.
 - b. Internal condensation at temperatures above -10 C-degrees.
 - c. Other visual evidence of seal failure or performance failure.
- 2.7.4 Relevant Standards:
- a. ASTM C1087 - Standard test method for determining compatibility of liquid-applied sealants with accessories used in structural glazing techniques.
 - b. ASTM E546 - Test for dew point of sealed insulating glass units.
 - c. ASTM E773 - Standard test methods for seal durability of sealed insulating glass units.
 - d. ASTM E774 - Standard specification for sealed insulating glass units.
 - e. SIGMA - Sealed and Insulating Glass Manufacturer's Association.
- 2.8 Visual Effects, Opacifiers and Coatings:-
- 2.8.1 Provide coatings and visual effects of paint, coatings or interlayer to glass to match Accepted samples.
- 2.8.2 Coatings may include:
- a. Translucent, coloured or patterned interlayer to laminated glass.
 - b. Decorative painted patterns, colours and textures.
 - c. Reflective or Low-E solar control coatings.
- 2.8.3 Relevant Standards:
- a. PBS-4-0885.
- 2.9 Glass Coatings:-
- 2.9.1 Relevant Standards:
- a. PBS-4-0885
 - b. BS (EN) 1096
 - c. ASTM 1376

2.10 Decorative Ceramic Paints :-

2.10.1 All ceramic fritted glass shall have ceramic paint applied to the glass using the silkscreen process, and fused into the surface of the glass during the heat treatment process.

2.10.2 Paint coverage shall be to within 6 mm of the edge of the glass.

2.10.3 Defects, including scratches and pinholes shall not be visible when viewed at a distance of 3m.

3.0 GLAZING ACCESSORIES

3.1 General

3.1.1 Provide Accepted non-cellular elastomeric extruded profiles, including gaskets, seals and glazing accessories, required for a complete installation, in accordance with ASTM C864.

3.1.2 Glazing accessories, including spacers, setting blocks, wedges, and the like, shall comply with AS 1288, and the recommendations of the glass manufacturer or glazing system.

3.1.3 Relevant Standards:

AAMA 701.2	Specification for pile weatherstrip.
ASTM C864	Specification for dense elastomeric compression seal gaskets, setting blocks and spacers.
BS 2571	General-purpose flexible PVC compounds for moulding and extrusion.
BS 4255	Rubber used in preformed gaskets for weather exclusion from buildings
BS 4255.1	Specification for non-cellular gaskets.
ASTM D1149	Standard test method for rubber deterioration -Surface ozone cracking in a chamber (Flat Specimens).
ASTM D2240	Standard test method for rubber property - Durometer hardness.
ASTM D297	Standard test method for rubber products – Chemical analysis.
ASTM D395	Standard test method for rubber property - Compression set.
ASTM D412	Standard test method for rubber properties in tension.
ASTM D624	Standard test method for rubber property – Tear resistance.
ASTM D746	Standard test method for brittleness temperature of plastics and elastomers by impact.
ASTM D865	Standard test method for rubber - Deterioration by drying in air (test tube enclosure).
BS 4315.2	Methods of test for resistance to air and water penetration.

3.2 Gaskets

3.2.1 Co-extrusions : Provide Accepted coextruded profiles of polypropylene and polypropylene compatible products.

- 3.2.2 Hard profiles : Provide dense profiles including flashings, wiper seals and the like, complying with ASTM C864.
- 3.2.3 Soft profiles : Provide soft profiles including bulb seals, sponge seals and the like, complying with ASTM C509.
- 3.3 Setting Blocks and Side Blocks
 - 3.3.1 Settling Blocks:
 - a. Locate setting blocks at quarter points unless otherwise Accepted but not less than 150 mm or 0.125 x glass width between edge of glass and edge of setting block.
 - b. Setting Block lengths shall be calculated in accordance with BS6262 and shall be not less than 80mm.
 - 3.3.2 Side Blocks:
 - a. Install side block with 3 mm clearance between block and bearing surface. Block shall be of sufficient length to prevent point loading on the glass.
 - b. Side blocks are not required where glass is supported along the vertical edges with structural silicone.
 - 3.3.3 Pads:
 - a. Provide Accepted friction reducing pads to separate moving surfaces at all connections subject to thermal or other movement (Acceptable materials include Teflon).
 - b. Pads shall have minimum 3 mm thickness, shall sufficiently reduce friction to permit movement, shall be resistant to wear, shall be positively retained in position (open ended slots are not acceptable).
 - c. Pads shall not be subjected to heat damage from welding or cutting, or to excessive pressure from over-tightening of bolts.
 - 3.3.4 Shims:
 - a. Shims which transfer shear forces shall be steel plates, set in a staggered pattern and fillet welded to each other and adjacent steel surfaces.
 - b. Polypropylene shims may be Accepted at static connections where shims transfer only compressive loads.
 - 3.3.5 Contact With Structural Silicone Sealants : Extruded profiles in contact with structural silicone sealants shall be black, heat cured, silicone rubber.
- 3.4 Structural Silicone
 - 3.4.1 Design and provide structural sealant glazing systems where indicated on the Drawings, or otherwise if Accepted in writing. All structural silicones shall be from Dow Corning, Sika or Accepted equivalent. Comply with minimum dimensional requirements for edge clearance, edge cover, front clearance, back clearance, and as required by AS 1288 and sealant manufacturer.
 - 3.4.2 Relevant Standards:
 - a. AAMA CW 13 - Structural sealant glazing systems (A Design Guide), Aluminium Curtain Wall.
 - b. Dow Corning - Structural Glazing: Industry Code of Practice.
- 3.5 Silicone Sealants
 - 3.5.1 Provide Accepted elastomeric joint sealants and joint fillers where indicated on the Drawings and required. All silicone sealants shall be from Dow Corning, Sika or equivalent Accepted by the PMC. All sealants for each joint type shall be the same product and from the same manufacturer.

3.5.2 Relevant Standards:

- a. ASTM C510 - Standard test method for staining and colour change of single or multi-component joint sealants.
 - a. ASTM C794 - Standard test method for adhesion-in-peel of elastomeric joint sealants.
 - b. ASTM C962 - Standard guide for use of elastomeric joint sealants.
 - c. ASTM D2203 - Standard test method for staining of caulking compounds and sealants.
 - d. ASTM D412 - Standard test method for vulcanised rubber and thermoplastic elastomers - Tension.
 - e. ASTM D897 - Tensile testing of adhesive bonds.
 - f. FGMA - Sealants manual.
 - g. TT-S 001543A - Sealing compound, silicone rubber base (for caulking, sealing and glazing in buildings and other structures).
 - h. TT-S 00227E - Sealing compound, elastomeric type, multicomponent (for caulking, sealing and glazing in buildings and other structures).
 - i. TT-S 00230C - Sealing compound, elastomeric type, single component (for caulking, sealing and glazing in buildings and other structures).
 - j. TT-S 01657 - Sealing compound, single component butyl rubber based, solvent release type (for buildings and other types of construction).

3.5.3 Movement requirements:

- a. Where sealants are used to seal movement joints, movement capability of sealant shall be appropriate to expected maximum deflection or movement.
- b. Unless otherwise Accepted, sealant depth for movement joints shall not exceed half the joint width.

3.5.4 Fire rated requirements:

- a. Provide Accepted fire-rated sealant and joint fillers where indicated or required. All fire rated products shall comply with the Relevant Indian Standards.
- b. Fire-rated fillers may include elastomeric sealants and rigid dry foam fillers.
- c. Rigid dry foam fire rated fillers which may be Accepted include Epirez "Firemaster", or equivalent.
- d. Where dry foam fire rated fillers are proposed for wall types which also have acoustic or air infiltration requirements, provide an elastomeric cover bead.

3.5.5 Compatibility : All proposed sealants and accessories shall be compatible with substrates, adjacent materials, accessories and other sealants, and shall be non-staining and non-bleeding.

3.5.6 Sealant Accessories : Provide all required accessories recommended by sealant manufacturer, including backing rods, bond breaker tape and the like.

3.5.7 Backer Rods : Backer rods shall be silicone compatible, non-gassing and non-staining.

3.5.8 Tapes:

- a. Tapes shall be by Norton or equivalent Accepted by the PMC. They are to be silicone compatible, non-gassing and non-staining.

- b. Tapes shall align with the glass edge to within +/- 1mm. They shall be held by sealant or a captive edge so as to be prevented from dislodging in the event of a breakdown to the adhesive surfaces.
- c. Tapes are not permitted to be used as an airseal or rainscreen to the building envelope system or in place of a compression gasket in a glazing rebate.

3.6 Point Supported Fixing Brackets (Spiders):-

- 3.6.1 The spider fittings shall be manufactured from the lost wax casting process with standard 316 grade stainless steel with a tensile strength of 600mPa.
- 3.6.2 The Spider assembly is to be completed with fasteners consisting of swivel articulated countersunk bolts and round headed nuts, manufactured from 316 grade stainless steel rod with machined screw threads complying to ISO965/1 metric M thread profile.
- 3.6.3 Swivel articulated countersunk head screws is the fixing member which is manufactured from 316 Grade stainless steel with tensile strength of 600 MPa, a Yield Strength of 220 MPa and with external threads complying with the British standard BS3643.
- 3.6.4 The fittings are protected from direct contact with the glass by an insulating material.
- 3.6.5 The glass hole is insulated from the countersunk screw by a black countersunk, U.V resistant nylon or anodized aluminium bush.
- 3.6.6 A threaded collar is utilized for efficient transfer of load from the glass to the Spider fitting and manufactured from 316 Grade stainless steel.
- 3.6.7 Non-compressible vulcanised fibre gaskets insulates between metal to metal surfaces to eliminate undue noise.
- 3.6.8 A washer, manufactured from 316 grade stainless steel with a tensile strength of 600 MPa, distributes the clamping load.
- 3.6.9 A spring washer manufactured from 316 stainless steel acts as a lock mechanism to secure the nut in place ensuring full tightness for long periods of time.
- 3.6.10 The Spider assembly is securely fastened using 316 grade nuts, with internal threads complying to BS3643.

3.7 Tension Anchor Brackets:-

- 3.7.1 All Brackets providing end fixings for the tension rod systems shall be fabricated from high strength low thermal expansion ferritic austenitic 2205 duplex stainless steel with an ultimate tensile strength of 800mPa or equivalent.

3.8 Suspension Rods:-

- 3.8.1 The vertical suspension rods shall be machined from standard size round bar of high strength low thermal expansion ferritic austenitic 2205 duplex stainless steel with an ultimate tensile strength of 800mPa, or equivalent.

4.0 ALUMINIUM

4.1 General

- 4.1.1 Provide Accepted aluminium extrusions and/or sheet of alloy and grades suitable for the structural requirements, applied finishes and project conditions not less than the strength and durability properties of the alloy and temper designated in the relevant Standards.
- 4.1.2 All exposed surfaces shall be free of scratches and other serious blemishes.

4.2 Relevant Standards: (British)

BS 1161	Specification for aluminium alloy sections for structural purposes.
BS 1470	Specification for wrought aluminium and aluminium alloys for general engineering purposes - plate, sheet and strip.
BS 1471	Specification for wrought aluminium and aluminium alloy for general engineering purposes - drawn tubes.
BS 1473	Specification for wrought aluminium and aluminium alloys for general engineering purposes - rivet, bolt and screw stock.
BS 1474	Specification for wrought aluminium and aluminium alloys for general engineering purposes: bars, extruded round tubes and sections.
BS 4873	Specification for aluminium alloy windows.
BS CP 118	The structural use of aluminium.

4.3 Relevant Standards: (US)

ASTM B22	Specification for aluminium alloy extruded bars, rods, wire, shapes and tubes.
ASTM B429	Specification for aluminium alloy extruded pipe and tube.
ASTM B483	Specification for aluminium alloy drawn tubes for general purpose applications.
ASTM B209	Specification for aluminium alloy sheet and plate.
ASTM B247	Specification for aluminium alloy die forgings, hand forgings, and rolled ring forgings.
ASTM B026	Specification for aluminium alloy sand castings.

4.4 Aluminium Extrusions:-

4.4.1 Unless otherwise indicated or required, extruded aluminium alloy shall be Grade 6061 or 6063, Temper T5 or T6.

4.4.2 Structural sections minimum wall thickness is 3.0mm, and the minimum wall thickness of non-structural trims is 1.5mm.

4.5 Aluminium Panels

Aluminium panels shall be solid aluminium or composite panels and shall satisfy the following minimum requirements:

4.6 External Panels – minimum thickness

4.6.1 4mm solid aluminium

4.6.2 6mm composite aluminium

4.7 Internal Panels – minimum thickness

4.7.1 3mm solid aluminium

4.7.2 4mm composite aluminium

4.8 Perforated Panels- minimum thickness

1 mm perforated corrugated aluminium

4.9 Composite Aluminium Panels:

The core is a fully-cured fibre-reinforced Phenolic Resin Bonded under heat and pressure to the outside metal faces.

4.10 Solid Anodized Panels shall be :

4.10.1 Aluminium alloy 1100 - H14

4.10.2 25 micron clear anodized

4.11 Solid Painted Panels shall be :

Aluminium alloy 3003 - H14 or, 5005 - H14

4.12 Perforated Aluminium Panels:

4.12.1 The perforation shall conform with 41% opening comprising of hole sizes of 3.3 mm at a pitch of 4.9 mm or as Accepted by the Architect.

4.12.2 The minimum thickness of panels to be 1 mm.

4.12.3 Coating to be two Coat of PVDF exterior coating.

4.13 Aluminium Welding:-

4.13.1 Carry out all welding, including detailing of all joints, welding procedures, appearance and quality of welds, and correction of defective work in accordance with Accepted samples AS 1665 or for aluminium welding.

4.13.2 Other than site welds indicated on Accepted shop drawings, do not weld on site. Where practical, locate site welds in positions for down hand welding.

4.13.3 Do not weld:

a) Finished surfaces.

b) Adjacent to finished surfaces or glass, unless adequately protected from damage.

4.13.4 Finished welds shall be de-scaled and free of surface and internal cracks, slag inclusion, and porosity.

4.14 Aluminium Anodizing

4.14.1 Where required, finish aluminium by an Accepted anodized coating process in accordance with relevant Standards to match Accepted samples.

4.14.2 Relevant Standards: (British)

BS EN 12373-1	Anodic oxidation coatings on aluminium and its alloys.
BS 3987	Specification for anodic oxidation coatings on wrought aluminium for external Architectural applications.

4.14.3 Relevant Standards: (US)

AAMA 607.1	Voluntary guide specification and inspection methods for clear anodic finishes for Architectural aluminium.
AAMA 608.1	Voluntary guide specification and inspection methods for electrolytically deposited colour anodic finishes for Architectural aluminium.
AAMA 609.1	Voluntary guide specification cleaning and maintenance of Architectural anodized aluminium.
ASTM B449	Chromate treatments for aluminium.
ASTM D1730	Practices for preparation of aluminium and aluminium-alloy surfaces for painting.
NAAMM	Metal Finishes Manual

4.14.4 Colour and Finish:

- a. There shall be two sets of three range samples in each set representing both the degree of specula gloss and the lightest, median and darkest shades of that colour to be Accepted for use on the project.
- b. (one set is to be used by the Anodiser and the other by the PMC for checking).
- c. Materials acceptable shall be clear(or natural) anodised to AAMA 607.1 or colour anodised to AAMA 601. The etched surface shall be permanently sealed. The etched surface shall have 25 microns minimum of material removed from all exposed surfaces.
- d. Surfaces to be finished shall be free from imperfections, scratches, scrapes and dents. When the finish is applied, all coatings when cured shall be visibly free of spots, stains and streaks.

4.14.5 Grade and Thickness:

- a. Unless otherwise required, anodising grade and average thickness shall be:
- b. External: 25 microns with local thickness not less than 20 microns.
- c. Internal: 25 microns with local thickness not less than 20 microns.

4.15 Aluminium – Powder Coating

4.15.1 Powder-coated aluminium surfaces shall receive a super-durable polyester coating, factory-applied by electrostatic spray. Colour to be Accepted by the PMC.

4.15.2 Colour and Finish

- a. The colour and gloss range samples shall be submitted to the PMC for Acceptance.
- b. Aluminium surfaces shall be pre-treated in accordance with ASTM B 449 Class1.
- c. The Façade Subcontractor shall provide a compatible air-dried coating for field touch-up as recommended by the coating manufacturer and based on, at the minimum, the standards set out in AAMA 2605-98, to match the factory-applied finished work.

4.15.3 Grade and Thickness:

- a. Acceptable materials shall be organic high performance coatings, which exceed the AAMA Standard 2605-98.
- b. Dry film thickness of coatings on exposed surfaces when measured in accordance with ASTM B244-97 shall not be less than 40µm except in channel recesses and internal corners, which should be visually covered.

4.15.4 Relevant standards the Façade Subcontractor shall comply with:

AAMA-2605:1998	Colour uniformity
AAMA-2605 ASTM B244-97	Film thickness
AAMA-2605 ASTM D523-89	Specular gloss at 60° viewing angle

F-2H ASTM D523-89	Pencil hardness
ASTM D1737-62	Post formability, 180 degree bend around 3mm mandrel
AAMA-2605 ASTM D3363	Film adhesion
ASTM D968-93	Abrasion resistance, 65min
AAMA-2605-98	Chemical resistance
AAMA-2605-98	Corrosion resistance
Fed Test 6152 Fed Stds 141a	Weather thermometer 500 hv exposure
ASTM D714-02 ASTM D2247-02	Humidity 3000hrs exposure at 100% relative humidity
ASTM B117-02 ASTM D714-02	Salt spray 3000hrs in salt fog at 95°F
ASTM E84	Flame test

4.15.5 In addition to the standard tests listed above, the coating shall comply with the following:

- a. Colour shall be in accordance with the Architect's selection.
- b. Powder coatings shall be in full compliance with AAMA 2605-98.
- c. Coating thickness for single coat system to be at least 65 to 100 microns and must be of super-durable polyester grade.
- d. Powders shall be of thermosetting and superdurable type. It must be Lead, Cadmium and TGIC (triglycidyl isocyanurate) free, to ensure strict environmental compliance.
- e. Aluminium surfaces shall be pre-treated in accordance with ASTM B 449 (Standard Specification for Chromates on Aluminium) under chromates Class 1 to provide maximum corrosion protection.

4.16 Aluminium – Fluorocarbon Coatings

- 4.16.1 A factory over cured 3-coat system is required with 70% minimum Kynar 500 fluoropolymer resin formulated and applied in strict accordance with the manufacturer's requirements.
- 4.16.2 The dry film thickness according to ASTM D1400 shall be not less than 33 microns.
- 4.16.3 The surface shall not have any dents, scratches, scrapes, die lines or other extrusion streaks or lines.
- 4.16.4 The paint film shall not show flow marks, crack, peel or blister for the warranty period.
- 4.16.5 Sets of 2 samples 300mm x 300mm showing the extreme colour range shall be submitted for acceptance. Samples outside this colour range shall be rejected.
- 4.16.6 The paint finish shall comply with AAMA 2605.
- 4.16.7 Colour changes shall not exceed 5E NBS units as defined by ASTM D244-97 for the warranty period.
- 4.16.8 Chalking shall not exceed No. 8 rating in accordance with ASTM D659-44.

4.16.9 Site touch-up of damaged surfaces shall not be permitted without written instructions from the PMC. Where touching up is not authorised, damaged material shall be replaced.

4.17 Aluminium Fabrication

4.17.1 Fabrication Tolerance : Tolerances at joints and junctions shall take precedence over tolerances for components or assemblies.

4.17.2 Holes : Provide holes and connections for site assembly and to accommodate work of others as required. Holes shall be drilled, or punched and reamed, perpendicular to the surface.

4.17.3 Marking : Provide suitable clear marking to enable correct setting out, and installation. Marking shall be of a type that can be removed with water or solvents after assembly. Marking should be positioned on unexposed surfaces where possible.

4.17.4 Built-up Members and Reinforcement : Where two or more sections of aluminium are used in built-up members, contact surfaces shall be smooth, true and even, and secured so that the joints are tight without the use of filling materials. Steel reinforcement of aluminium members shall be completely enclosed and separated from aluminium.

4.17.5 Glazing Rebates :Glazing rebates shall be of adequate size to hold the weight and size of glass required, with necessary clearances and tolerances, and to withstand the specified loading. Where required, provide snap-on cover-strips to secure glass.

4.17.6 Protection : Provide factory applied protective film, tape or coatings which will not bond to the aluminium surfaces when exposed to sunlight or weather.

4.18 Aluminium Frame Assembly:-

4.18.1 Fabricate aluminium in accordance with Accepted shop drawings and prototypes.

4.18.2 Cut edges, drilled holes, riveted joints and flat sheets shall be clean, neat, free from burrs and indentations. Remove sharp edges without excessive rounding off or chamfering.

4.18.3 Relevant Standards: (British)

BS 4873	Specification for aluminium alloy windows.
BS 8118	The structural use of aluminium.

4.19 Joints and junctions:

4.19.1 All visible joints shall be fixed by concealed means, unless otherwise indicated on the shop drawings or Accepted in writing.

4.19.2 Fit exposed joints accurately to provide close continuous contact to a fine hairline.

4.19.3 Make junctions with concealed mechanical connectors so that no fixings, pins, screws, pressure indentations and the like are visible on exposed faces.

4.19.4 Sections shall be sized to eliminate edge projection or misalignment at joints.

4.19.5 Where required, joints shall be watertight and weather tight.

4.19.6 Other than for concealed stud welding, aluminium extrusions shall not be welded except where Accepted in writing, and, if Accepted, only on concealed surfaces.

4.19.7 Joints between fabricated assemblies may be concealed with suitable aluminium extruded covers or clip-ons.

4.20 Fixings in aluminium work:

- 4.20.1 Fixings to aluminium or aluminium alloys shall be non-magnetic stainless steel unless otherwise Accepted on the Shop Drawings. Cadmium-plated steel or aluminium fixings shall not be used. Selftapping screws shall be stainless steel. Non-visible screws may be pan-head type.
- 4.20.2 Visible fixings where required and/or Accepted, shall be indicated on the shop drawings. Visible fixings shall be finished to match adjacent substrate. Unless otherwise indicated on the shop drawings, visible screws shall be countersunk stainless steel with Phillips or "pozidrive" heads, evenly and neatly located.
- 4.21 Testing of aluminium fixings:
 - 4.21.1 Carry out testing of the tensile strength of welded aluminium stud fixings and extrusion flute connections by an Accepted testing programme.
 - 4.21.2 Test programme shall include an initial proof testing procedure of not less than 100 examples of each type of fixing, and subsequent trend testing of not less than 10 examples progressive through the fabrication programme at not less than 8 evenly spaced intervals.
- 4.22 Curtain Wall System Drainage:-
 - 4.22.1 All glazing rebates, back pan cavities, stack joints, window & door frames, working louvers and external trims shall be outward draining.
 - 4.22.2 Drains shall have baffles to prevent the ingress of wind driven water.
 - 4.22.3 The effect of the drainage system on air flow and the partial or full pressure equalisation of the system shall be considered in the design of the cladding and back pans.

5.0 BRACKETS, FIXINGS AND ANCHORS

- 5.1 Scope
 - 5.1.1 Provide all required anchors and fixings to assemble and install work in a neat, secure manner, including bolts, washers, screws, rivets, welds, proprietary fasteners, and the like, templates and other accessories of Accepted types for a complete installation.
 - 5.1.2 Fixings shall be concealed unless otherwise Accepted or indicated on the Drawings.
 - 5.1.3 Co-ordinate with the Main Contractor to ensure that anchorage is provided and accurately built into base-structure without delay or disruption to the Civil works.
 - 5.1.4 Ensure that all bolts and similar fixings are tight at completion of installation.
- 5.2 All items shall (be):
 - 5.2.1 Appropriate to the substrates and members to be fixed or assembled.
 - 5.2.2 Ensure the rigidity of the assembly.
 - 5.2.3 Corrosion resistant equal to or exceeding the members to be fixed or assembled.
 - 5.2.4 Structural strength capable of transmitting the loads and stresses imposed.
 - 5.2.5 Installed to prevent galvanic corrosion.
 - 5.2.6 Allow generous on-site adjustment in accordance with Accepted shop drawings.
 - 5.2.7 Installed to accommodate all substrate movements and thermal movement of the members to be fixed or assembled.
- 5.3 Minimum Level of Protection:
 - 5.3.1 All bolts, nuts, washers in any given assembly shall be of the same material.
 - 5.3.2 Bolts between steel components shall be galvanised.

- 5.3.3 Bolts between aluminium and steel shall be stainless steel and fully insulated.
- 5.3.4 Bolts between aluminium and stainless steel shall be stainless steel.
- 5.3.5 Bolts between steel and stainless steel shall be stainless steel and fully insulated.
- 5.3.6 Bolts between aluminium components shall be stainless steel.
- 5.3.7 Apply an Accepted nut locking compound or device to all nuts.
- 5.4 Fixings
 - 5.4.1 Bolts, Nuts and Washers:
 - a) All bolts, nuts and washers behind air seals shall be stainless steel or galvanised High Strength Grade 8.8 to BS 3692, unless specified otherwise on the PMC's drawings.
 - b) All bolts, nuts and washers in front of air seals shall be stainless steel grade A4 property class 80 to BS EN ISO 3506, unless specified otherwise on the PMC's drawings.
 - 5.4.2 HSFG Bolts:
 - a) High Strength Friction Grip Bolts and associated nuts and washers shall comply with BS 4395: Part 1 unless otherwise specified.
 - b) Contact surfaces shall be left unpainted or prepared as otherwise indicated on the shop drawings.
 - c) HSFG Bolts shall be installed in accordance with BS 4604 using a wax based lubricant and coronet type load indicator washers or as Accepted by the PMC.
- 5.5 Stainless Steel Bolts, Nuts and Washers:
 - 5.5.1 Stainless steel bolts and nuts shall comply with BS 6105, strength A4, class 80.
 - 5.5.2 Stainless steel washers shall comply with BS1449:Pt2, Grade 316 S 31.
- 5.6 Cast-in Channels :
 - 5.6.1 Cast-in channels shall be Grade 43 with welded studs or mild steel reinforcement welded to the plates in accordance with the Shop drawings.
 - 5.6.2 Cast-in channels shall be hot dip galvanised after all the fitments have been attached.
 - 5.6.3 Cast-in channels shall be Halfen/Jodahl hot rolled steel galvanised or equivalent Accepted by the PMC.
 - 5.6.4 The channel shall be able to carry the design load including any prying forces at the most eccentric setting of the channel.
- 5.7 Holding Down Bolts:
 - 5.7.1 Holding Down Bolts and associated nuts and washers shall be galvanised Grade 4.6 to BS 4190 unless otherwise specified.
 - 5.7.2 They shall be rigidly held in place at the top and bottom by tack welding to mild steel links before galvanising.
 - 5.7.3 They shall be located using a template supplied by the Façade Subcontractor (to be coordinated with the Contractor) that is firmly secured to the formwork or reinforcement.
 - 5.7.4 The threaded length is to be sufficient to take up all construction tolerances, and is to be protected by taping and covering where impact damage may occur.
 - 5.7.5 Studs : Shear studs shall be Nelson Studs or an Accepted equivalent welded to the structural steel in accordance with manufacturer requirements.

5.8 Masonry Anchors:

5.8.1 Mechanical masonry anchors shall be Hilti HDA or Fischer FDA, Chemical anchors shall be Hilti HVU or Fischer FVU Injection anchors.

5.8.2 The Subcontractor is responsible for confirming that all edge distance, spacing and embedment requirements are satisfied.

5.8.3 The Subcontractor shall be responsible for ensuring that where masonry anchors clash with reinforcement, there is an alternative anchor set-out that satisfies the design requirements. End plate modifications to suit a new anchor set-out shall be carried out in accordance with BS 5950, slotting of holes and flame cutting are not permitted. Holes in the concrete shall be repaired by dry packing with a 40MPA cementitious non-shrink grout.

5.9 Anchorage to Superstructure :-

5.9.1 Provide proprietary anchorage, with corrosion-resistant finish, suitable for the substrates and conditions, with holding power at least 10 x design load.

5.9.2 Products which may be Accepted include those manufactured by Hilti or Fischer Fasteners, or equivalent.

5.10 Channel anchorage:

5.10.1 Provide channel anchorage in hot-dip galvanised steel or Grade 304 stainless steel where required, complete with polystyrene insets and plastic end caps.

5.10.2 Channel length, tail size and tail locations shall satisfy the most extreme loading conditions allowed for in the structural calculations.

5.11 Anchorage and Bracket Installation

5.11.1 Anchors to installed concrete substrates

a. Install mechanical and/or chemical anchors as required to support the work by Accepted methods into base-structure.

b. Be responsible for providing setting out details for all cast-in. Check building structure setting out prior to concreting to confirm that cast-in items are correctly positioned.

c. Refer to Drawings for concrete reinforcement locations, and position anchors to minimise risk of conflict with reinforcement.

d. Do not install anchors into post-tensioned concrete structures, void sections of precast concrete panels, and non-conventional concrete structure, unless Accepted in writing.

e. Accepted methods may include drilling, pre-formed pockets, or explosive driving. Select and install anchors strictly in accordance with manufacturer's instructions.

5.11.2 Relevant Standards:

ASTM E488	Standard test methods for strength of anchors in concrete and masonry elements.
BS 5080	Methods of test for structural fixings in concrete and masonry
BS 5080.1	Tensile loading.
BS 5080.2	Method for determination of resistance to loading in shear

5.11.3 Anchor placement tolerances : Install anchors to not exceed:

f. Maximum deviation from correct position: +/- 12 mm.

- g. Minimum distance from the concrete edge to the nearest part of the anchor: 100 mm.

5.11.4 Testing of built-in anchors:

- h. Carry out testing of installed anchorage in accordance with ASTM E488 and a testing programme to be submitted to the PMC for review and Acceptance before commencing.
- i. Provide sufficient tolerance to fixings and attachments to compensate for anchorage which become dislodged or damaged during placement of concrete

6.0 BUILDING ENVELOPE ATTACHMENTS

6.1 Back-pans

- 6.1.1 All back pans shall be aluminium 1.5mm minimum thickness, fully sealed with backing rods and sealant to form a drained spandrel cavity.
- 6.1.2 Back-pan construction should have folded back edges providing a continuous sealing edge.
- 6.1.3 Back-pans to spandrel glass shall be painted to a Specified colour as instructed by the PMC.

6.2 Insulation

- 6.2.1 Any spandrel glass or other non-vision areas shall have a minimum thermal resistance of a value specified by the PMC, and shall be comprised of a foil-backed insulation panel. (USG Thermafibre CW90 50mm or Accepted equivalent).
- 6.2.2 The insulation shall be sealed to the aluminium frame on 3 sides using foil tape to prevent condensation in the cavity between the insulation and the back-pan.

- 6.3 Fire Stops : The continuous gap between the building envelope insulation and the concrete slab at each slab level shall be filled with a mineral fibre insulation material with a 2-hour fire resistant period that is Accepted for use by the PMC and relevant local Authorities.

- 6.4 Smoke seal : Provide 3mm thick sealed galvanised steel sheet with USG Firesafing (or Accepted equivalent) back-up as a continuous smoke seal between the slab edge and the building envelope at each slab level.

- 6.5 Internal Wall Linings : Internal lining shall be 13mm thick cement sheet to ISO/TC77/DP8336 and ASTM C1186-2002 (with no asbestos). The lining shall be supported off galvanised cold formed steel battens, separated from the building envelope frame to prevent bimetallic corrosion.

- 6.6 Internal Trims to Heads & Jambs : Internal trims shall be provided to jambs and ceiling transoms at all floors. These trims are to provide a uniform surface, with hairline joints.

7.0 HARDWARE

7.1 Operable Vents:-

- 7.1.1 All window hardware shall be of a proprietary type stainless steel, grade 316, which has been fully designed and tested.
- 7.1.2 Operable vents, formed of extruded aluminium with a profiled handle, shall be constructed with end pieces which have been cut to match the end profile of the vent extrusion.

- 7.1.3 The profile of the handle shall be designed in coordination with the Contractor to ensure its operability in terms of depth and access for recoverability of the vent when it is in open position.
- 7.2 Locking System:-
- 7.2.1 Locking System for operable vents shall be Ferco Multi-Point Locking System or Accepted Equivalent.
- 7.2.2 Locking Points shall be calculated based on acceptable vent deflection and stress limits, with a minimum of 4 locking points.
- 7.2.3 The locking system shall be fully concealed within the body of the vent frame and shall lock into a concealed location.
- 7.3 Hinges & Limiting Devices:-
- 7.3.1 The vents shall be manually opened to a point of full extension (minimum of 45 degrees) allowing the full cross-sectional area of the vent opening to be vented.
- 7.3.2 At full extension there shall be a stainless steel 'keeper' which shall be adequate to restrain the open vent in full wind loading conditions.
- 7.3.3 The hinges shall be free-moving but shall be designed to a 'snug' fit so as to prevent any vibration of the vent in either closed or open positions.
- 7.4 Safety Rails:-
- 7.4.1 Metal or glass rails to be provided at each operable vent unit (as noted on drawings), to raise the effective height of the sill to the minimum requirement of 1000mm above finished floor.
- 7.4.2 Rails must be 'replaceable'.
- 7.5 Operable Doors & Hinges:-
- 7.5.1 Entry Door hinges shall be Dorma concealed spring hinges or Accepted equivalent.
- 7.5.2 Door locks and handles shall be Dorma, Assa Abloy or Accepted equivalent. Locking mechanisms shall be Assa Abloy, Dorma or Accepted equivalent and shall be based on a Master-Keying System.
- 7.5.3 All hardware shall be Grade 316 Stainless Steel of a finish specified by the PMC.
- 7.5.4 Entry doors shall have a Grade 316 Stainless Steel kick-plate of at least 150mm height unless otherwise specified.
- 7.6 Louvres
- 7.6.1 Provide Accepted proprietary louver assemblies complete with all accessories and fixings, together with structural calculations for blades, frames, fixings, and blanked off sections.
- 7.6.2 Structural frames and stiffening rib members shall not deflect by an amount greater than span/240 when tested the required design wind pressure.
- 7.6.3 Where required for access, provide framed and hinged louvered access doors to match adjacent louvers.
- 7.6.4 Louvers shall be waterproof and weatherproof and self draining.
- 7.6.5 They shall be anodised in a colour accepted by the PMC.
- 7.6.6 Air flow : Design louver assemblies with a free area of at least 70% to allow for free air flow requirements indicated on the shop drawings.
- 7.7 Insect wire-mesh : Provide Accepted concealed stainless steel insect wire mesh to the interior of all external louver assemblies, and blank off plates to all other false louvers. Mesh opening shall not exceed 3 mm.

- 8.0 Flashing
- 8.1 Scope
 - 8.1.1 Provide all required flashings, baffles, trims, cappings and the like to prevent the entry of water and weather, and make neat and clean junctions with the base-structure and adjoining work.
 - 8.1.2 All flashings shall be cut and folded to Accepted profiles out of noncorrosive materials, with protective coatings as required.
 - 8.1.3 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.
 - 8.1.4 Continuous flashings shall be welded or mechanically fixed to form continuous uninterrupted lengths. If the flashing is concealed, flashing joints shall be lapped at least 100mm and sealed.
 - 8.1.5 Where flashings are fitted to pre-formed rebates, co-ordinate cast-in grooves or reglets as required.
 - 8.1.6 Construct weep-holes as required to enable the passage of moisture to the outside of the building.
- 8.2 Relevant Standards:
 - 8.2.1 BS 6561 - Specification for zinc alloy sheet and strip for building.
 - 8.2.2 ASTM D1149 - Test method for rubber deterioration -Surface ozone cracking in a chamber (Flat Specimens).
- 8.3 Locations : Unless otherwise indicated on the Drawings, types and locations shall be as follows:
 - 8.3.1 Concrete wall flashings at every second storey: Stainless steel sheet.
 - 8.3.2 Louver flashings: Stainless steel sheet.
 - 8.3.3 Continuous horizontal and vertical smoke flashings: Zincanneal steel.
 - 8.3.4 Feature column flashing at every second storey: Stainless steel sheet.
- 8.4 Materials : Unless otherwise indicated on the Drawings, types and locations shall be as follows:
 - 8.4.1 Lysaght "Zincanneal" steel, or equivalent, steel base grade G2, coating class Z 275.
 - 8.4.2 Stainless steel sheet, 0.8 mm thick, Grade 304.
 - 8.4.3 Lysaght "Galvabond", or equivalent, steel base grade G2, coating class Z 275.
 - 8.4.4 Aluminium sheet, not less than 0.4 mm or more than 1.0 mm thick, in accordance with AS 1734, Type A3203 or D5050, containing magnesium or manganese or both, with a maximum copper content of 0.25%.
 - 8.4.5 Neoprene strip shall be 3 mm minimum thickness, and shall comply with ASTM D1149 with regard to ozone and flame resistance.
- 8.5 Anti-Carbonation Coating
 - 8.5.1 All concrete surfaces that are not protected by an air-sealed building envelope shall receive a protective finish layer. These surfaces are typically behind stone cladding, aluminium rain-screen cladding and louvers.
 - 8.5.2 The surface protection shall be an anti-carbonation coating by Sika or Accepted equivalent.
 - 8.5.3 Carbon Dioxide Diffusion resistance: the anti-carbonation coating shall have a minimum equivalent Air Layer thickness $R > 100m$.

- 8.5.4 Moisture vapour Diffusion resistance: the antic-carbonation coating shall have a maximum equivalent Air Layer thickness $SD < 2m$.
- 8.6 Earthing Tabs : The Façade Subcontractor shall Co-ordinate with the Electrical Sub-Subcontractor for details of connection tabs for earthing strap connection.
- 8.7 Triangles for F.A.P. : Provide and install triangles for the marking of Firemen Access Panels, in accordance with local Authorities requirements.

9.0 STEELWORK

9.1 SCOPE

9.1.1 The work shall consist of the design, supply, fabrication, surface treatment, storage, delivery and erection of all the steelwork required to support the building envelope as part of the subcontract works.

9.1.2 This also includes the supply and installation of all cast-in items used to support the steelwork, the grouting of base plates, the provision of cleats and drilling of holes for the attachment of the cladding system, and repairs to damage surfaces during construction.

9.2 Standard

The Façade Subcontractor shall comply with all applicable Indian Building (Construction) Regulations, and all British Standard that are relevant to this subcontract works, including but not limited to the British Standards, and other Overseas Standards specified below.

9.2.1 British Standards:

BS 638	Arc Welding Plant, Equipment and Accessories
BS 639	Covered Electrodes
BS 709	Methods of Non-Destructive Testing Fusion Welded Joints
BS 729	Hot Dip Galvanised Coatings on Iron and Steel Articles
BS 916	Black Bolts, Screws and Nuts
BS 1449	Steel Plate, Flat and Strip
BS 1580	Unified Screw Threads
BS 2600	Methods for Radiographic Examination of Fusion Welded Butt Joints in Steel
BS 2910	Methods for Radiographic Examination of Fusion Welded Circumferential Butt Joints in Steel Pipes
BS 3100	Steel Castings for General Engineering Purposes
BS 3889	Methods of Non-Destructive Testing of Pipes and Tubes
BS 3923	Methods Ultrasonic Examination of Welds
BS 4165	Electrode Wires and Fluxes for the Submerged Arc Welding of Carbon Steel and Medium Tensile Steel
BS 4190	ISO Metric Black Hexagon Bolts, Screws and Nut
BS 4232	Surface Finish of Blast Cleaned Steel or Painting
BS 4320	Metal Washers For General Engineering Purposes

BS 4360	Weldable Structural Steel
BS 4515	Field Welding of Carbon Steel Pipelines
BS 4848	Hot Rolled Structural Steel Sections
BS 4871	Approval Testing of Welders
BS 4882	Bolting for Flanges and Pressure Containing Purposes
BS 5135	Metal Arc Welding of Carbon and Carbon Manganese Steels
BS 5493	Protective Coating of Iron and Steel Against Corrosion
BS 6072	Method of Magnetic Particle Flaw Detection
BS 6323	Seamless and Welded Steel Tube
BS 6399	Chapter V. Wind Loading

9.3 MATERIALS :

- 9.3.1 Structural Steelwork : Structural steelwork shall comprise weldable structural steel to BS 4360 Grade 43A (mild Steel) or Grade 50B (high yield steel), unless otherwise indicated on the drawings.
- 9.3.2 Hot Rolled Sections : Dimensions, mass, tolerances and rolling margins are to comply with the following standards:
- a. Universal beams, columns, tee sections and channels to BS 4:Pt 1.
 - b. Hollow sections to BS 4848: Pt 2.
 - c. Angles to BS 4848: Pt 4.
 - d. Flats, plates, round bars and square bars to BS 4360
- 9.3.3 Stainless Steel:
- a. Wrought Stainless Steel shall comply with BS 970: Pt1 grade S16.
 - b. Flat rolled Stainless steel shall comply with BS1449 and shall be grade 316 S16 softened.
 - c. Stainless steel tubes shall comply with BS6323 designation LW 23 GZF(S).
- 9.3.4 Cast Iron and Cast Steel:
- a. Grey cast iron shall comply with BS 1452, grade 10.
 - b. Malleable cast iron shall comply with BS 6681.
 - c. Spheroidal cast iron shall comply with BS 2789.
 - d. Carbon manganese steel castings shall comply with BS 3100.
- 9.3.5 Forged Steel : Steel forgings and forged steel pins shall comply with BS 29.
- 9.3.6 Welding:-
- All welding of structural steel shall comply with BS 5135. Welding consumables used in fusion welding shall comply with BS 4570. Welding consumables used in metal arc welding of austenitic stainless steel shall comply with BS 4677.
- 9.3.7 Supply and Substitution:-
- a. The Subcontractor shall be responsible for the ordering of all materials and the Tender shall be based on an assured source of supply.

- b. The substitution of materials shall not be made without the Contractor's written instructions. Any Accepted substitution shall not cause an increase to the contract sum or a delay to the project.
- 9.3.8 Test Certificates : Fabrication shall not commence until the Test Certificates for all steel plates, sections, connections and welding consumables are verified by the Contractor in writing.
- 9.3.9 Protective Coatings :
- a. All steelwork is to be provided with a protective coating system with a 25 year minimum design life. The coatings shall be provided over the full surface area of steelwork. Exposed edges and site weld areas are to be coated with an Accepted coating system for site applications.
 - b. For more aggressive environments, higher performance paint systems shall be used
 - c. Internal & External Concealed Steelwork : Internal & External concealed steelwork shall be Hot Dip Galvanised with a minimum dry film thickness of 70 microns.
- 9.3.10 Internal & External Exposed Steelwork:-
- a. The coating system is to be by Dulux, Taubmans, Coultards, or Contractor Accepted equivalent suitable for internal & external surfaces and wear from UV, pollution (including acid rain), impact and traffic as necessary.
 - b. The coating system shall comply with the following minimum requirements:
 - c. 3 Part or 4 Part Inorganic Zinc Silicate system
 - d. Surface preparation - Blast Cleaned to Sa 2.5 in accordance with BS 7079 Part A1.
 - e. Primer Ethyl Zinc Silicate, 75 micron minimum dry film thickness, conventionally sprayed.
 - f. Barrier Coat - Two pack epoxy Micaceous Iron Oxide (MIO), 75 micron minimum dry film thickness, conventionally sprayed.
 - g. Finish Coat - to be specified by the Contractor.
- 9.3.11 Hot-Dip Galvanised Steelwork:-
- a. Surface Preparation : The steelwork shall be chemically descaled and cleaned, so that rust, mill scale, oil, grease and other foreign matter are removed immediately prior to galvanising. Tubular sections are to have bleed holes as necessary.
 - b. Galvanising Process : Hot dip galvanising shall be carried out in accordance with BS729.
 - c. Following galvanizing, the steelwork is to be left to cure for 48 hours before transportation to site.
 - d. Repair and touching up : All abrasions site welds etc are to be repaired by grinding (wire brushing) the surface back to a sound substrate and batch coating with an inorganic zinc silicate primer equivalent in quality to 110 micrometers dry film thickness of Dimetcote 6.
- 9.3.12 Fire-Proofing Material : All structural steelwork where specified shall be protected by Accepted fire proofing material and must be Accepted by local authorities.
- 9.3.13 Storage and Handling :

- a. All structural steel shall be stored and handled so that members and their coatings are not subjected to excessive stresses or damage.
- b. Open ends of tubular members at all times shall be securely protected from the ingress of water or deleterious materials.

9.3.14 Site Safety Considerations:-

- a. Safety requirements, erection cranes, equipment, scaffolding and staging, shall meet the requirements of India Building (Construction) Regulations.
- b. The Façade Subcontractor shall take full responsibility for the Safety and Stability of the steelwork during erection and until such time as it is finally completed and handed over, must take all precautions including temporary bracings necessary to ensure stability of the partially assembled structure against wind forces, and those stresses exerted due to erection equipment and its operation tending to distort or deform the framework.

9.3.15 Temporary Supports:-

As each section of steel is erected, all members shall be line, leveled and plumbed before final bolting up or welding commences. The ties, jacks braces, etc, used in lining, levelling and plumbing the steelwork shall be left in position until all bolts have been finally tightened.

9.3.16 Construction Tolerance:-

Fabrication tolerances for steelwork shall comply with BS5400:Part 6, Clause 4.2 or BS5950: Part 2, sub-section 7.2 as appropriate.

9.3.17 Foundation Bolts:

The position of cast-in foundation bolts at the top of base plates shall be within 3mm of the specified position. The position of foundation bolts in bolt pockets at the top of base plates shall be within 5mm of the specified position. The line of bolts shall not be tilted from the specified line by more than 1 in 40.

9.3.18 Erection of Steelwork:

- c. The position in plan of vertical components at the base shall be within 10mm of the specified position along either principal setting out axis.
- d. The level of the top of base plates and the level of the lower end of vertical or raking components in a pocket base shall be within 10mm of the specified level.
- e. The thickness of packing plates shall not vary from the specified nominal thickness or 10mm, whichever is less.
- f. The line of vertical or raking components other than in portal frames shall be within 1 in 600 and within 10mm of the specified line in every direction.
- g. The line of vertical or raking components in portal frames shall be within 1 in 600 and within 10mm of the specified line in every direction.
- h. The position and level of components connected with other components shall be within 5mm of the specified position and level relative to the other components at the point of connection.
- i. The position of components supported on a bearing shall be within 5mm of the specified position relative to the bearing along both principal axes of the bearing.

10.0 STAINLESS STEEL

- 10.1 Stainless steel generally Grade 304 or 316. Grade 302 shall not be used. Structural applications and all exposed stainless steel works shall be Grade 316.
- 10.2 Relevant Standards:
- AS 1449
 - BS1449:Part 2.
 - ASTM A666.
- 10.3 Unless otherwise indicated on Drawings, exposed stainless steel shall be finished to match Accepted samples in accordance with AS 1449, designated as follows:
- a. "Linished".
 - b. "6" Soft satin.
 - c. "7" Semi-mirror.
 - d. "8" Bright mirror.
- 10.4 Flatness of Architectural stainless steel shall be not less than "stretcher level" grade.

11.0 INSTALLATION

Commencing installation will be construed as complete acceptance of substrates and site conditions, including acceptance of reference lines and marks, and embedment in base-structure.

11.1 General

11.1.1 Supply glazing lites, [including BiPV lites] factory pre-glazed in accordance with BS952 or AS1288. No site glazing or re-glazing shall take place unless Accepted in writing.

11.1.2 Installation of each lite component shall be watertight and airtight and withstand all required temperature changes and wind loading without failure, including loss or breakage of glass, failure of sealants or gaskets, deterioration of glazing materials and other defects.

11.1.3 Install lite with correct edge distances at all rebates. Protect glass from edge work damage during handling and installation.

11.1.4 Install lite so that base-structure movement loads and deflections are not transferred to the lite.

11.1.5 Surfaces to receive glazing materials shall be free of dirt, dust, grease, oil and other foreign materials.

11.1.6 Provide temporary marking, if required, with an Accepted removable marking for visibility during construction, by a method which does not harm the lite, and remove all traces on completion.

11.1.7 Maintain a glazing & structural glazing logbook on a daily basis for all glazing and submit progressively.

11.1.8 Site glazing shall be carried out by Accepted glaziers under the supervision of the factory supervisor as for factory glazing in accordance with BS952 or AS 1288.

11.1.9 Ensure that all weep holes and drainage channels are unobstructed and free of debris including alkaline material likely to etch glass.

11.2 Structural glazing :

The dead load of the glass shall be fully supported by the setting blocks in the installed position, and fully engaged with the setting blocks prior to the application of structural adhesive.

11.2.1 Acceptance will not be given for structural site glazing unless:

- a. The design provides for independent support of the glass until the structural adhesive has fully cured.
- b. The manufacturer certifies in writing the suitability and experience of individual glaziers.

11.2.2 Sealant

- a. Prepare joints and install all sealants strictly in accordance with sealant
- b. manufacturer's recommendations and Accepted shop drawings.
- c. Comply with the sealant manufacturer's recommendations regarding surface preparation, priming, pot-life, sealant bead application, and the acceptable range in surface temperature at time of application and for a period at least eight hours following sealant application.
- d. Maintain and submit progressively logbooks for all sealant installation.
- e. Clean joint surfaces immediately before installation of backing rod and again before applying the sealant as recommended by sealant manufacturer.
- f. Areas adjacent to joints to be sealed shall be protected where there is a likelihood that contamination by cleaning compound, primer or sealant could occur.

11.2.3 Installation of sealant accessories:

- a. Backer rod : Install sealant backer rod for sealants, except where otherwise indicated, or not recommended by sealant manufacturer, at a proper depth to provide sealant bead profiles indicated on Accepted shop drawings. Backer rods shall be an Accepted non gassing type.
- b. Bond breaking tape : Install bond breaker tape where indicated and where required by the manufacturer's recommendations to ensure the proper performance of elastomeric sealants.

11.2.4 Sealant proportions : Provide elastomeric sealant of depth not greater than the joint width, and not less than half the joint width or 6 mm, whichever is the greater.

11.2.5 Considerations for Installation :

- a. Install sealants during ambient temperature and humidity conditions recommended by the manufacturer.
- b. Employ only proven installation techniques which will ensure that sealants are deposited in uniform, continuous ribbons without gaps or air pockets, and with complete "wetting" of joint surfaces equally on opposite sides.
- c. Unless otherwise indicated on the Accepted shop drawings, fill vertical joints to a slightly concave surface, slightly below adjoining surfaces, and fill horizontal joints to slightly convex profile, so that joint will not trap moisture and dirt.
- d. Apply sealant under pressure using a hand or power actuated gun or other appropriate means.
- e. Provide weep holes where indicated or required.

11.2.6 Curing:

- a. Provide for the appropriate cure conditions, in accordance with the sealant manufacturer's written recommendations at factory and on-site. Protect external sealants from inclement weather until fully cured.

- b. Cure sealants in compliance with manufacturer's recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.
- c. Do not relocate sealed components within the factory or on-site, until the joint has developed sufficient bond strength and cohesive integrity.
- d. Install sealants to interior at the same time using the same or compatible materials as the exterior sealants.

11.2.7 Curtain Wall

- a. Install the cladding system plumb, level and true to line within required tolerances, and suitably anchored to the base-structure.
- b. Install all required flashings, trim and seals to ensure the finished work are weatherproof and waterproof.

11.2.8 Site modifications:

- a. Finished work which contains unauthorised site modifications, or work not in accordance with the Accepted shop drawings, may be required to be removed and replaced.
- b. Unauthorised work may be Accepted subject to additional computations and testing at the Contractor's sole discretion.
- c. Cladding shall be installed in an orderly sequence. Where practical, cladding shall be completed and closed off on a floor-by-floor basis.

11.2.9 Hardware

- a. Install all hardware and accessories including but not limited to latches, locks, openers and remote controllers.
- b. Fit insect screens where supplied.
- c. Opening units shall be checked to ensure that operation is full, free and smooth, and that all operable hardware, locks and controllers are operating properly and smoothly.
- d. Exposed sealants will not be Accepted, except where indicated on Accepted shop drawings.
- e. Ensure that weep-holes are located to prevent staining of finished coated surfaces.
- f. Where sub-framing has been installed by others, inspects the subframing before fixing any cladding to ensure that sub-framing is plumb, level and aligned with required tolerances.

11.2.10 Vapour barrier

- a. Where required, install a cavity membrane / vapour barrier to face of subframing in accordance with Accepted shop drawings.
- b. Seal all penetrations and through fixings, and ensure continuous barrier to prevent passage of moisture to the inside of the cladding system.

PART 09 : GRC [GLASS REINFORCED CONCRETE] WORKS

1.0 SCOPE

The specifications refer to GRC [Glass Reinforced Concrete] works in the building.

1.1 SPECIALIST CONTRACTOR

The work specified in this section is to be undertaken by a Manufacturer who is a Member of the National Precast Concrete Association Australia, GRC Industry Group with experience in the GRC industry, which includes the production of architectural panels (or other products for which this specification is being used). With his tender, the contractor shall submit to the construction manager written evidence indicating his capability of producing panels of a reliable and consistent quality.

1.2 STANDARDS AND CODES

AS 3972	Portland and blended cements.
BS 1	Portland Cement.
BS 3892	Pulverised Fuel Ash for use in Concrete.
BS 476	Test Methods and Criteria for the Fire
Part 8	Resistance of Elements of Building Construction.
	GRC Industry Group of National Precast Concrete Association Australia,
	A Recommended Practice – Design, Manufacture and Installation of Glass Reinforced Concrete (GRC)
AS 3582.1	Supplementary cementitious materials for use with portland and blended cement - Fly ash.
AS 1130	Code of practice for use of fly ash in concrete.
AS/NZS 1170.1	Structural design actions – Permanent, imposed and other actions.
AS/NZS 1170.2	Structural design actions – Wind actions.
AS 1170.4	Minimum design loads on structures (known as the SAA Loading Code) – Earthquake loads.
AS 1379	Specification and supply of concrete.
AS 3610	Formwork for concrete.
AS 1478.1	Chemical admixtures for concrete, mortar and grout – Admixtures for concrete .
BS 1014	Pigments for Portland Cements and Portland Cement Products
BS EN 1169	Precast Concrete Products – General Rules for factory production control of glass fibre reinforced cement.
BS EN 1170	Precast Concrete Products – Test Methods Parts 1-8 for glass-fibre reinforced cement.

2.0 MATERIALS

2.1 GENERAL & CODES

- 2.1.1 Materials used for making the GRC unit shall generally comply with relevant British and Australian Standards and Codes. Any reference to a British Standard shall mean that current at the time of going to tender.
- 2.1.2 Where materials are not fully covered by this specification or alternative materials are offered, the Contractor shall forward to the Construction Manager prior to commencing the work, details of those he proposes to use together with supporting evidence indicating that the finished product will be capable of meeting the performance requirements of this specification.

2.2 ALKALI-RESISTANT GLASSFIBRE

- 2.2.1 Glass fibre shall be an alkali-resistant, continuous filament fibre developed and formulated specifically to have high strength retention in Ordinary Portland Cement environments. The glass fibre shall have a minimum ZrO₂ content of 16% by weight, in accordance with internationally-recognised standards, and shall have a minimum strength retention (determined by Strand In Cement (SIC) testing) of 300 MPa (Test Method: GRCA SO 104/0184).
- 2.2.2 The producer shall provide certification from the glassfibre manufacturer to show that the glass fibre conforms to these requirements, has a history of successful use in similar matrices, and is manufactured under an internationally-recognised Quality Management system.
- 2.2.3 Suitable alkali-resistant glassfibres are "Cem-FIL", manufactured by Saint-Gobain/Vetrotex and "NEG ARG Fibre" manufactured by Nippon Electric Glass.

2.3 CEMENT

- 2.3.1 The cement shall be Ordinary Portland Cement, supplied by a manufacturer of assessed capability to AS 3972– 1997 and BS 12 or its derivatives, and should be supported by suitable certification. Cement shall be obtained from one source throughout manufacture.
- 2.3.2 Cement shall be correctly stored and kept dry to avoid deterioration.

2.4 SAND

- 2.4.1 Sands should be washed and dried to remove soluble matter, and to permit control of the water/cement ratio. Sand added to the mix shall not exceed 50% by weight of the total mix and sand/cement ratio shall not exceed 1:2. Sand shall be only high silica and conform to the following specification:
 - Silica content > 967%
 - Water content < 2%
 - Soluble salts < 1%
 - Grain size < 1.2 mm
 - < 10% passing a 150 micron sieve
- 2.4.2 Sands other than silica sands may be used subject to approval of the architect and PMC, but the producer must be able to show proof of their suitability.

2.5 ADMIXTURES

- 2.5.1 The manufacturer shall ensure that any admixtures used do not have any harmful effects on the product, and are used in accordance with the manufacturers' recommendations. The use of superplasticisers may be

encouraged to keep water content of the composite to a minimum without loss of suitable working characteristics, especially the ease of attaining full compaction.

2.5.2 Any admixtures used, shall comply with AS 1478.

2.6 PIGMENTS

Any pigments used shall conform to BS 1014. These shall be:

- Harmless to the GRC's set and strength.
- Stable at high temperature.
- UV-resistant and alkali-resistant.

The Authority should recognise that some colour variation may occur, and must agree an acceptable range of variation with the producer.

2.7 WATER

Water shall be free from deleterious matter that may interfere with the colour, setting, or strength of the concrete.

2.8 MIX DESIGN

The mix shall have been determined by the manufacturer, and written confirmation of the mix design shall be submitted so the proportions shall be chosen to achieve the quality-control requirements specified herein.

2.9 MOULD-RELEASE AGENT

The mould-release agent shall be selected by the manufacturer and approved by the architect or PMC. This should be compatible with the surface finish required for the product. Any residue shall be removed from the finished product so that this does not interfere with any joint sealants or applied finishes which may be used.

2.10 FORMWORK

The design, material and manufacture of the forms shall be consistent with the type and quality of the surface finish required from the panel, and with the tolerances specified. The forms shall be constructed such that the finished products conform to the profiles and dimensions indicated by the contract documents.

2.11 SUPPORT STEELWORK AND FIXINGS

2.11.1 The Manufacturer will be responsible for the design, manufacture and installation of all support framing, cleats and fixings inserted into and affixed to the GRC panels, or provided for the support of the GRC panels. Fixing zones are described on the drawings, together with primary structural concrete and steelwork provided by others for use by the contractor if required.

2.11.2 Fixings shall be concealed and cast into panels unless otherwise specified. They shall be of non-corrosive material and located at suitable spacings to ensure support of panels without creating undue stresses to the panels under thermal movements and/or moisture movement.

2.11.3 The recommendations of the Recommended Practice – Design, Manufacture and Installation of GRC – NPCAA Publication, August 1999 (herein after called NPCAA Recommended Practice) shall be incorporated in the design of fixings.

- 2.11.4 Steel materials and workmanship shall comply with the relevant codes, and all steel will be free from rust, loose scale, pitting and other defects.
- 2.11.5 Fabricated steel components shall be true to line and free from twists, bends and open joints.
- 2.11.6 All ungalvanised materials shall be thoroughly cleaned prior to fabrication, by grit blasting to Class 2 in accordance with AS 1627 Part 4 and painted with Red Oxide Zinc Chromate in two coats to a minimum dry film thickness of 80 microns.
- 2.11.7 Fixing cleats to existing steelwork, where indicated on the GRC cladding shop drawings, shall be site-welded unless otherwise arranged with the construction manager.
- 2.11.8 Any damage to protective coatings on steelwork, supplied as part of this contract works, shall be repaired.

3.0 WORKMANSHIP

3.1 WEIGHING AND BATCHING

Dry ingredients shall be batched by weight using calibrated weighing equipment capable of an accuracy of $\pm 2\%$ of the stated batch weight. Liquids should be weighed, volume-batched or automatically dispensed. The producer must demonstrate that the method employed will give an accuracy of $\pm 2\%$.

3.2 MIXING

The cement slurry should be mixed in a high-speed shear mixer, or other high-speed mixer which can achieve a good and even dispersion of all slurry ingredients.

3.3 APPLICATION

- 3.3.1 Application shall be by spraying, using purpose-built equipment which allows the simultaneous deposition and uniform mixing of the glassfibre and cement matrix.
- 3.3.2 The glassfibre and cement slurry shall be metered to the spray head at rates to achieve the desired mix proportion and glass content. These shall be checked for each spray pump at least once per day and prior to commencing spray production after each stoppage. The test shall be conducted in accordance with the method described in BS EN 1170-3. Distribution of fibre in the mix shall be controlled by the operator in such a way as to be as uniform as possible.
- 3.3.3 Cleanliness of equipment and working areas shall be maintained at all times.

3.4 SHAPE AND FINISH

- 3.4.1 The panels are to be formed of GRC in moulds to achieve the profiles indicated by the architectural drawings.
- 3.4.2 The manufacturer shall provide a means for producing a replacement panel at any time during the building contract. Moulds shall be adequately cured to eliminate shrinkage and distortion and shall be properly braced.
- 3.4.3 The exposed face of the GRC panels surfaces shall be free of blowholes, cracks, undulation or similar imperfections.

3.5 MANUFACTURE

- 3.5.1 The panels shall be manufactured by a spray technique as detailed in the NPCAA Recommended Practice or as otherwise agreed between the manufacturer and architect/PMC to an approved method.
- 3.5.2 Spray applicators shall be experienced personnel whose proficiency meets industry standards.
- 3.5.3 If an architectural face mix is being used, this will first be sprayed into the mould. The thickness shall generally be the minimum possible to achieve the desired finish, which will normally make it at least 20% thicker than the largest sand or aggregate being used and normally 4 mm minimum and 12 mm maximum thickness. An acrylic polymer should be used in the face mix to reduce any risk of this unreinforced layer cracking.
- 3.5.4 If no face mix is being used, a mist coat consisting of the basic mortar composition without fibre may, if necessary, be sprayed onto the moulds to prevent fibres from being visible on the finished surface of the product. The mist coat is intended to be just thick enough to cover mould details and surfaces so that fibres are not visible on the surface, but not so thick that crazing of this unreinforced layer may occur.
- 3.5.5 layer may occur.
- 3.5.6 The normal target thickness of a mist coat for non-polymer GRC is 1 mm, though the use of acrylic polymer in the mix may allow the thickness to be increased up to a maximum of 3 mm. However, it should be noted that for design purposes the thickness of the mist coat should not be considered as contributing to the strength of the GRC panel.
- 3.5.7 Spray-up of GRC backing material shall proceed before any mist coat or face mix has set.
- 3.5.8 The method of spraying the main body of material shall achieve the greatest possible uniformity of thickness and fibre distribution.
- 3.5.9 Consolidation shall be by rolling and such other techniques as are necessary to achieve complete encapsulation of fibres and full compaction.
- 3.5.10 Control of thickness shall be achieved by using a pingauge or other acceptable method. Minimum thickness of panels is recommended as 8 mm (hand-spray) and 6 mm (auto-spray).
- 3.5.11 All hand-forming of intricate details, incorporation of formers of infill materials and over-spraying shall be carried out before the material has achieved its initial set so as to ensure complete bonding.
- 3.5.12 Inserts shall be properly embedded into thickened, homogeneous areas of GRC. Waste material such as over-spray is not acceptable to encapsulate inserts or for bonding pads.
- 3.5.13 Any rigid embedded items bonded to the GRC shall not create undesirable restraint to volume changes.

3.6 SHOP DRAWINGS

- 3.6.1 Prior to commencing manufacturing work, the manufacturer shall submit for approval detailed shop drawings showing the following information:
 - a) layout (sectional plan and elevation) of complete wall panelling;
 - b) full-size section of typical panel and support members;
 - c) method of assembly and supports and fixings to the existing structure and provision to withstand imposed stresses;
 - d) method of installation, caulking, flashing and provision for vertical and horizontal expansion;

- e) junction and trim to adjoining surfaces; and
 - f) fittings and accessories,
- 3.6.2 The submission of shop drawings shall be supported by engineering design computations to show that cladding and supports comply with the design criteria specified.

3.7 TOLERANCES

The GRC elements shall be manufactured and installed to the tolerances stated in the NPCAA Recommended Practice (Section 10).

3.8 DEMOULDING AND CURING

- 3.8.1 Once the initial set has taken place, GRC elements should be covered with polythene for their protection and to prevent them from drying out fully. They must not be moved again until they are ready for demoulding.
- 3.8.2 The GRC elements must not be demoulded until they have gained sufficient strength to be removed from the mould and transported within the factory, without being overstressed.
- 3.8.3 If the GRC elements are too large to be demoulded by hand, special demoulding sockets or loops should be embedded in the panel during manufacture, and demoulding should be assisted with a lifting frame. This procedure should be agreed with the PMC.
- 3.8.4 During demoulding, the panels shall be uniformly supported in a manner which avoids undue stresses in the panels.
- 3.8.5 If polymers are used in the mix to avoid wet curing, the panels should be stored under cover for a minimum of 7 days at a temperature of between 5°C and 35°C.
- 3.8.6 If polymers are not used in the mix, curing shall be continued after demoulding under conditions which shall provide free water on the surfaces of the panels at a temperature not exceeding 50°C for a period of not less than 7 days (including the initial cure in the mould).

3.9 IDENTIFICATION OF ELEMENTS

- 3.9.1 All panels shall be identified individually to indicate the panel type and date of manufacture.
- 3.9.2 At the time of preparation of shop drawings the manufacturer shall indicate his required order of delivery.

3.10 HANDLING, TRANSPORTATION AND INSTALLATION

- 3.10.1 The products shall be handled, transported and installed using methods which ensure that no damage or marking of architectural surfaces occurs and so that the panels are not subject to undue stress.
- 3.10.2 The safety and protection of GRC units shall be ensured throughout the whole of the contract works.
- 3.10.3 Site access and, if necessary, storage space shall be provided by the main contractor.
- 3.10.4 The main contractor shall also provide true, level and clean support surfaces and shall provide for the accurate placement and alignment of connection hardware on the structure.

3.11 TEST REQUIREMENTS

- 3.11.1 The specified glassfibre content shall be 5% by total wet weight of materials.
- 3.11.2 The GRC from which the panels are made shall have the following properties on completion of curing:
 - a) Characteristic Modulus of Rupture (MOR) 18 MPa at 28 days.
 - b) Characteristic Limit of Proportionality (LOP) 7 MPa at 28 days.
- 3.11.3 The value of MOR and LOP design stresses to be used should be determined by the design PMC for specific service requirements.
- 3.11.4 The minimum dry density shall exceed 1800 kg/m³.

3.12 TESTS

- 3.12.1 The following tests shall be carried out on coupons cut from the test boards in accordance with BS EN 1170 Parts 2, 4, and 5. If acrylic polymer is used in the mix, presoaking immediately prior to testing shall not be required for Modulus of Rupture or Limit of Proportionality.
 - a) Glass Content – BS EN 1170 Part 2
 - b) Modulus of Rupture – BS EN 1170 Part 5 (and simplified method in Part 4)
 - c) Limit of Proportionality. – BS EN 1170 Part 5
- 3.12.2 Test boards shall be produced alongside each day's production (at least one per day for each production team). The recommended size of these sample boards is 600 x 600 mm. The test boards shall be produced with the same quality, thickness and curing as the actual panels.
- 3.12.3 Those test boards which are not required for testing should be kept for the duration of the contract, or for a period to be agreed between the manufacturer and PMC.

3.13 FREQUENCY OF TESTING

- 3.13.1 The frequency of testing shall be agreed between the architect, PMC and manufacturer.
- 3.13.2 The recommendation of BS EN 1169 is as follows:
 - a) Glass content – tested in accordance with BS EN 1170 Part 2. Once per week for each spray team. (This is in addition to the calibration test referred to in section 3.3).
 - b) Modulus of Rupture and Limit of Proportionality – tested in accordance with BS EN 1170 Part 5. Should be tested by the manufacturer or by a qualified laboratory as the mix design is being set-up and thereafter at least twice per year, or when the mix design is changed.
 - c) A simplified bending strength test to determine the Modulus of Rupture (MOR) should be conducted by the manufacturer more frequently. The frequency of testing recommended by BS EN 1169 is for each 10 tonnes of GRC produced, or at least once per week.
 - d) Water Absorption and Dry Density – tested in accordance with BS EN 1170 Part 6. As the mix design is being set-up, and then for each 10 tonnes of GRC produced, or at least once per week.

3.14 COMPLIANCE

- 3.14.1 Compliance with glass content and the characteristic strength for both LOP and MOR shall be assumed if the following conditions are met:

- a) Glass Content : The glass content shall not vary from the specific amount by more than $\pm 20\%$.
- b) Modulus of Rupture and Limit of Proportionality : The characteristic MOR and LOP is defined as the value which 95 per cent of all the mean strengths of the individual test-boards shall exceed.

Compliance with the characteristic MOR and LOP requirements shall be assumed if no single test-board mean shall be less than 85 per cent of the characteristic MOR and LOP, and the average of 4 consecutive test board results shall exceed 21 MPa (MOR), and 8 MPa (LOP).

If any single test-board fails to meet any of the compliance requirements, the GRC at risk shall be that produced between the previous complying test board and the next complying test board.

Where failure to comply arises from consideration of consecutive groups of four test-boards, the GRC at risk shall be that represented by the first and fourth testboards, together with all intervening material.

Note: If different values for MOR and LOP are required for specific service requirements, these should be determined by the design engineer for the specific service requirements. The selection of unnecessarily high strength requirements may result in cost penalties.

- c) Dry Density : The dry density of the GRC shall exceed 1800 kg/m³.
- d) Non-Compliance : In the event of non-compliance, the action to be taken should be agreed between the manufacturer and the Authority. Due regard should be paid to the technical consequences of the non-compliance and the economic consequences of adopting remedial measures or replacing the rejected products. Account should also be taken of the safety factors incorporated in the design and also the thickness of the GRC produced, compared with the design thickness. Re-testing may be considered appropriate if it is considered that the storage conditions of the product may result in improved properties because of extended curing, or if the sampling, testing or calculation may have been at fault.

The material at risk may be reduced by the testing of additional test boards from the same, previous, or next manufacturing periods. Testing may also be performed on GRC samples cut from the actual GRC elements at risk.

3.15 WEATHERPROOFING

- 3.15.1 Responsibility for the weatherproofing of the whole installation of GRC panels rests with the GRC manufacturer.
- 3.15.2 The joint details shown on the drawings represent the appearance required and their minimum standard of weatherproofing acceptable.
- 3.15.3 Joints shall be weather-sealed with closed-cell polyethylene compressible backing rods and caulked with 2-part polysulphide sealant or other approved sealant in selected colours, installed completely in accordance with the sealant manufacturer's recommendations with regard to joint dimension, priming, substrates, mixing, curing, masking, cleaning and the like.
- 3.15.4 The GRC manufacturer shall submit details of the proposed sealant and the application recommendations for approval by the construction manager prior to commencement of the contract works.
- 3.15.5 Joints located and indicated on the drawings are those required for sealing the GRC cladding against adjacent materials and those required for

architectural purposes for division of the panels into the design modules. Should the GRC manufacturer or contractor propose to subdivide the cladding into smaller panels for ease of casting, handling and erection, additional joints may be introduced in the design, provided the location proposed is discreet. The GRC manufacturer shall submit proposed locations and designs of additional panel joints with their tender submission.

4.0 OTHER ISSUES

4.1 RESPONSIBILITY

The GRC manufacture shall be solely responsible for the design and performance of the GRC panels and their supports. Information provided on the drawings or this specification shall not affect this responsibility.

4.2 GUARANTEES

The Manufacturer shall warrant the GRC panels installed, or to be installed, against any and every defect or failure which may occur during the period of practical completion for the works arising out of any fault of the GRC cladding system, workmanship, fabrication, fixing or quality of materials used.

4.3 DESIGN CRITERIA

Glassfibre-reinforced wall cladding shall comply with the following:

FINISH : Class 1 to the formwork code, smooth face suitable for high paint finish.

DESIGN LOADS : Cladding and framing shall be designed in accordance with AS1170.

DEFLECTIONS OF MAIN FRAME STEEL MEMBERS : The attention of the contractor is drawn to the allowance made for differential deflections between the structure at level 2 and the ground. The anticipated allowance is 30 mm. The detailing of the GRC cladding should take this into account

PART 10 : MISCELLENEOUS WORKS

1.0 RAILING

All Stainless Steel to conform to SS 304 Grade

1.1 SS RAILING WITH BALUSTERS

Staircase Railing 1050mm high with main 38mm dia SS pipe as main runner and 25mm dia pipe at 5 levels along the running length of the staircase and vertical supports in 6mm thick and 38mm wide twin SS plates @ 1500mm c/c, with necessary supports, anchor fasteners, supports, base plates, SS counter sunk screws. The joinery should be assembled at site by Alenkey.

1.2 MS RAILING WITH BALUSTERS

Staircase Railing 1050mm high with 38 mm dia MS pipes as main runner and 25 mm dia pipe at 5 levels along the running length of the staircase and vertical supports in 6mm thick and 38mm wide twin MS plates @ 1500mm c/c, with necessary supports, anchor fasteners, supports. The handrail to be finished with approved Enamel paint from ASIAN PAINTS or EQUIVALENT inclusive of all surface preparation as specific etc complete.

1.3 SS GRAB RAIL ALONG WALLS

SS Hand Rail along walls with main bar 38mm dia and 1.5mm thick with all necessary fitting as the main runner joined to 6mm thick 25mm wide twin SS plates and vertical bracket 2mm thick held on to walls by means of fasteners base plates to be @ every 1500mm c/c etc. complete.

1.4 MS GRAB RAIL ALONG WALLS

Providing, fabricating and fixing in position MS Hand Rail along walls with main bar 38mm dia and 1.5mm thick with all necessary fitting as the main runner joined to 6mm thick 25mm wide twin MS plates and vertical bracket 2mm thick held on to walls by means of fasteners base plates to be @ every 1000mm c/c etc. complete etc. complete. The handrail to be finished with approved Enamel paint from ASIAN PAINTS or EQUIVALENT inclusive of all surface preparation as specific etc complete.

2.0 ELECTRICAL OPERATED GATES

Supplying and fixing Electrical operated sliding gates of specified size and width in single / two leaves MS frames as per design including all accessories and bottom angle, roller tracks with heavy duty roller at bottom of gates .Cost to be inclusive of buffing, painting 3 coats with approved shade synthetic enamel paint over a coat of Zinc chromate primer etc. complete and all as directed. Item shall include fixing in position, alignment, grouting the MS support for sliding panels using cement concrete 1:2:4 and finishing the surface neat and smooth etc. Consider weight for sliding gates as 110 Kgs per sqm.

3.0 RUBBER SPEED BREAKERS

Providing and installing readymade rubber speed breakers of size 380x400x50mm square piece, with necessary nails, epoxy adhesive as per manufacturer's specifications. Sample to be approved prior to installation.

4.0 MS COLUMN GUARD

Providing and fixing 2mm thick Mild steel wall guard of size 75 x 75 mm fixed to edges of column by means of nails, fasteners etc. complete. MS angle guards to be MS powder coated.

5.0 CLOSING OF DUCTS

Providing, fabricating, welding and/or bolting, as required, erecting and fixing in position all types of structural steel works for Closing Ducts made up of MS Angles 50x50x6mm, site fabricated including all accessories viz. nuts, bolts, cleats, gussets, suspenders etc as per specification complete as directed by PMC/Authority at locations as desired by the Structural PMC, including one coat of anti-corrosive paint & two coat of enamel paint. Laying of 4mm thick Chequered plate, welded on to this including filling joints and final layer of 30mm thick PCC bedding of cement concrete ratio 1:1.5:3 in necessary level and slope, finished smoothly as IPS finish.

6.0 CHAINLINK FENCING

1.	Chainlink Fencing Mesh	Wire core wire dia 2.5mm. olive green plastic coated to 3.55mm. Mesh : 50 x 50mm. Height : 4.5/3m. (vertical height) Colour : Olive green
2.	Tension Wire	PVC coated G.I core wire dia 3.0mm. olive green plastic coated to 4.0mm.
3.	Horizontal Pipe	40mm. dia. Galvanised pipe
4.	Stirrup Wire	Core wire dia 2.3mm. olive green plastic coated to 3.2mm.
5.	Tie Wire	Core wire dia 1.8mm. olive green plastic coated to 2.5mm.
6.	Fittings	G.I Bolt & Nut, Eyebolt, strainer fittings etc. galvanized
7.	Fence Post	Spacing at 3.0m. interval. 60mm. OD x 3.25mm thick galvanized pipe
8.	Strainer Post / Corner Post	Spacing at 30m. c/c in straight run & in change in directions. Main Post – 60mm. OD x 3.65mm. thick Galvanized pipe.
9.	End Post	At start & finish of fence line. Main Post – 60mm. x 3.65mm. thick galvanized pipe. Struts 1 no. – 60mm. OD x 3.65 mm. thick galvanized pipe.
10.	Finish	All metal works, fabricated and finished with 2 coats of Epoxy Primer and one final coat of Epoxy Polyurethane in Green colour as specified.

6.1 FENCING SYSTEM INSTALLATION GUIDELINES

6.1.1 MARKING FENCE RUN

Mark the fence run, as per layout drawings, with a string and chalk marker. Stake out the fence run with steel stakes along salient points and regular intervals.

6.1.2 MARKING POSITION OF POSTS, GATES, ETC.

Along the marked fence run stakeout the position of Gates, End Posts, Corner Posts, Strainer Posts, their supports and the Line Posts.

6.1.3 EXCAVATION

Excavate the ground to the desired depth to create the holes for the Posts and their supports. (Follow the foundation drawings of the project for details).

6.1.4 INSTALLATION OF POSTS: IMPORTANT

Check the fencing run with respect to posts. Ensure the correctness of fence position, whether inside of posts looking from outside or outside of posts looking from inside of fenced area. Accordingly position at the Strainer Posts with Stretcher bar nuts positioned on fence side. Similarly check fence run and install the Line Posts accordingly. Grout the bottom of the posts with the recommended concrete mixture adopting standard building industry practices to ensure vertically, line of collimation, level of tops of posts. On installing Strainer posts, position the supports tighten the fasteners and then grout the supports.

6.1.5 STRINGING OF LINE WIRE OR STRAINING WIRE

The Line wire is fastened to the first Straining posts. (This may be at End Post, or a Corner Post as the case may be). This is done by stirruping the Line wire to the eye of the Eyebolt of the Loopnut. Stretch the Straining wire taut and stirrup it into the ring nut of the Eyebolt at the next Straining post. Tension the Line wire by tugging and wind the end over the line at least six turns. After this increase the tension by tightening the ring nut. After the line wire is tightened the next step is to bind the line wire to intermediate posts. Pass the Stirrup wire through the holes in the Line Post. Keep the stirrup wire sufficiently long enough to wrap around the line wire at least three turns on each side.

7.0 ROLLING SHUTTER

7.1 Providing and fixing in position push and pull type Rolling Shutters with interlocked MS laths and frames of approved make made from 14 gauge MS sheets and required size MS laths interlocked together through their entire length as indicated in the drawing and painting with one coat of Zinc chromate primer two coats of synthetic enamel paint, including providing ball bearings, pulleys, necessary accessories such as guide channels, chain or handle set, locking arrangement, top MS cover of 18 gauge and making holes in brickwork or RCC work and restoring the same and fixing strike plate of 100 x 6 mm MS flat in flooring and all materials and measures required to complete the job. Providing mechanical device chain and crank for mechanically operated rolling shutter

7.2 Providing grilled rolling shutters manufactured out of 8 mm dia. M.S. bars instead of laths as per design approved by PMC.

7.3 Note : Clear structural opening will be measured and paid for. The hood/ hood cover area will not be measured separately.

8.0 ROAD MARKING

8.1 Provision of road and Pavement marking with hot applied thermoplastic road marking material for center line, directional arrows and other necessary marking required. The Application and product shall comply to MORTH (Ministry of Road Transport and Highways, India) Clause 803.4.2

- 8.2 The work under this section consists of marking traffic stripes using a thermoplastic compound meeting the requirements specified herein.
- 8.3 The thermoplastic compound shall be screeded/extruded on to the pavement surface in a molten state by suitable machine capable of controlled preparation and laying with surface application of glass beads at a specific rate. Upon cooling to ambient pavement temperature, it shall produce an adherent pavement marking of specified thickness and width and capable of resisting deformation by traffic,
- 8.4 The colour of the compound shall be white or yellow (IS colour No. 556) as specified in the drawings or as directed by the ER/PMC
- 8.5 Where the compound is to be applied to cement concrete pavement, a sealing primer as recommended by the manufacturer, shall be applied to the pavement in advance of placing of the stripes to ensure proper bonding of the compound.
- 8.6 On new concrete surface any laitance and/or curing compound shall be removed before the markings are applied.

9.0 SITE BARRICADING

Providing and maintaining Plain Trafford sheet profile barricading made of galvanized steel cold rolled of thickness 0.55mm instead of corrugated GI sheets. on the site 2.4m (8') high by using 50mm dia GI pipe as vertical support at 3m c/c and 25 mm dia horizontal support at 900mm C/C etc., complete. Item to include fabricating, cutting and fixing in position GI pipe framework, painting the same with two coats of approved anti rust paint, all necessary supports for frame work, etc.

10.0 POLYCARBONATE ROOFING

10.1 SCOPE :

- a) Solid polycarbonate plastic glazing.
- b) Multiwall polycarbonate plastic glazing.
- c) Corrugated polycarbonate plastic glazing.
- d) Accessories for installation of plastic glazing.
- e) Skylight Glazing.

10.2 GENERAL & CODES

16 CFR 1201	Safety Standard for Architectural Glazing Materials.
ANSI Z97.1	American National Standard for Glazing Materials Used in Buildings.
ASTM D 635	Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.
ASTM D 648	Standard Test Method for Deflection Temperature of Plastics Under Flexural Load.
ASTM D 696	Standard Test Method for Coefficient of Linear Thermal Expansion.
ASTM D 790/ASTM 790M	Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
ASTM D 1003	Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics.
ASTM D 1044	Standard Test Method for Resistance of Transparent Plastic to Surface Abrasion.
ASTM D 1929	Standard Test Method for Ignition Properties of Plastics.
ASTM D 2843	Standard Test Method for Density of Smoke from the Burning and Decomposition of Plastics.
ASTM D 3763	Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of A Striker Impacted by A Falling Weight (40 ft-lbs).

ASTM G 53	Standard Practice for Operating Light and Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Non-Metallic Materials.
QUV 313B	Accelerated Weathering Test of Non-Metallic Materials.
ISO-9002	International Standards Organization.

10.3 POLYCARBONATE SHEETING : Typical Property Values

Property	Test Method	Unit	Value
Physical Density	ISO 1183	g/cm ³	1.2
Water absorption, 24 hours	ISO 62	mg.	10
Water absorption, saturation /23°C	ISO 62	%	0.35
Mould shrinkage	ASTM-D955	%	0.6-0.8
Poisson's ratio	ASTM-D638	-	0.38
Mechanical			
Tensile stress at yield 50 mm/min	ISO 527	MPa	60
Tensile stress at break 50 mm/min	ISO 527	MPa	70
Tensile strain at yield 50 mm/min	ISO 527	%	6
Tensile strain at break 50 mm/min	ISO 527	%	120
Tensile modulus 1 mm/min	ISO 527	MPa	2350
Flexural stress at yield 2 mm/min	ISO 178	MPa	90
Flexural modulus 2 mm/min	ISO 178	MPa	2300
Hardness H358/30 95	ISO 2039/1	MPa	95
Impact			
Charpy impact, notched	ISO 179/2C	kJ/m ²	35
Izod impact, unnotched 23°C	ISO 180/1U	kJ/m ²	NB
Izod impact, unnotched -30°C	ISO 180/1U	kJ/m ²	NB
Izod impact, notched 23°C	ISO 180/1A	kJ/m ²	65
Izod impact, notched -30°C	ISO 180/1A	kJ/m ²	10

PHYSICAL			
Specific Gravity	ASTM D792	ó	1.20
Sound Transmission, STC Rating (36" x 84")	ASTM E9070	ó	
	@ 0.118"		25
	@ 0.177"		29
	@ 0.236"		31
	@ 0.375"		34
	@ 0.500"		34
Light Transmission (Average)	ASTM D1003	%	88
Rockwell Hardness	ASTM D785	ó	M70, R118
Chemical Resistance	ANSI Z26.	1	Passes
MECHANICAL			
Tensile Strength, Ultimate	ASTM D638	psi	9,500
Tensile Modulus	ASTM D638	psi	340,000
Flexural Strength	ASTM D790	psi	13,500
Flexural Modulus	ASTM D790	psi	340,000
Flexural Endurance @ 1,800 Cycles/Min, 73°F, 50% RH	ASTM D671	psi	1,000
Compressive Strength	ASTM D695	psi	12,500
Elongation	ASTM D638	%	110
Izod Impact Strength, up to 125 mils, Notched	ASTM D256A	ft-lbs/in	12ñ16

Drop Dart Impact Strength, 1" dia.	dart GE Test	ft-lbs	
	@ 73°F		>200
	@ 0°F		>200
THERMAL			
Coefficient of Thermal Expansion	ASTM D696	in/in/°F	3.75 x 10-5
Thermal Shrinkage	GE Test	%	1
Heat Deflection Temperature	ASTM D648	°F	
	@ 264 psi		270
	@ 66 psi		280
Shading Coefficient	ASHRAE	ó	
	Clear		1.02
	Gray/Bronze		79
FLAMMABILITY			
Horizontal Burn (Flame Spread), AEB	ASTM D635	in	<1
Ignition Temperature	ASTM D1929	°F	
		Flash	873
		Self	1,076

10.4 ACCESSORIES

Profile : Aluminium custom profile 60 mm wide
Finish : 15 micron silver anodized
Flashing : Aluminium angle 35x35x1.5 thk
Gasket : EPDM rubber
Fastners : Self drilling and self tapping (SDST) screws
Washer : EPDM
Tapes : Aluminium tape roll
Sealant : Silicon, non stain

10.5 PREPARATION

- 10.5.1 Glazing channels or recesses shall be cleaned and free of obstructions, soil, debris, and other materials.
10.5.2 Seal porous glazing channels or recesses with primer-sealer compatible with substrate and polycarbonate sheet materials.
10.5.3 Cut polycarbonate sheet materials to exact sizes required, with clean edges free of notches; clean contact edges with solvent compatible with polycarbonate sheet materials, as specified or approved by polycarbonate sheet manufacturer.

10.6 INSTALLATION

- 10.6.1 Install plastic glazing in accordance with polycarbonate sheet manufacturer's instructions.
10.6.2 Do not use glazing accessories not specified or approved by polycarbonate sheet manufacturer.

10.7 CLEANING

- 10.7.1 Immediately after completing construction activities relating to installation of polycarbonate sheet materials, remove remainder of strippable masking from surfaces of polycarbonate sheet glazing; do not expose masking to sunlight for an extended period of time.
10.7.2 Immediately after removing masking, clean glazing in accordance with polycarbonate sheet manufacturer's instructions:
10.7.3 Rinse surface with lukewarm water.

- 10.7.4 Wash surface with mild soap and lukewarm water.
- 10.7.5 Use soft cloth or sponge gently to loosen dirt and grime; scrubbing glazing surfaces, or using squeegee on glazing surfaces, is not permitted.
- 10.7.6 Repeat rinse as above, and wipe surface dry with soft cloth until surfaces are spotless and dry.

10.8 PROTECTION OF INSTALLED PRODUCTS

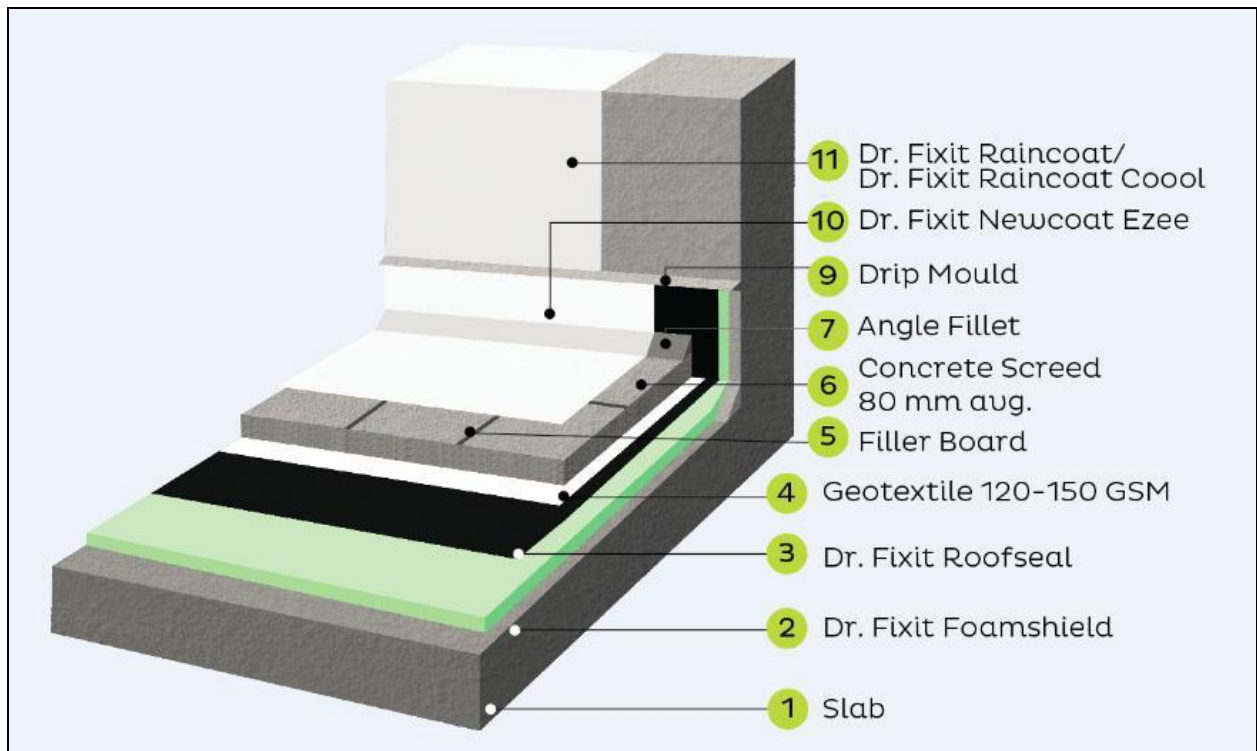
- 10.8.1 Immediately after cleaning, cover polycarbonate sheet glazing surfaces with polyethylene sheeting, or other covering material approved by polycarbonate sheet manufacturer; secure covering in place by taping to framing members - do not tape covering to polycarbonate sheet materials.
- 10.8.2 Protect installed glazing from damage to function or finish by subsequent construction activities.
- 10.8.3 Repair minor damage to finishes in accordance with polycarbonate sheet manufacturer's recommendations.
- 10.8.4 Replace glazing having damage to function, and glazing having damage to finishes

PART 11 A : TERRACE INSULATION & WATERPROOFING

1.0 GENERAL

The system shall be a green and sustainable solution for the roof with high energy savings, and a combination of waterproofing and thermal insulation with a guarantee of 25 years.

The system shall have an average thickness of **45 mm** "Dr. Fixit Foamshield" or equivalent insulation to meet/achieve a system **U value of 0.36 W/m².K or R15**.



SECTIONAL VIEW OF "DR. FIXIT LEC" SYSTEM ON COMMERCIAL/RESIDENTIAL FLAT ROOF

2.0 FEATURES

2.1 "Fixit Foamshield" or equivalent two component, water blown, polymeric M.D.I. based system for producing rigid Polyurethane Foam with a nominal core density of 45 - 50 kg/m³ by a spray process. the foam shall be self flashing and provide seamless protection by sealing cracks, crevices and holes while insulating decks from temperature extremes.

2.2 The foam shall provide :

2.2.1 A high R-value and can reduce condensation when applied correctly ;
Improves thermal comfort

2.2.2 Enhancing energy efficiency; lowering lifecycle costs by reducing the
operating costs.

2.2.3 Stops Leaks

2.2.4 Adheres well to concrete, masonry and variety of other substrate

2.2.5 Light Weight

2.2.6 Does not attract rodent and harbour mould growth.

3.0 Technical Details

Properties	Value	Test Method
Core Density (Kg/m ³)	45 - 50	ASTM D-1622
Compressive Strength (Kg/cm ²)	4.2	ASTM D-1621/94
Initial Thermal Conductivity @ 25° C (W/m.k)	0.018	ASTM C - 518 / 91
Fire Resistance	Class B2	DIN 4102
Water Absorption, per cm ² (gm/cc) with protective coating	0.0019	ASTM C - 272

4.0 U & R VALUE CALCULATOR:

Roof System (SI Units)				
Description	Specification	Thermal Conductivity (k Value) W/m.k	Thickness m	Thermal Resistance (R Value) m ² . k/W
Outside Film		-	-	0.040
Dr. Fixit New Coat	2 Coats	-	0.001	--
Screed (avg thickness)	M20	1.73	0.080	0.046
Geotextile	150 GSM	-	0.001	--
Dr. Fixit New Coat	1 coat	-	0.001	--
Dr. Fixit Foamshield (avg thickness)	45 - 50 kg/m ³	0.018	0.045	2.500
Dr. Fixit Extensa	0.5mm	-	0.005	-
RCC Slab	M40	1.95	0.150	0.077
Inside Film	-	-	-	0.12
TOTAL RESISTANCE		m² °k/W		2.78
TOTAL U VALUE		W/m² °k		0.359

The required R15 will be matched by spraying "Fixit Foamshield" or equivalent, up to a thickness of 45 mm as can be seen from the calculator

5.0 APPLICATION METHOD STATEMENT:

- 5.1 The entire roof area shall include the following works and materials to be supplied and installed by with a Comprehensive Waterproofing Guarantee of 25 years provided by the system manufacturer & installer.
- 5.2 The roof area shall be cleaned using a compressed air system, to ensure that the substrate is free from dust, laitance, debris, etc. Appropriate repair materials shall be applied to make the good any cracks, crevices, etc., in the substrate.
- 5.3 Depending upon the condition of the roof, the surface shall be applied with a slurry coat of "Dr. Fixit URP" or equivalent, compulsorily after filling up all the cracks.

- 5.4 Any pipes or openings / protrusions shall be provided prior to taking up the surface preparation. Since this application would be quite thick, adequate provision shall be made to provide water vents to the drain points in the roof, pointing upwards, so that rain water will drain with ease into them & pass off into the down-take rainwater pipes.
- 5.5 The first layer shall be spray application of "Fixit Foamshield" or equivalent, polyurethane foam of 45-50 kg /m³ Density, at an average thickness of 45mm to meet a system U value of 0.36 W/m².K over the terrace.
- 5.6 This shall be followed by roller/brush application of 2 coats of "Dr. Fixit Roofseal" or equivalent, at an average thickness of 0.80-1mm mm thickness (@consumption of 1.5 liters/Sqm)
- 5.7 Water ponding / Flood test after the application shall be done after this. Water shall be filled up and retained for at least 24 to 48 hrs.
- 5.8 After emptying the water, a Geotextile membrane of 120 gsm shall be placed.
- 5.9 A bitumen board meant for construction joints shall be placed vertically at 3 to 4 metres along the length and breadth of the roof area. Each rectangular bay formed in this manner shall not exceed 12 m².
- 5.10 Concrete screed of M 20 grade thickness 80mm (or depending upon the span of the roof and slope required) shall be cast into these bays, either from a RMC pump (material, pump / machine and laying shall be carried out by you / your contractor).
- 5.11 All around on the roof, at the parapet wall junction, an angular fillet of 50 mm X 50 mm shall be trowel applied in cement-sand mortar (material shall be supplied by you) in 1 : 3 proportion, in which the sand shall be cleaned & washed off its silt content. Curing of the concrete screed & angle fillet shall be done as per regular concrete curing practices, by means of regularly wetting a hessian cloth.
- 5.12 The bituminous filler board shall be exposed by means of a mechanical cutting machine, and loose mortar shall be cleaned or vacuum-sucked to make a clean surface. The grooves formed by exposing the filler board shall be applied with polysulphide sealant, "Dr. Fixit Pidiseal PS 41 G / 42 P", or "Dr. Fixit PU sealant". The width of the sealant fill shall not be more than approx. 10 mm and 10 mm deep.
- 5.13 Over this two finishing coats of "Dr. Fixit Newcoat Ezee" or equivalent, fiber reinforced water based acrylic coating shall be applied with a roller.

OR:

- 5.14 If tiling is to be done, instead of "Dr. Fixit Newcoat Ezee" or equivalent, 2 coats of "Dr. Fixit Fastflex" or equivalent which is two component cementitious coating is brush applied. While the surface is wet, sand is to be sprinkled over it.

PART 11 B : TERRACE GARDEN / LANDSCAPE AREA WATERPROOFING

1.0 GENERAL

- 1.1 "Dr. Fixit Extensa" or equivalent shall be used waterproofing membrane for new roofs, foundations, plaza decks, bridge decks, interior and exterior walls, walking decks, steel or wood beams, and a wide range of specialty waterproofing applications.
- 1.2 "Dr. Fixit Extensa" or equivalent shall be used for waterproofing of composite podiums where features like swimming pools, driveways, landscape features etc. are present. It shall form a seamless monolithic tough waterproofing layer which has excellent crack bridging ability.

2.0 Technical Details

Physical Properties (liquid Form)		Test results
Color	-	Brown to black
Volatile Organic Compounds	-	Contains no solvents (no VOCs)
Properties (Tested on 1.5mm cured film)	Test method	Typical Value
Tensile Strength of film N/mm ²	ASTM D 412	≥ 1.00
Tear Resistance N	ASTM D 1004	≥ 5
Puncture Resistance	ASTEM E 154	Pass [UTM ultimate limit reached]
Elongation %	ASTM D412	≥ 1000%
Water vapor transmission	ASTM E96	0.2gr/h/m ²
Water Permeability	BS EN 12390-8	Nil
Accelerated weathering (1,000 hrs. 7 yrs.)	ASTM G155	Excellent
Impact resistance	ASTM D3746	Pass
Xenon exposure 1,000 hrs. (UV)	ASTM G155	Excellent
Peel adhesion to primed concrete N	ASTM C 794	≥ 25
Low temperature bend	ASTM D2136	Passes at -30deg F
Resistance to puncture	ASTM E154	Pass

3.0 APPLICATION METHOD STATEMENT

- 3.1 The surface area shall be cleaned using a compressed air system, to ensure that the substrate is free from dust, laitance, debris, etc. Appropriate repair materials from the "Dr. Fixit" or equivalent range shall be applied to make the good any cracks, crevices, etc., in the substrate
- 3.2 Any pipes or openings / protrusions shall be provided prior to taking up the surface preparation. Since this application would be quite thick, adequate provision must be made to provide water vents to the drain points in the roof, pointing upwards, so that rain water will drain with ease into them & pass off into the down-take rainwater pipes.
- 3.3 With a suitable spray gun, "Dr. Fixit Extensa" or equivalent shall be applied, at an average thickness of 1.5 mm thickness.

4.0 Water ponding / Flood test after the application

- 4.1 Water shall be filled up and retained for at least 24 to 48 hrs.
- 4.2 After emptying the water, a Geotextile membrane of 150 gsm shall be placed.
- 4.3 A bitumen board meant for construction joints shall be placed vertically at 3 to 4 metres along the length and breadth of the roof area. Each rectangular bay formed in this manner shall not exceed 12 m².
- 4.4 80mm thick (or depending upon the span of the roof and slope required) Concrete screed of M 20 grade shall be cast into these bays, either from a RMC pump (material, pump / machine and laying shall be carried out by you / your contractor).
- 4.5 All around on the roof, at the parapet wall junction, an angular fillet of 50 mm X 50 mm shall be trowel applied in cement-sand mortar (material shall be supplied by you) in 1 : 3 proportion, in which the sand shall be cleaned & washed off its silt content. Curing of the concrete screed & angle fillet shall be done as per regular concrete curing practices, by means of regularly wetting a hessian cloth.
- 4.6 The bituminous filler board shall be exposed by means of a mechanical cutting machine, and loose mortar shall be cleaned or vacuum-sucked to make a clean surface. The grooves formed by exposing the filler board shall be applied with polysulphide sealant, "Dr. Fixit Pidiseal PS 41 G / 42 P, or Dr. Fixit PU sealant" or equivalent. The width of the sealant fill shall not be more than approx. 10 mm and 10 mm deep.
- 4.7 Over the surface which requires anti root treatment 3 Coats of "Dr. Fixit" or equivalent coal tar epoxy shall be brush/ roller applied at a minimum interval of 6 hours. For reasonably sound screed no priming is required as the product is self priming. However for porous surfaces a priming coat of "Dr. Fixit Coal" or equivalent Tar epoxy mixed with industrial grade Toluene in a (1:1) ratio. This treatment will prevent the penetration of roots into the screed without inhibiting the growth of the roots.
- 4.8 This shall be followed by fixing of HDPE drain cell boards spot bonded with a 120 GSM geotextile on the top surface over the entire surface of the landscaping after the anti-rooting treatment.
- 4.9 This is to be followed by careful loading of soil so as to avoid the puncturing of the geotextile and planting of shrubs. Please note that the providing and laying of the drain boards, geotextile, soil and vegetation layer is excluded from our scope.

PART 11 C : WASHROOM / BATHROOM / TOILET WATERPROOFING

1.0 METHOD STATEMENT

- 1.1 Surface Preparation: Thorough surface preparation by removal of all laitance and deposits in the surface of the sunken portions of toilets. If needed, mechanical means can also be used to plane the surface. All voids, honeycombs, etc., must be filled with polymer modified mortar admixed with "Dr. Fixit Pidicrete URP" or equivalent, a polymer based latex liquid that shall added into the wet mix (at 5% by wt. of cement), to the cement - sand mortar.
- 1.2 Angle fillets of 50 mm X 50 mm must be made / placed in the cement-sand mortar made with the above specification, all round the periphery of the sunken portion, at the right angled junction of the horizontal and vertical surfaces.
- 1.3 Pipes which are to be inserted through the core cut sections will need to properly grouted, to make them water-tight against any seepage or leakage. For this the pipes shall first be wrapped with "Dr. Fixit Bathseal Tape" or equivalent, a two-way adhesive tape that shall stick to the pipe as well as the grout in the bore-packing. The length of the tape shall be a little more than the depth of the hole that is core- cut in the bathroom (bottom side or at the side – that will determined as per the situation)
- 1.4 After the pipe has been properly placed, the bore packing or the grouting of the annular space (around the pipe and in-between the pipe and the bore's inner side), shall be shuttered from the backside side to provide a leak-free shuttering.
- 1.5 Into the space a non-shrink, free flow cementitious high strength grout, "Dr. Fixit Bathseal Grout" or equivalent shall be poured, to fill up the annular space. The grout on drying for 24 hours will provide a totally leak-free hole. The pipe inserted should be sufficiently long initially and then cut as needed, before taking up the application of the waterproof coating
- 1.6 After a day of water- curing, the sunken portion shall be pre-wetted with water and brought to a SSD condition, to allow the application of the waterproofing coating.
- 1.7 "Dr. Fixit Bathseal WPC" or equivalent, a cementitious – acrylic, 2 component brush applied coating shall be mixed with a forced action, slow speed drilling machine attached to a suitable paddle. Water should not be added into the mix. The first coat shall be applied over the entire area of the sunken portion, and be extended to about 300-350mm above the expected / indicated finished floor level of the bathroom flooring, which shall be decided by the Authority's civil engineer -in-charge. After the 1st coat dries, the second coat shall also be applied over the first one. While the 2nd coat is still wet, sieved sand, clean and washed, shall be broadcast over the coating, to provide a mechanical key to the plaster, which shall be applied over the "Dr. Fixit Bathseal WPC" or equivalent waterproofed coating. This will protect it from damage to work on the site. Curing of the protective plaster shall be done as per standard curing practices. 6 days later the sunken portion can be filled up with water for a period of 24 – 48 hours, to check / observe for any leakage.
- 1.8 Later, Brick-bat coba or a bloc-bat-coba, can be placed in the sunken portion to fill up the sunken portion, as needed.
- 1.9 After finalizing plumbing work in the bathroom floor, tiling work can be carried out using Roff Tiling Adhesives & RTM Tile grouts.

PART 12 : FIRE STOPS AND SEALANTS

1.0 Fire Barrier mortar : Hilti CP636 or approved equivalent

- 1.1 Providing & fixing Fire Barrier mortar with minimum 2 hours fire rating when tested in accordance with BS 476 part 20 and UL 1479 for horizontal openings in fire rated floors or slabs and vertical openings in walls for passing service shafts. The mortar shall have a minimum hardened density of 0.8 g/cm³. The service lines could be of various types like electrical cables trays, metal pipes, GI Ducts for AC, etc. The product shall be tested for withstanding Zone 4 earthquake when tested in accordance with acceleration time history waveform VERTEQII as per IEC 60068 and Telcordia Technologies GR-63-Core 2006-03. The product shall be age tested for 30 years as per Dafstb and DIBT standards. The product shall be tested and approved by third party agencies such as UL, FM and LPCB. The product shall bear the UL and FM approval logo on the packing

2.0 Fire resistant board system mortar : Hilti HMWB or approved equivalent

- 2.1 Providing & fixing Fire resistant board system with minimum 2 hours fire rating when tested in accordance with BS 476 part 20 for horizontal openings in fire rated floors or slabs and vertical openings in walls for passing service shafts. The fire resistant board system shall comprise of a mineral wool board having a minimum density of 160Kg/m³ coated with an ablative coating at 1mm dft. All contact surfaces and cavities shall be sealed with an intumescent filler. The service lines could be of various types like electrical cables trays, metal pipes, etc. The product shall be age tested for 30 years as per Dafstb and DIBT standards. The product shall be tested and approved by third party agencies such as FM and LPCB. The product shall bear the UL and FM approval logo on the packing.

3.0 Fire expanding foam : Hilti CP620 or approved equivalent

- 3.1 Providing & fixing Fire expanding foam with minimum 2 hours fire rating when tested in accordance with BS 476 part 20 and UL 1479 for horizontal openings in fire rated floors or slabs and vertical openings in walls made of concrete/ masonry or Gypsum for passing service shafts. The expanding foam expands seven times its volume to fill the cavity at the time of dispensing the material and shall fully cure within two minutes after dispensing. The service lines could be of various types like electrical cables, cable trays or metal pipes etc. The product shall be tested for withstanding Zone 4 earthquake when tested in accordance with acceleration time history waveform VERTEQII as per IEC 60068 and Telcordia Technologies GR-63-Core 2006-03. The product shall be age tested for 30 years as per Dafstb and DIBT standards. The product shall provide water tightness when tested for W rating as per UL standards and shall be tested for providing a sound insulation of 50 when tested in accordance with ASTM E 90. The product shall be tested and approved by third party agencies such as UL, FM and LPCB. The product shall bear the UL and FM approval logo on the packing. The product shall bear the UL and FM approval logo on the packing.

4.0 Intumescent based coating : Hilti CP678 or approved equivalent

- 4.1 Supply and application of intumescent based coating on cables/ cable tray along the horizontal runs at every 15 mtr in case of horizontal runs, every 5m in case of vertical runs and tee-offs shall be provided at intervals of 30mtr. The coating shall have a density in the range of 1.2 to 1.4 Kg/ L. The coating shall be non-toxic, asbestos and halogen free and shall have good mechanical strength. The coating shall comply with IEC 332 part 3 (1992).

5.0 Ablative coating : Hilti CP679A or approved equivalent

- 5.1 Supply and application of ablative coating on cables/ cable tray along the horizontal runs at every 15 mtr in case of horizontal runs, every 5m in case of vertical runs and tee-offs shall be provided at intervals of 30mtr. The coating shall have a density in the range of 1.2 to 1.4 Kg/ L. The coating shall be non-toxic, asbestos and halogen free and shall have good mechanical strength. The coating shall comply with IEC 60332 part 3 (1992), IEC 60331-21:1999.
- 5.2 The product shall be FM approved to class 3971, tested by DNV for IEC 30332 part3 and German Loyd for IEC 60331 and approved by ABS (American bureau of ship building). The critical oxygen index shall be tested in accordance with ISO 4589 and shall not have a value lesser than 44.8% and determination of flexibility (mandrel bending test) having a value of 6 when tested in accordance with DIN EN ISO 1519. In addition to the same, the products shall retain the critical oxygen index and flexibility even after salt spray test as mentioned in DIN 50 021-SS.
- 6.0 Acrylic Firestop Sealant : Hilti CP606 or approved equivalent**
- 6.1 Install Acrylic Firestop Sealant in services passing thru fire compartment walls and floors made of concrete, masonry, metal, gypsum construction to provide up to 2 hours insulation and integrity when subject to the test conditions of UL standards, The product shall also be age tested to DafStb guidelines. The services can be metal pipes or HVAC ducts having an annular space of not more than 30mm all around. Sealant to provide sufficient MAF, water and gas tight seal apart from providing an airborne sound transmission reduction (STC of 50) when tested in accordance with ATM E 90-90 for joints in gypsum partition and shall be FM approved. All installations to be in full accordance with the supplier. The product shall bear the UL and FM approval logo on the packing.
- 7.0 Silicone Firestop Sealant : Hilti CP601S or approved equivalent**
- 7.1 Install silicone Firestop Sealant in services passing thru fire compartment walls and floors made of concrete, masonry, metal, gypsum construction to provide up to 2 hours insulation and integrity when subject to the test conditions of UL standards, The product shall also be age tested to DafStb guidelines and will be W rated as per UL 1479. The services can be metal pipes or HVAC ducts having an annular space of not more than 30mm all around. Sealant to provide sufficient MAF, water and gas tight seal apart from providing an airborne sound transmission reduction (STC of 50) when tested in accordance with ATM E 90-90 for joints in gypsum partition and shall be FM approved. All installations to be in full accordance with the supplier. The product shall bear the UL and FM approval logo on the packing.
- 8.0 Sprayable Fire-rated Mastic : Hilti CP672 or approved equivalent**
- 8.1 Providing and installing Sprayable Fire-rated Mastic in curtain wall joints, edge of slab joints, top of wall joints and expansion joints in Concrete, Masonry and Gypsum to give 2 hours of fire rating when tested as per UL standards .The product shall have passed the 500 cycles requirement as specified by ASTM E 1399 and UL2079. The product to have upto 50% Movement Capability and Sound Insulation of 55db as per ASTM E90. The product shall also be resistant to the growth of mould and mildew when tested in accordance with ASTM G21. The product shall bear the UL and FM approval logo on the packing

PART 13: WORKSTATIONS AND TABLES

- 1.0 Supply and installation of workstation in office areas with combination of Left hand and right hand side. Workstation of make Godrej Enterprise or equivalent.**



- 1.1.1 Top- Work surface - 18mm thk. Prelaminated particle board. All work surface edges to be duly sealed with 2mm thk. PVC edge banding. Modesty panel- 18mm thk. Pre laminated particle board. All work surface edges to be duly sealed with 2 mm thk PVC edge banding. (Optional). Rectangular frame- Fabricated component in 1.2 mm thk. CRCA "D" Grade as per IS: 513. Finish: Epoxy polyester powder coated thickness of 50 micron.(+-10 micron). Leg: Fabricated component in 38 X 25 X 1.2 mm thk. MS ERW Tube (IS:7138). Finish- Epoxy polyester powder coated to thickness of 50 micron (+-50mm). CPU Modesty-0.8 mm thk."D"Grade as per IS: 513. Finish: Epoxy polyester powder coated to thickness of 50micron (+-10mm). Levellers glide for Leg- Nylon 6 & MS Bolt. Horizontal wire carrier- 0.7 MM THK. CRCA "D"grade as per IS:513. Finish: Epoxy polyester powder coated to thickness of 50mm (+-10mm). Vertical wire carrier- 0.8 mm thk. CRCA "D"grade as per IS: 513. Finish: Epoxy polyester powder coated to thickness of 50mm (+-10mm). Pedestal- Drawer configuration/product size/ styling: Box-Box- File 355.5 x 559 x 870, Enclosing, Including leveller. Construction and material- Welded assembled.Shell-0.6 mm thk. CRCA as per IS-513. Drawer tray & back - 0.5 mm thk. CRCA as per IS-513. Drawer front- 0.6mm thk CRCA as per IS-513. Locking- Cam lock, Leveller- Plastic M8 leveller mounted below body shell. Handle- Injection moulded polypropylene, Finish- Epoxy polyester powder coated to the thickness of 50 microns (+_10).

2.0 Supply and installation of workstation in cabin with combination of Left hand and right hand side. Workstation of make Godrej Finesse + ERU or equivalent.



- 2.1.1 Top: 25 mm thk. Particle board clad with 0.6 mm thk. Post formed laminate and 1 mm thk. Backing laminate. Flat edge duly sealed with 2 mm thk. PVC beading. Modesty- 18 mm thk. Plain particle board clad with 1.0 mm thick decorative laminate on both sides. Edge sealed with 2 mm thk. PVC beading, Extended Return Unit (ERU). Top: 25 mm thk. Particle board clad with 0.6 mm thk. Post formed laminate and 1 mm thk. Backing laminate. Flat edge duly sealed with 2 mm thk. PVC beading. Modesty- 18 mm thk. Plain particle board clad with 1.0 mm thick decorative laminate on both sides. Edge sealed with 2 mm thk. PVC beading, Hinge door unit. Top & Side Panel- 25 mm thk. Particle board clad with 0.6 mm thk. Post formed laminate and 1 mm thk. Backing laminate. Flat edge duly sealed with 2 mm thk. PVC beading. Doors, Partitions and Shelves- 18 mm thk. Plain particle board clad with 1.0 mm thick decorative laminate on both sides. Edge sealed with 2 mm thk. PVC beading,

3.0 Supply and installation of workstation in MD's cabin - Godrej Cignus or equivalent.



3.1.1 Main Table- Work surface - Made of 25 mm thk. Pre laminated twin board and approved shade conforming to IS - 12823:1990, Edge banded with matching 2 mm thk. PVC lapping. Secondary work surface made up of 25 mm thk. MDF on one side pre-laminate board confirming to IS-14587:1998 WITH 0.4 mm PVC membrane pressed on top. Soft closing access flap within build power box to be provided on work surface for wire management. Modesty panel to be 25mm thk. MDF - one side of which to be laminate board confirming to IS-14587:1998 with 0.4mm PVC membrane pressed on top. Under structure made of 25 mm thk pre laminated twin board and approved shade conforming IS - 12823:1990, Edge banded with matching 2 mm thk. PVC lapping. Integrated pedestal of 25 mm thk. Pre laminated twin board of E1-P2 grade and approved shade confirming to IS-12823:1990, edge banding with 2 mm thick PVC lapping. Drawer fronts made of 25mm thk.MDF - one side per laminated board confirming to IS 14587:1998 with 0.4 mm PVC membrane pressed on to top. Drawers to have soft closing and anti-slam mechanism. Pedestal to be provided with lock for security. Handles to be provided for ease of operation. Main table with ERU with pedestal 2350W X 1150 D X 750 H., Back unit. Top panel made of 25mm thk MDF - one side pre laminate board confirming to IS-14587:1998 with 0.4 mm PVC membrane pressed to top. Slide door unit made of 25mm thk. Pre laminated twin board and of approved shade confirming to IS-12823:1990, edge banded with matching 2 mm thick PVC lapping for body panels like side, bottom , back and shelves. Shutters are to be made up of 25mm thk. MDF- one side pre laminate board confirming to IS-14587:1998 with 0.4mm PVC membrane pressed on to top. Shutters have a soft closing and anti slam mechanism. Handles are provided for ease of opening. Storage to be provided with lock for security.

4.0 Supply and installation of workstation in Service area other than office. Workstation of make Godrej Unitized tables or equivalent.



4.1.1 Top- Work surfaces- The panels are made from 18+-0.5 mm thk. Pre laminated boards as per with 2 mm thk. PVC edge banding on all sides. * T-104- 25+_0.5 mm thk . Pre laminated board. Under structure C-Frame - Made from 0.9+_0.09mm thk. Powder coated 50 microns (+_10) CRCA MS. Tubular frame- For T8 & t9 - Dia

25.4+_{-0.3}mm X 1.2+_{-0.096}mm thk. MS ERW. For others- Dia 25.4+_{-0.3}mm X 1.2+_{-0.096}mm thk. MS ERW tube. Modesty panel- Made from 1.0 +_{-0.09}mm thk. Powder coated 50 microns (+₋₁₀) CRCA MS. Storage, Shell- 0.6 mm thk. CRCA as per IS – 513, Drawer tray & back- 0.5 mm thk. CRCA as per IS – 513, Drawer front- 0.6 mm thk. CRCA as per IS – 513, Lock- Cam lock, Handles- Plastic handle.

5.0 Supplying and installing discussion Meeting/Conference Room tables in sizes and shapes as per the details given below:

Talk 4 Seater Square



5.1.1 Work surface (Veneer)- Top thickness 31mm thk+_{-1.5}mm(18mm +12mmMDF as per IS 12406 + Natural veneer on top surface and balancing laminate on bottom surface) . Chamfer edges and veneer portion of worksurface in finished in PU Matt paint. Work surface (Membrane)- Top thickness 30 mm +_{-1.5} mm (18mm +12mmMDF as per IS 12406 +0.4 mm membrane foil and balancing laminate on bottom surface. Work surface (Laminate)- Top thickness 31 mm +_{-1.5} mm (18mm +12mmMDF as per IS 12406 +0.6 mm post laminate on top surface and balancing laminate on bottom surface) and PVC banding on straight top side edge and specially designed T Beading fixed side edge for sleek look. Under structure, Legs- Made from 1.6 mm matt silver anodized aluminium extrusion. Leg assembled together with a plastic holder at bottom and 5 mm HR Steel (IS:2062) which is powder coated (DFT 40-60 microns). The plastic glide holder is having provision for wire entry and glide fixing. The wire carrying is facilitated through the hollow space between two led extrusions and the wired are concealed between removable rigid PVC extrusions in the leg. Veil & cross members- Made from 18 mm thk. PLT+₋₁mm as per IS- 12823 and PVC edge banding on all the sides. Access flap and switch mounting tray- Made from matt silver anodized aluminium extrusion and plastic moulded components to facilitate access of Electrical/ Data / Voice sockets access from top. Powder coated (DFT 40-60 microns) switch mounting tray made from 0.8/1.2 mm CR steel IS- 513. Switches to be mounted on tray as per requirement. Provision for mounting 8 module anchor roma witch plate on switch mounting tray.

6.0 Supplying and installing discussion / Conference Room tables in sizes and shapes as per the details given below:



6.1.1 Work surface (Membrane) Top thickness 25 mm thk. ± 1.5 mm (25mm +12mmMDF+0.4mm membrane foil). Work surface (Laminate) Top thickness 25 mm thk. ± 1.5 mm (25mm MDF OSR As per IS 12406 +0.6 mm post laminate on top surface and balancing laminate on bottom surface) with PVC edge banding . The work surface has rounded corners. Legs- Nickel chrome plated squeeze leg made from dia. 50.8 x 1.6 mm thk. MS ERW tube. Leg assembled together with a plastic glide at bottom and powder coated leg connector made from Aluminium (Pressure die cast) alloy at top. Laminated modesty- Made from 18mm thk. PLT ± 1 mm as per IS- 12823 OR 16 mm plain particle board +0.6mm top laminate on either side (postlam)and PVC edge banding on all the sides. Work surface and modesty are assembled together with powder coated (DFT 40-60 microns). Modesty bracket made from 2mm thk. CR Steel IS:513. Access flap and switch mounting tray- Made from matt silver anodized aluminium extrusion and plastic moulded components to facilitate access of Electrical/ Data / Voice sockets access from top. Powder coated (DFT 40-60 microns) switch mounting tray made from 0.8/1.2 mm CR steel IS: 513. Switches to be mounted on tray as per requirement. Provision for mounting 8 module anchor roma switch plate on switch mounting tray. Flexible wire carrier- Fixed to work surface from bottom side for holding wires. The wire carrying is facilitated through the hollow space between plastic components.

PART 14: CAFETERIA TABLES:

1.0 Supplying and installing of Cafeteria tables:



1.1.1 Option 01: Work surface of base material 25mm MDF Board, PVC Membrane on top 8 X 2 mm deep groove on centre of the table as graphics. Edge to be specially profiled to prevent striping of foil and comfortable touch. Option -02: PU Painted - Base material - 25mm MDF Board, On top PU painting of minimum 2H hardness with 75 % glass as per colour chart. Specially profiled edge for comfort. Bend pipe under structure of MS Powder coated. Pipe dia 38mm, 2 mm thk. Under structure fitted with top by SS machine screws. Legs: MS Powder coated legs for PU top and SS Legs for membrane top 38mm dia. Pipe legs are fixed with under structure and table top. Glide; Plastic glide fixed at the under structure to prevent the damage of table top during stacking.

PART 15: OTHER TABLES:

2.0 Supplying and installing for tables for reading purpose – Godrej insight or equivalent:



- 2.1.1 Worktop of 25 mm thk. PLB tops with 2 mm thk. PVC edge beading. Under structure of 1.6 mm thk C frame supporting the top, and legs of dia. 38.1 x 1.6 mm thk. MS ERW tube.

3.0 Supplying and installing for Side table – Godrej insight or equivalent:



- 3.1.1 Under structure to be a welded assembly made in SS 202 grade having dia 12+-0.04 as per IS : 1762. Glass- It is 12+-0.3mm thick black tinted Toughened glass UV glued with bushes made in SS 202 grade for fixing with under structure.

4.0 Supplying and installing for Centre table – Godrej insight or equivalent:



- 4.1.1 Under structure to be a welded assembly made in SS 202 grade having dia 12+-0.04 as per IS: 1762. Glass- It is 12+-0.3mm thick black tinted Toughened glass UV glued with bushes made in SS 202 grade for fixing with under structure.

PART 16: SEATING CHAIRS:

5.0 Supplying and installing of high back seating in GM Cabin - Godrej La-sede or equivalent:



- 5.1.1 Seat Assembly to be cushioned made of injection moulded plastic outer and inner . Inner plastic to be upholstered with pure leather and moulded high resistance (HR) Polyurethane foam of density 45.2+-2 kg /m³and hardness load of 16+-2 kgf as per 7888 for 25% compression. Back assembly to be cushioned back made of PU foam with in situ moulded MS ERW. Round tube of size 1.9+_0.03 cm x 0.16 +_0.0128 cm

and upholstered with pure leather. Armrests- To be moulded from PU upholstered with pure leather and moulded on to a drop lift adequate type tubular armrest support. Adjustable tilting mechanism with active bio synchro mechanism. Seat depth adjustment to be integrated in the seat through a sliding mechanism. Back support with up/dn mechanism housed in plastic T Spine. Pneumatic ht. Adjustment. Pedestal assembly of high pressure die cast polished Aluminium and filled with twin wheel castors. Twin wheel castors to be injection moulded in plastic.

6.0 Supplying and installing Seating in Cabin Areas - Godrej Ace or equivalent:



- 6.1.1 The seat back assembly- The cushioned seat assembly to consist of seat outer (material -30% glass fibre nylon) and upholstered seat inner in polypropylene with moulded polyurethane foam and polyester fabric and upholstered using Polyester mesh fabric with high tenacity yarn. The HR polyurethane foam is moulded with density =45 +/- 2 kg/m³ and hardness load 12+/-2 kgf as per 1S; 7888 for 25% compression. The back support spine to be made up of High pressure die cast polished aluminium. Armrests to have 2 adjustments. Height (6.0 +_0.5cm) and depth (6.0 +_0.5cm). Height adjustment is provided in Al. Structure of armrest which is connected to Al. Back spine and is operated by button. The depth adjustment is provided in pad which is fixed to armrest structure. Armrest top is made of PU moulded over plastic inner. Active Bio synchro mechanism- The adjustable tilting mechanism is designed with the following features:360 degree revolving type. Front pivot for tilt with feet resting on ground and continuous lumbar support ensuring more comfort. Tilt tension adjustment can be operated in seating position. 5 position tilt limiter giving option of variable tilt angle to the chair. Seat/ back tilting ratio of 1:2. The mechanism housing is made up of HPDC Aluminium and black powder coated (DFT 40 to 60 micron). Seat depth adjustment is integrated in the seat through a sliding mechanism. Seat depth adjustment range is of 3.75+_0.1cm. The lumbar support assembly consists of lumbar spine (material - glass fiber filled nylon) which is fixed to Al. Back spine. Lumbar pad is fixed to lumbar spine through lumbar pad support. Lumbar support assembly has height adjustment of 5.0 +_0.5 CM. The neck rest assembly consists of upholstered neckrest inner with moulded polyurethane foam and polyester fabric. Upholstered inner is fixed to neck rest cover .Neck rest is to be fixed to back assembly through neck rest spine . Neck rest assembly has height adjustments of 5.5+_0.5cm and rotation adjustment of overall 20 +-2. The pneumatic height adjustment has an adjustment stroke of 10.0 +-0.3 cm. The pedestal assembly to be high pressure die cast polished aluminium and fitted with 5no. Twin wheel castors. The pedestal Twin wheel castors to be injection moulded in black PP having 6.0+-0.1mm wheel diameter.alsis 65+-0.5 cm pitch centre dia.

7.0 Supplying and installing Seating in Office Areas - Godrej Bravo or equivalent:



- 7.1.1 **Seat / Back Assembly:** The seat and back to be made up of 1.2 ± 0.1 cm thk. Hot pressed plywood measured as per QA method described in OCP- QLTA-P14-18 and upholstered with fabric upholstery covers and moulded polyurethane foam. The back foam is designed with contoured lumbar support for extra comfort. HR Polyurethane foam to be moulded with density 45 ± 2 kg/m³ and hardness load of 16 ± 2 kgf as per IS 7888 for 25% compression. Armrests to be one piece in injection moulded from black co-polymer polypropylene. The seating to have central tilt synchro mechanism, The pneumatic height adjustment of adjustment stroke of 12 ± 0.3 cm. Telescopic bellow assembly in 3 piece telescopic type and injection moulded in black polypropylene. Pedestal assembles to be injection moulded in black 33% glass filled nylon-66 and fitted with 5 nos. Twin wheel castors. The pedestal to be 66.3 ± 0.5 cm. Twin wheel castor to be injection moulded in black nylon.

8.0 Supplying and installing Seating in Conference Rooms - Godrej BEAT or equivalent:



- 8.1.1 57.5 (W) x 58.2 cm (D) x 100.8 cm (H) x 47.0 cm (Seat Height). Under structure to be MS Powder Coated U/S with Fixed Arm Rest. The seat to have wider upper back and contoured seat in trapezoidal shaped back with lever-less, drop lift function for intuitive height adjustment.

9.0 Supplying and installing Chairs for cafeteria - Godrej Unwind or equivalent:



- 9.1.1 The seat and back to be made of injection moulded high impact strength polypropylene polymer compound with indoor grade UV resistance. Seat size- 52.5 x 53.2 cm, Back seat 51.6 X 40.5 cm. S.S Tubular welded frame from 2.22 ± 0.03 x 0.12 ± 0.0128 cm and 3.5 ± 0.3 cm x 1.5 ± 0.3 cm 0.12 ± 0.0128 cm stainless steel 202 grade tube. The tubes to be buff polished to give shiny finish.

10.0 Supplying and installing of Auditorium Chairs - Godrej Mars with synchro slide or equivalent:



10.1.1 Seat assembly- The seat assembly to be made of polyurethane foam moulded with M.S. Tubular frame insert upholstered with fabric. The insert to be tubular frame made of 1.9 dia. $+_{-0.02}$ cm X $0.16+_{-0.13}$ cm thk. MS E.R.W. Round tube with flexible support straps running across the length and width of the frame. The seat to have an anti tip up feature making it stays in upright position when not in use to enable clearing of the row passage. Backrest - The back assembly of PU foam moulded with M.S.Tubular frame insert upholstered with fabric. The chair to rest on ground on two side panel frames fabricated from $0.12 +_{-0.020}$ cm thk. CR Steel sheet, clad with fabric upholstery. The side panel frame to be grouted to the floor using anchors. The synchro slide mechanism with heavy duty slides aiding in relaxed posture. Slider to be connected to back using linkages to achieve synchronous motion between seat and back. Armrest to be made of integral skin PU foam with hardness and reinforced with wooden insert. The armrest is snap fitted with side panel. All steel component to be epoxy polyester powder coated. (DFT 40-60 microns).

11.0 Supplying and installing Chairs for Green Room - Godrej multipurpose chair 1112 or equivalent:



11.1.1 The seat and back to be made up of $1.2 +_{-0.1}$ cm thk . Hot pressed plywood and upholstered with fabric or synthetic leather and moulded polyurethane foam. The back foam is designed with contoured lumabr support for extra comfort. HR Polyurethane foam moulded with density = $45 +_{-2}$ kg.m³ and hardness load $16+_{-2}$ kf as per IS 7888 for 25% compression. Under structure assembly of welded under structure made of $3.5+_{-0.03}$ cm X $1.5+_{-0.02}$ cm X $0.16 +_{-0.0128}$ cm thk MS ERW oblong tube and black powder coated of 40-60 microns.

PART 19: SOFA SEATING:

1.0 Supplying and installing 3 Seater Sofa - Godrej Pisa or equivalent:



- 1.1.1 Foam- The seat is made of PU foam with density 32 ± 2 kg/cu/mtr having an additional top layer of PU foam with density 28 ± 2 kg/cu. Seat is upholstered with fabric or leatherette. Back foam- The back to be made of PU foam with density 28 ± 2 kg /cu. Mtr with two additional top layer of super soft foam of density 23 ± 2 kg/cu upholstered with fabric or leatherette. Under structure- Under structure is made up of 1.2 ± 0.1 cm thick hot pressed plywood measured as per QA method describes in OCP-QLTA-PL14-18.4. Dia.4 mm zigzag spring assembly is mounted in under structure for support and additional cushioning purpose. Leg Assembly- It is a welded assembly made in stainless steel (grade SS 202) tube and plate.

2.0 Supplying and installing 3 Seater Sofa at Reception / waiting areas:



- 2.1.1 Seat Foam- The seat is made of PU foam with density 32 ± 2 kg/cu/mtr having an additional top layer of PU foam with density 28 ± 2 kg/cu. Seat is upholstered with fabric or leatherette. Back foam- The back to be made of PU foam with density 28 ± 2 kg /cu. Mtr with two additional top layer of super soft foam of density 23 ± 2 kg/cu upholstered with fabric or leatherette. Under structure- Under structure is made up of 1.2 ± 0.1 cm thick hot pressed plywood measured as per QA method describes in OCP-QLTA-PL14-18.4. Dia.4 mm zigzag spring assembly is mounted in under structure for support and additional cushioning purpose. Under structure- Under structure is made up of 1.2 ± 0.1 cm thick hot pressed plywood measured as per QA method describes in OCP-QLTA-PL14-18.4. Dia.4 mm zigzag spring assembly is mounted in under structure for support and additional cushioning purpose. S.S Tubular welded frame from $2.22 \pm 0.03 \times 0.12 \pm 0.0128$ cm and 3.5 ± 0.3 cm x 1.5 ± 0.3 cm 0.12 ± 0.0128 cm stainless steel 202 grade tube. The tubes to be buff polished to give shiny finish.

PART 17: STORAGES:

1.0 Supplying and installing Metal Storages:



1.1.1 Metal door partitions at centre with half shelves on each side. Construction and Metal- Rigid knock down construction. Back, side and door are made from 0.7 mm (+_0.07mm) high yield strength CRCA**, rest in 0.8mm (+_0.08mm) CRCA** as per IS- 513. Sliding / openable door arrangement. Aesthetically appealing door handle to be provided. Screw type leveler with plastic base and finish with epoxy polyester powder coated to the thickness of 50 microns (+/- 10).

2.0 Supplying and installing 4 Door Book Rack:



2.1.1 Top, back and side panel to be 0.7mm high yield strength CRCA, rest in 0.8mm CRCA. With cam lock. Door to have 3 mm thk. Transparent glass for clear inside vision secured in metal frame. Book case to be epoxy polyester powder coated to thickness of 50 microns (+/- 10).

3.0 Supplying and installing Optimizer – Welded Storage System:



3.1.1 Optimizers made of CRCA Steel conforming to IS: 513. The sheet thickness for back and shelves to be 0.8 mm while for top and sides to be 0.9 mm. Under carriage to be

a welded frame made of HR Sheet 3.15 mm thk. Conforming to IS: 10748 suitably fabricated to take loads based on configuration. The under carriage after pre treatment is coated with final finish of epoxy polyester powder coat of approved color with a dry film thickness of 40 microns. Optimizer to be equipped with centralized locking, Door locking/ handle, fasteners, guide channels etc.

4.0 Supplying and installing Storage Units in Laminate Finish:

- 4.1.1 Providing and constructing Low/ full height storage of width 450mm / 600 mm and size as per drawings, with top, sides and bottom in 19mm thick OSL MDF, back in 8mm thick DSL MDF, intermediates in 19mm thick DSL MDF, shutters in 19mm thick Exterior grade MDF with post formed edges. All external surfaces to be finished in approved laminate, with balancing laminate on the interior surface. All exposed edges for intermediates to be in PVC edge binding. Drawers to be provided as indicated in drgs. Rate to include hardware such as approved telescopic sliding channels, approved locks, auto closing hinges for shutters, approved handles, door stop,

5.0 Supplying Overhead Storage:



- 5.1.1 Providing and constructing overhead storage of depth 300mm, height 600 mm and Length as per drawings, with top, sides and bottom in 19mm thick marine grade plywood, back in 8mm thick marine ply, intermediate in 19mm thick marine grade plywood, shutter in 19mm thick MDF with post formed edges. All external surfaces to be finished in approved laminate, with balancing laminate on the interior surface. All exposed edges to be finished in approved PVC edge binding. Rate to include hardware such as approved locks, auto closing hinges for shutters, approved handles, door stop, tower bolt, etc. complete. (Shutter width not to exceed 450mm).

6.0 Supplying and Supplying Below Counter Storage:



- 6.1.1 Providing and constructing shutters below pantry/kitchen/ any other counter made of 19mm thick Marine ply finished in approved shade laminate on exposed surface and balancing laminate on internal surfaces inclusive of necessary teak wood beading and frame work finished in matching colour polish matching the shade of the

laminated or as directed, Cost to be inclusive of horizontal shelves in 19mm thick marine ply finished in approved laminate and vertical supports in 19mm marine ply @ 600mm c/c. (as required). Cost also to include SS trolleys in 304 grade, as indicated in drg. Cost to include providing SS baskets in 304 grade for garbage, fixed on shutter inside at Sink area. Hardware to include approved Telescopic sliding channels, dead locks with SS finished keyhole, brush SS finish handle, SS tower bolt, magnetic ball catches etc. complete. Storage below counters - 3000mm length X 750-800 mm height X 600 mm depth. Consider one trolley for one division of minimum 900mm width.

PART 18: RECEPTION DESK:

1.0 Supplying and Supplying Reception Desk:



- 1.1.1 Providing and supplying Reception desk in modern design 2400 (L)X 900 (W) x 900 (H) with table top thickness of 36mm in pre laminate particle board. Modesty and side panels to be made up of 18mm thick pre laminate particle board. Pedestal in 18mm thick particle board to be provided with sufficient no. of drawers. Key board and pedestals to have proper lock and key arrangement.

PART 19: PELMETS AND MIRROR:

1.0 Supplying and Supplying Pelmets:

- 1.1.1 Providing and fixing pelmets for projection screen made of 19mm thick MDF of approved make, having clear internal dimensions as 150 x 200mm, finished in approved shade laminate, supported from RCC ceiling slab by necessary framework, giving additional supports in aluminium angles, inclusive of cutting to required sizes etc. complete.

2.0 Supplying and Supplying Mirror:

- 2.1.1 Providing and fixing Mirror for Toilet of all shapes and sizes as per drawings using 6mm thick mirror of approved make cut to required sizes on a backing of 12mm thick Marine plywood of approved make stuck to wall/partitions. All edges of the mirror to be machine polished. The mirror to be stuck by means of BOW or 3M tapes. The cost to be inclusive of making mirrors in any profile as indicated in the drawings and also include SS Beading all along the edges of the mirror

PART 20: PANELLING AND BOXING:

1.0 Supplying and Supplying Panelling and Boxing:

- 1.1.1 The cost of laminate given below is the landed cost of the material, with all taxes, delivery, transport and all taxes thereon. All internal wooden framework to be treated with 1 coat of anti-termite coat/paint of approved make as per manufacturer's specifications. For all panelling at the junction of plaster / putty with panelling, the rate to include 4mm groove. For all Acoustical board and soft boards, fabric to be wrapped by 150mm onto the inner side of the board as shown in the drawings. The cost of extra fabric is to be incorporated in the cost. For all laminate or any other panelling up to false ceiling level, the rate to include 4mm groove at the junction of false ceiling. All laminate joints to be painted with matching colour laminate to the approval of the architect. Rate for all panelling and boxing to include treating all ply and wood and or wood derivatives with anti termite chemicals. Wherever mentioned, 1mm thick laminates to be Rs. 450/Sqm inclusive of all applicable taxes and delivered at site. The cost to include wooden packing below bottom member fixed on floor and on ceiling or where ever applicable to get the fixing level of the member correct and aligned to other existing finishes. The cost to include T angle at the junction of White board and soft board wherever applicable Mode of measurement to be Length of Boxing or Panelling x height.

PART 21: MDF Panelling:

1.0 Supplying and Supplying MDF Panelling:

- 1.1.1 Providing and fixing in proper line and level, 12mm thick MR (moisture resistant) premium (fire retardant) exterior grade MDF of approved make with seasoned salwood battens fixed on to existing wall/Partition by means of approved wooden screws/nails. The MDF surface to be finished with approved shade and sample, 1mm thick laminate, with grooves as directed. The junction between the MDF panel and Gypboard / POP to be finished as directed. Panelling with laminate.

2.0 Supplying and Supplying MDF Panelling with Lustre Paint:

- 2.1.1 Lustre paint instead of laminate.

PART 22: Plywood Panelling:

1.0 Supplying and Supplying Plywood Panelling with Laminate Finish:

- 1.1.1 Providing and fixing in proper line and level, 12mm thick MR (moisture resistant) premium (fire retardant) exterior grade plywood of approved make with seasoned salwood battens fixed on to existing wall/Partition by means of approved wooden screws/nails. The plywood surface to be finished with approved shade and sample, 1mm thick laminate, with grooves as directed. The junction between the panel and Gypboard / POP to be finished as directed. Panelling with laminate.

2.0 Supplying and Supplying Plywood Panelling with Texture Paint Finish:

- 2.1.1 Textured lustre paint instead of laminate.

PART 23: Gypboard Panelling:

1.0 Supplying and Supplying Gypboard Panelling:

- 1.1.1 Providing and fixing Gypsum Boxing consisting of approved GI framework @ 600mm c/c both ways by means of approved screws, framework to ensure right angles and plumb level. Cladding of 13mm thick Gyproc® Duraline (conforming to BS 5234, Part 2) screw fixed with 35mm dry wall screw at 300mm c/c. Finally square and tapered edges of the boards are to be jointed and finished so as to have a flush look which includes filling and finishing with Jointing compound, Joint Paper tape and two coats of Drywall Top Coat (as per recommended practices of the manufacturer).

PART 24: Low Height Partition:

1.0 Supplying and Supplying Low Height Partition:

- 1.1.1 Supplying and installation of 60 mm to 70 mm thick Tile Based Partition System of having inner framework of CRCA steel of 16 gauge of Grade D as per IS:513 covered with tiles on both sides and covered with Aluminium powder coated trims on top and end sides. with steel raceway at bottom level. And the system with option of various kinds of board like 9 mm MDF tiles of exterior grade - I conforming to IS : 14587 fabric board & white marker board. All metallic parts undergo a 7 stage antirust treatment and powder coated in matt finish to a thickness of 40-60 microns, The modular partitions will be independent and not to be grouted in the floors. The modular partitions assembly will be with the following parts a) Frame b) Tiles as specified c) Trims d) Corner Post e) Junction connector f) Groove Covers g) Wire Management and h) Levellers as per particular specification.

PART 25: False Ceiling:

1.0 Supplying and fixing False Ceiling:

- 1.1.1 Providing and fixing seamless ceiling with gyproc or equivalent of 12.5mm thick with 9.2 KG/ Sqm, fixed to the underside of the suspended Gypsteel grid form with GI perimeter channel of size 20mmx27mmx30mm (MF 6A) fixed along the wall by using wood screws and metal expansion rawl plugs. The GI intermediate channel of size 45mmx15mmx0.90mm (MF7) shall be fixed to the suspended strap hanger / GI ceiling angle at intervals not more than 1220mm. The suspended GI ceiling angle / strap hanger is to be connected with GI soffit cleat of size 37mmx27mmx25mmx1.6mm and it should be fixed on the roof slab / beam, by using metal expansion fasteners (wt. Type) of 12.5mm dia. to a length of 35mm with 6mm dia. bolt / screw at top ends. The GI ceiling section of size 80mmx26mmx0.5mm (MF 5) is to be provided across the intermediate channel at intervals not more than 457mm centres at bottom and the same shall be fixed by GI connection clips 2.64mm dia. at the intersection points. Rate includes providing and fixing of Hot dip galvanized M.S angle support for false ceiling at under the AC ducts or other equipment where ever required, Using 63mmx50mmx6mm thick of required length supported to the true ceiling through 12mm thick G.I treaded rod with necessary hanger fasteners. Complete. The ends of ceiling section (MF5) channel by adopting an overlap length of minimum 150mm, connected with intermediate channel shall be fixed to perimeter channel in insertion. The Gypboard shall be fixed to the underside of the suspended grid by using 25mm long dry wall screws. The joints shall be finished with joint fiber tape by using jointing compound of India Gypboard Ltd., and applying over it 3 layers of the filler compound of USG or approved equal make to provide a smooth surface. Rate shall be inclusive of applying three coats of acrylic emulsion paint over the gyp primer. The rate shall include making cutouts for various lights, duct doors, for specified size, grills etc. for which no extra will be paid separately. Rate shall include for providing additional trims at ends, middle and

around cutouts for light fittings/AC grills and providing additional supports from ceiling where main / cross members are cut for light fittings/AC grills etc.; complete all as per trim detail drawing. The rate shall include with cove as per drg (No extra RMT will be paid for any cove patta) vertical as well as horizontal surfaces as per detailed drawing. Actual "visible" surfaces of horizontal and vertical will be measured and paid.

2.0 Supplying and fixing Designer False Ceiling:

- 2.1.1 Same specifications as above with designer ceiling in gyp with steps, coffers, curves, splays etc as per design. Payment Measurement on plan area only.

PART 26: False Ceiling in MDF:

1.0 Supplying and Supplying MDF False Ceiling Features:

- 1.1.1 Providing and fixing the MDF panels of 50mm thickness with varying curvatures as per mark out plan drawn by architect. Rate should include sub frame work to hold the panels in place from the raw ceiling. Rate shall also include matt enamel paint finish as specified by the architect. Gap between panels is 600 approx. Panel depth as per drawing. Cost shall include the pattern merging into the walls. Mode of measurement shall be the plan area. Ref dwg No: ID-1004,1005. Providing and fixing the MDF panels of 50mm thickness with straight profiles as per mark out plan drawn by architect. Rate should include sub frame work to hold the panels in place from the raw ceiling. Rate shall also include matt enamel paint finish as specified by the architect. Gap between panels is 600 approx. Panel depth as per drawing. Cost shall include the pattern merging into the walls. Mode of measurement shall be the plan area.

PART 27: Modular False Ceiling:

1.0 Supplying and Supplying Modular False Ceiling:

- 1.1.1 Tiles : Rock Wool based Mineral Fibre (Wet Felt bounded) & Not Glass Wool.
Grids : GROOVELINE / Centre Black / Omega White / Black - 15 mm wide flat with BLACK groove grids finished in approved shade.

The main runners & coss Tees to have " Click " Installation sytem made of Corrosion - protected high tensile steel or approved equivalent.

Tile Specification :

- Tile Type : Lay - in ceiling type.
- 600 * 600 , Perforated Mineral Fibre Tile.
- Edge Detail : SK, Square Edge
- Light Reflectance : upto 88%.
- Humidity Resistance : 90%.
- Colour : White Similar to RAL 9010.
- Surface Burning Characteristics : Class1, BS 476:Part 7:1987.
- Class A2 as per DIN 4102 Part 1.
- smoke Developed = 0 & Flame Spread = 5.
- Thermal Conductivity : 0.052 - .057 W/mK
- NRC (Absorption) : Not less than 0.7.
- Dncw (Insulation) : 34 dB.
- Thickness/Weight : 4.5 Kg/m2

- Approved make : AMF / Nitobbo / Armstrong .
- Tile Name : AMF Thermatex STAR COMPLETE / Armstrong Ultima / Nitobbo Solation - Nashiji.

Ceiling Suspension System (Installation) :

Proprietary supplied ceiling suspension system to consist of 4mm GI suspension rod/wire with adjustable Butterfly Clip of 4mm dia securely affixed to structural ceiling using 10mm dia hook type anchor fastener . Ceiling Suspension System to be fixed at interval (grid) of 1200 mm in both direction . Proprietary supplied ceiling suspension system to consist of Main Runners @ 1200mm and joined by Cross Tees @ 600mm to form overall are to be placed where appropriate for light fixtures, AC diffusers etc. The Grid system shall be hot dipped galvanized steel sections, with exposed surfaces chemically cleaned and capped prefinished in high -gloss polyester enamel with two coat system on cold rolled steel. False ceiling will be measured on horizontal plane only. Horizontal plane measurements are to be inclusive of all vertical drops, edge mouldings, AXIOMS fascias, etc. All extra tiles occupied by lights and diffusers to be returned to Authority. Rate quoted to include all cut - outs required for light fixtures, smoke detectors and other services cut - outs complete as directed by Architect.

PART 28: Carpets and Floor Covering:

1.0 Supplying and Supplying Carpet Floor:

- 1.1.1 Providing and laying Carpet Floor of approved make, size, shade, design as per manufacturers specifications complete. Rate to include necessary wastage, under layer, handling, laying in pattern as per drawing, adhesive, protecting till handing over etc. complete. 2.5% Quantity to handover to Authority after completion of work (of carpet under item No.M-1.0) Rates to include labour, materials, wastage, transportation, handling, use of tools, equipments, scaffolding and other items incidental to the satisfactory completion of item work at all depths, heights and at any levels. Protecting, Covering finished job as directed till handing over the same to PMC/Authority. All necessary miscellaneous items to complete the item to the satisfaction of PMC, Design PMC & Authority. Necessary tests of materials at site OR at laboratory recommended by PMC/Design PMCs/PMC as and when directed.

2.0 Supplying and Supplying Entrance Mats:

- 2.1.1 Supplying and fixing of barrier mat roll of Boulevard 6000 of GRADUS MATTING or 3M or equivalent. The rate inclusive of necessary edging strips/mat well frames ect, all as per manufacture standard specification.

PART 29: Blinds:

1.0 Supplying and Supplying Roller Blinds For Admin Cabin and Conference Rooms:

- 1.1.1 Providing and fixing roller blinds of approved make as per the manufacturer's specifications with drive unit, End plug, support brackets, roller tube, bottom rail, ball chains all described below. Drive unit to be of moulded plastic with straight rectangular support pin and inserted into the tube end. It shall be driven by a ball chain pulley and can be positioned at right or left side of the shade. The shade when lowering or raising shall automatically be lockable upon release of the ball chain by means of friction lock. End plug shall be moulded to plastic locking pin. The plug shall be inserted into the tube end. Support brackets shall be of zinc plated steel and provided with moulded plastic covers and used in right or left hand positions differentiated by acceptance of the rectangular drive unit support or the round idler plug pin. Roller tube shall be made out of roll formed steel of thick. Suitably protected

against corrosion, and keyway integral with the tube to accommodate the spline , Outside diameter of the roller tube shall be 25mm. Bottom rail shall be a stiffening element inserted into a bottom rod pocket. Tube to be of the material as approved out of timber, PVC, steel or VB bottom rail. Ball chain shall be 2mm diameter cord with acetyl balls moulded co-axially to it on 6mm pitch to form ball chain. Rate to include the cost of decorative trims also. Consider Basic rate of Fabric as Rs. 400/Rmt.

2.0 Supplying and Supplying Venetian Blind:



- 2.1.1 Supplying and Installing, venetian blind consists of approved color & shade, Opaque , with high tear strength constructed out of Antistatic, resilient, color fast & Sanitized Treated 100% spun bonded polyester fiber & precision manufacture to form a hexagonally shaped pleat with cellular construction, Easy Rise Shaft, Easy Rise Lift Set, Spool Assembly, Easy Rise Tape, Easy Rise Clutch Set, Clutch Cover, Clutch End cap, Shaft Retainer, Head Rail End Cap, Cord Loop, Cord Tensioner, Mounting Kit, Easy Rise Headrail, Filler strip, Bottomrail, Bottomrail End Cap, Easy Rise Installation Bracket , Extension Bracket Polyester Code, Slat Insert, Cord lock, Cord Guide, Hold on Bracket, Cord Equalizer etc. All mountings and supporting cords are concealed.

3.0 Supplying and Supplying Vertical Blinds: For Admin Office Spaces



- 3.1.1 Supplying and Installing, vertical blind consists of:
- 3.1.2 Fabric: of approved color & shade, Opaque , with high tear strength constructed out of Antistatic, resilient, color fast, fade resistant, twist resistant & Sanitized Treated 100% spun bonded polyester fiber. 0.023" thick
- 3.1.3 Head Rail shall be of 1 15/16" in width and 1 3/8" in height, with an average wall thickness of 0.029 inch. Painted off-white finish, weight 0.221 lbs/ft.
- 3.1.4 Carrier body: Pantograph system for smooth of operation and even spacing of carriers. Molded, impact-resistant plastic, with a detachable stem. Carrier shall traverse on self-lubricated wheels to reduce draw force, and the louver stem shall be replaceable without demounting the headrail. Carriers to be located located in the center headrail, making headrail reversible.
- 3.1.5 Gear system: Rotation and traversing of louvers is accomplished by an aluminum wand attached to the lead carrier. This drives an extruded (.300 dia.) 8-prong aluminum pinion rod passing through all carriers and transmits rotation to each louver stem through a molded rack and pinion gear system. The drive system shall rotate all louvers simultaneously a full 180 degrees and hold them in a fixed position until reset.

PART 30: Soft Board and White Board:

1.0 Supplying and Supplying Soft Board:

- 1.1.1 Providing and fixing Fabric wrapped soft board panels 12mm thick of size and profile as per detail with 6mm grooves made at the junction of soft board and partition and finished with Aluminium Hat sections. Soft board to be fixed on a backing of 12mm exterior grade MDF with PVC grippers at the edges. The rate should include cladding the panels in approved fabric (basic price Rs. 300/Rmt), 4mm thick foam infill as per approved specification. Note the fabric shall be stretched uniformly along the direction of weave and shall be wrinkle free.

2.0 Supplying and Supplying White Board:.

- 2.1.1 Providing and fixing 1mm thick White writing laminate on 12mm thick exterior grade MDF with grooves at the junction of writing laminate and partition as shown in the

drawings. Cost to be inclusive of Aluminium beading at all edges of the MDF on which the laminate is stuck. The cost to include supplying and installing approved pen & duster holder with necessary supports, hardware, etc. complete. Approved makes: White Mark or Alko Sign or Fix graph

PART 31 : METAL "JALI" CLADDING WORKS

1.0 SCOPE

The specifications refer to Metal decorative "Jali" cladding works in the building, including supporting framework.

1.1 GENERAL & CODES

1.1.1 Materials used for making the Metal Jali unit shall generally comply with relevant British and Australian Standards and Codes. Any reference to a British Standard shall mean that current at the time of going to tender.

1.1.2 Where materials are not fully covered by this specification or alternative materials are offered, the Contractor shall forward to the Construction Manager prior to commencing the work, details of those he proposes to use together with supporting evidence indicating that the finished product will be capable of meeting the performance requirements of this specification.

1.2 SUPPORT STEELWORK AND FIXINGS

1.2.1 The Manufacturer will be responsible for the design, manufacture and installation of all support framing, cleats and fixings inserted into and affixed to the Metal Jali panels, or provided for the support of the Metal Jali panels. Fixing zones are described on the drawings, together with primary structural concrete and steelwork provided by others for use by the contractor if required.

1.2.2 Fixings shall be concealed and cast into panels unless otherwise specified. They shall be of non-corrosive material and located at suitable spacings to ensure support of panels without creating undue stresses to the panels under thermal movements and/or moisture movement.

1.2.3 Steel materials and workmanship shall comply with the relevant codes, and all steel will be free from rust, loose scale, pitting and other defects.

1.2.4 Fabricated steel components shall be true to line and free from twists, bends and open joints.

1.2.5 All ungalvanised materials shall be thoroughly cleaned prior to fabrication, by grit blasting to Class 2 in accordance with AS 1627 Part 4 and painted with Red Oxide Zinc Chromate in two coats to a minimum dry film thickness of 80 microns.

1.2.6 Fixing cleats to existing steelwork, where indicated on the GRC cladding shop drawings, shall be site-welded unless otherwise arranged with the construction manager.

1.2.7 Any damage to protective coatings on steelwork, supplied as part of this contract works, shall be repaired.

2.0 WORKMANSHIP

2.1 SHAPE AND FINISH

- 2.1.1 The panels are to be formed of Metal Jali in moulds to achieve the profiles indicated by the architectural drawings.
- 2.1.2 The manufacturer shall provide a means for producing a replacement panel at any time during the building contract. Moulds shall be adequately cured to eliminate shrinkage and distortion and shall be properly braced.
- 2.1.3 The exposed face of the Metal Jali panels surfaces shall be free of blowholes, cracks, undulation or similar imperfections.

2.2 SHOP DRAWINGS

- 2.2.1 Prior to commencing manufacturing work, the manufacturer shall submit for approval detailed shop drawings showing the following information:
 - g) layout (sectional plan and elevation) of complete wall panelling;
 - h) full-size section of typical panel and support members;
 - i) method of assembly and supports and fixings to the existing structure and provision to withstand imposed stresses;
 - j) method of installation, caulking, flashing and provision for vertical and horizontal expansion;
 - k) junction and trim to adjoining surfaces; and
 - l) fittings and accessories,
- 2.2.2 The submission of shop drawings shall be supported by engineering design computations to show that cladding and supports comply with the design criteria specified.

2.3 TOLERANCES

The Metal Jali elements shall be manufactured and installed to the tolerances applicable, as per norms

2.4 IDENTIFICATION OF ELEMENTS

- 2.4.1 All panels shall be identified individually to indicate the panel type and date of manufacture.
- 2.4.2 At the time of preparation of shop drawings the manufacturer shall indicate his required order of delivery.

2.5 HANDLING, TRANSPORTATION AND INSTALLATION

- 2.5.1 The products shall be handled, transported and installed using methods which ensure that no damage or marking of architectural surfaces occurs and so that the panels are not subject to undue stress.
- 2.5.2 The safety and protection of Metal Jali units shall be ensured throughout the whole of the contract works.
- 2.5.3 Site access and, if necessary, storage space shall be provided The main contractor shall also provide true, level and clean support surfaces and shall provide for the accurate placement and alignment of connection hardware on the structure.

2.6 TEST REQUIREMENTS

- d) The relevant tests shall be carried out to check the strength of the Metal Jali panels

- 2.6.1 Test boards shall be produced alongside each day's production (at least one per day for each production team). The recommended size of these sample boards is 600 x 600 mm. The test boards shall be produced with the same quality, thickness and curing as the actual panels.
- 2.6.2 Those test boards which are not required for testing should be kept for the duration of the contract, or for a period to be agreed between the manufacturer and PMC.

2.7 FREQUENCY OF TESTING

- 2.7.1 The frequency of testing shall be agreed between the architect, PMC and manufacturer.

2.8 COMPLIANCE

- e) Non-Compliance : In the event of non-compliance, the action to be taken should be agreed between the manufacturer and the Authority. Due regard should be paid to the technical consequences of the non-compliance and the economic consequences of adopting remedial measures or replacing the rejected products. Account should also be taken of the safety factors incorporated in the design and also the thickness of the Metal Jali produced, compared with the design thickness. Re-testing may be considered appropriate if it is considered that the storage conditions of the product may result in improved properties because of extended curing, or if the sampling, testing or calculation may have been at fault.

2.9 WEATHERPROOFING

- 2.9.1 Responsibility for the weatherproofing of the whole installation of Metal Jali panels rests with the manufacturer.
- 2.9.2 The joint details, if any, shown on the drawings represent the appearance required and their minimum standard of weatherproofing acceptable.
- 2.9.3 Joints shall be weather-sealed
- 2.9.4 The Metal Jali manufacturer shall submit details of the proposed sealant and the application recommendations for approval by the construction manager prior to commencement of the contract works.
- 2.9.5 Joints located and indicated on the drawings are those required for sealing the Metal Jali cladding against adjacent materials and those required for architectural purposes for division of the panels into the design modules. Should the manufacturer or contractor propose to subdivide the cladding into smaller panels for ease of casting, handling and erection, additional joints may be introduced in the design, provided the location proposed is discreet. The manufacturer shall submit proposed locations and designs of additional panel joints with their tender submission.

3.0 OTHER ISSUES

3.1 RESPONSIBILITY

The Metal Jali manufacture shall be solely responsible for the design and performance of the Metal Jali panels and their supports. Information provided on the drawings or this specification shall not affect this responsibility.

3.2 GUARANTEES

The Manufacturer shall warrant the Metal Jali panels installed, or to be installed, against any and every defect or failure which may occur during the period of practical completion for the works arising out of any fault of the Metal Jali cladding system, workmanship, fabrication, fixing or quality of materials used.

PART 32: ACOUSTIC PANELLING

Providing & fixing of Heradesign - Superfine OR equivalent - 600mm x 1200mm acoustic panel as a composite product consisting of mineral wool absorber with trickle protection system. Panels will be mounted on a framework of 0.90 mm thick GI studs which will be fixed on the walls with a minimum 100mm void from the wall. Studs will be placed at distance of 600mm c/c using rigid fixing system. The installation of Heradesign acoustic panels is part of interior decorating and may only be carried out under controlled humidity and temperature conditions.

TCH (Total construction height) - 225mm

Size: **1200 * 600 * 15mm** thickness

Type: DP-9 (Gross density = 90 kg/m³)

Fibre Width 1 mm

Humidity Resistance : 90%.

Colour : White Similar to RAL 9010.

Reaction to fire acc to EN 13501-1: B-s1,d 0

Sound absorption value: aw upto to 0.95

Thickness/Weight : 12 Kg/m²

Tile Name : HERADESIGN SUPERFINE OR EQUIVALENT

Cost shall include the painting as per shade approved by architect, Slits to hold light fixtures shall be finished to proper line using edge beadings or trims, Cost shall include all frame work complete. Openings to hold services shall be provided with no extra cost.

PART 33: WOODEN FLOORING

Providing & laying Engineered wooden flooring with wooden battens 2" x 2" @ 2' gap with a base layer, middle and top will be covered with wooden planks, finished with PU & anti scratch top coating. Necessary cutouts to be given for AV & electrical requirements. Specification in Detail :- a. Multi – layer of high quality finish b. Hardwood – surface: 5mm c. Solid wood middle layer: 11mm d. Solid wood base layer: 4.0mm.

Including providing & laying SOUND ATTENUATION ISOLATION PADDING beneath the wooden flooring. Including providing & laying RUBBER PADDING for acoustics beneath carpets

Wooden flooring to be provided shall be acoustically designed and effective to absorb unwanted sound and echo. This shall be taken into consideration while designing and procuring and applying the flooring.

In case adhesives are used for flooring, the rate to be inclusive of extra cement bedding required to match the existing levels. In case, adhesives are used for cladding on walls, the rate to include backing coat plaster in cement mortar 1:3, to bring the wall in proper plumb, line and level. The rate to include all materials, labour, surface preparation, working at all levels, tools and plants. The Quoted rates shall include for V-Grooves, edge ,Borders, chamfering, Nosing etc between the joints and at the corners. No separate payment will be made for these works.

PART 34: Landscape Works : Site Dressing and Land Modulation

1.0 Scope of work

- 1.1 The Scope consists of clearance of the Site of Works and preparation of the same to commence the proposed landscape execution activities. Wherever applicable, this is deemed to include all preliminary works like Dismantling/Demolition, Site Clearance, and General Leveling etc.
- 1.2 The drawings shall be read in conjunction with the specifications and matters referred to, shown or described in one are not necessarily repeated in the other.
- 1.3 In the event of any element of specification not available in any of the documents the instructions of the PMC in writing shall be followed by the Contractor.
- 1.4 The work shall be carried out in accordance with the drawings and designs as would be issued to the Contractor by the Landscape PMC duly signed and stamped by him. The Contractor shall not take cognizance of any drawings, designs, specifications, etc. not bearing Landscape PMCs signature and stamp.
- 1.5 The work shall be executed and measured as per metric dimensions given in the Schedule of Quantities, drawings etc.

2.0 General Items

The more important Codes, Standards and publications applicable to this section are listed hereinafter.

1.1. Setting out the works

- The Contractor shall supply without additional charges the requisite number of persons with the means and material necessary for the purpose of setting out works and checking, weighing and assisting in the measurement or examination at any time and from time to time, of the work or the materials. Failing this, the same may be provided by the Authority's designated representative In-charge at the expense of the Contractor and the expenses shall be deducted from any money due to the Contractor under the contract or from his security deposit.
- The Contractor shall arrange for a qualified surveyor to set out the works and obtain certification of its accuracy from the surveyor. The Contractor shall then set out the works and shall be responsible for the true and perfect setting out of the same and for the correctness of the

positions, levels, dimensions, and alignment of all parts thereof and for provision of all necessary instruments, appliances and labour in connection therewith. The Contractor shall submit to the Authority and the Landscape Architects, margins and the verifications of layout within seven days from the date of getting site layout from Landscape Architects / Authority.

- Mark the layout on the site. All bench marks, levels should be properly established and preserved for future use.
- Clearly check the surveyed map provided by the Authority and mark all drainage lines, water pipe lines, electrical lines, etc. Authority has been asked to remove the electrical lines and electrical poles. It needs to be checked by Contractor to satisfy him / herself from safety point of view before starting of work.
- The checking of any setting out or of any line or level by the Landscape Architects and AUTHORITY's representative or their representative shall not in any way relieve the Contractor of his responsibilities, for the correctness thereof. The Contractor shall carefully protect and preserve all benchmarks and other things used in setting out of the work.

1.2. Site Clearing / Excavation / Site Grading

- Light irrigation, by flooding the whole site with water. The water should penetrate up to depth of 15-20 cm only so that the weeds can germinate. Remove all grasses, small shrubs/weeds etc. with roots. Excavating the site as marked on the drawing/as instructed at the site, up to any lead and lift.
- Verify the levels and bench-marks from the up-dated surveyed drawing made available by the Authority. If there are any discrepancies between the site and the survey drawing, the same are to be brought to the Authority's notice by addressing a letter to the Authority and copy marked to the Landscape Architects.
- Grading and levelling of site as shown in drawing / specified on site by Landscape Architects. This will include spreading manually or by help of soil unloaded at different working areas in the site so as to obtain basic datum levels and grades.
- Excavated material shall be stacked off in the manner indicated at the site including stacking of excavated material up to any lead and lift. The rate shall only cover the cost of excavation, stacking and/or spreading of the material, if required at the site.
- Clearing the area of unwanted materials including the weeds, stones, masonry pieces etc. and all such matter that may cause damage to growth of the plant materials immediately or in future.

3.0 Earth Works

- Earthworks shall involve the grading of soil for earth mounding, the excavation of trenches and soil for formation levels of pathways and foundations, and the fine grading of earth banks and landscape areas roughly graded by others.
- Excavation shall be carried out to the depth shown on or implied in the drawings or to such greater or lesser depths as the Landscape Architect may direct. The Contractor shall supply and fit all shoring, sheeting, strutting and walling required to maintain the sides of excavations as long as necessary and to remove them as required. The Contractor is to allow for making all necessary adjustments to existing manholes in accordance to bring them to the same level as the required profiled grades. No claim shall be entertained for either bulking or compacting and all other quantities shall be measured net from the drawings.
- The stripping and replacement of the subsoil shall only be done in dry weather and ground conditions unless in exceptional circumstances the Landscape Architect authorizes otherwise. Subsoil in heaps or dumps shall not be sited so as to damage or impede water courses or other

drainage so long as they are capable of remaining in operation. Any weeds which may grow on the heaps of subsoil shall be sprayed with an approved selective weed-killer to prevent seeding.

- Notwithstanding the general description for the type of material to be excavated, if original bed rock is encountered during these operations which can only be removed by blasting or compressed air tools this work will be paid for separately as an extra over item for that given for normal excavation. This work shall only be undertaken when authorized in writing by the Landscape Architect.
- During excavation it is expected that the Contractor will take every prudent step or precautions such as tests or borings in order to prove the nature or type of material underneath or the ground bearing capacity in order to protect his workmen, plant or machinery employed in these operations.
- In the event of the Contractor excavating below the proper levels or otherwise in excess of the dimension given, he shall at his own expenses, remove all loose excavated material and replace the soil excavated in error.
- If, in the opinion of the Landscape Architect the bottoms of any excavation or any material to be excavated become unsuitable due to the Contractor's operations, the Contractor shall, at his own expenses, carry out any necessary excavation and make up in a similar manner to the above.
- If, in the opinion of the Landscape Architect the weather conditions are such as to preclude the satisfactory completion of any operation or cause unnecessary nuisance or disturbance to other parties, the Contractor shall, on receiving directions from the Landscape Architect suspend operations on that particular portion of the work until the Landscape Architect considers that weather conditions are satisfactory, or issues a direction to re-commence operations. The absence of such a direction shall in no way constitute the basis of a claim for delay or remedial work to a formation which is unsuitable.

3.1 Major Grading

- Site shall be complete with rough dressing including the base levels by civil contractor before handed over to landscape contractor for execution.
- Role of Landscape contractor involves major grading forming earth mounds / hillocks from imported fill materials where specified, or from the site debris and soil generated by excavations. The soil shall be graded using suitable earth moving machinery to the contoured earth forms indicated on the drawings. Soil, when in a dry enough state for easy working, shall be distributed to the correct areas and laid in layers not exceeding 100mm thick and compacted by at least 2 passes of the earth moving machine in each direction for each 100mm layer.
- Earth slopes are to be formed from the compacted mounds to the gradients and levels shown on the drawings, accounting for the topsoil depths to be included after subsoil formation is complete. If insufficient fill is available to complete the levels shown, additional suitable subsoil is to be imported to make up the required quantities. Importation of additional fill shall only be carried out with written permission of the Landscape Architect.
- Earthworks levels are to be carried out to the contours shown on the drawings to a maximum tolerance of 150mm measured vertically, and to a maximum gradient of 1:2. All subsoil levels are to account for the later additional of specified depths of topsoil.
- The Contractor shall be responsible for protection of completed subsoil mounds and shall take preventative measures to control erosion and siltation restore or replace any portion of the earthwork areas which erodes, slumps, silts or is otherwise damaged by the out-washing of soil.

3.1.1 Excavation for Formation Levels and Trenches

- For footpath areas or other paving areas, excavate subsoil to create a smooth formation for taking the sub-base for the paved area, to levels shown on the drawings accounting for the depth of the paving build up.
- Firmly compact sub-grade with a smooth wheeled vibratory roller to achieve an even level. Finished sub-grade is to be protected until the path sub-base or other construction such as pool sub-base is laid. If sub-grade is too dry to be compacted, water shall be added until suitable texture is achieved. If sub-grade is too wet, the material shall be left to dry out until workable.
- A completed sub-grade/formation on which there is standing water, soft spots or slurry shall be deemed to be unsuitable and shall be rectified at the Contractor's expense including making up of additional material as required to bring the formation to line and level again.
- Where soft or wet ground is encountered prior to preparation of the sub-grade and this soft or wet ground cannot satisfactorily be compacted, the Contractor shall submit a written request for this to be inspected and the area to be dug out and replaced with suitable material shall be evaluated by the Landscape Architect and directed accordingly.
- Surplus material resulting from excavations for path formation or drainage trenches shall be taken off site at Contractor's own expense unless otherwise directed by the Landscape Architect in writing.
- Excavation of drainage or formation trenches shall be carried out after the major grading has been completed and approved. Trenches shall be cut to lines and gradients shown on the drawings. Planking and strutting shall be carried out as required to make the sides of the trenches safe. The Contractor will be responsible for ensuring that drainage trenches are kept free from mud and water and side slippage.

3.2 Fine Grading and Shaping

- Slight unevenness, ups and downs and shallow depressions shall be removed by fine dressing the surface to the formation levels of the adjoining land, as directed by Landscape PMC and adding suitable quantities of Good earth, brought from approved source, if necessary.
- Fine grading shall be carried out using small sized earth moving equipment or by hand, and shall involve final modeling of the earth contours produced by the major grading exercise. The shaping will follow the contours shown on the plans in general terms, but the final forms will be developed by eye to create smoothly flowing and pleasing contours.
- The Fine Grading will provide the detailed earth contouring prior to cultivation of soil. Soil cultivation and the application of topsoil mixes shall not take place until the Fine Grading is completed.

4.0 Soils: Materials and Preparation

4.1 Soils

4.1.1 Subsoil

- Subsoil shall be a free draining soil, generally from horizon over 300mm below the original surface to be used as fill materials, either excavated from areas of the site, or imported.
- The Contractor shall:
 - I. Furnish the source of top soil to Authority.

- II. Study the soil report provided with the tender document, providing soil details such as pH, alkalinity, total soluble salts, porosity, sodium content and organic matter.
- III. Use the restored soil at site for landscape purpose, manure mixture, Neemcake, weedicide shall be added if required.
- IV. Not consider any external soil source unless the existing soil conserved from site is lacking in quality and/or quantity.

4.1.2 Topsoil Mixes

- The components of the Topsoil Mixes shall be as follows:
 - Topsoil shall be a free draining organic soil from horizons less than 300mm from the original surface, of a workable crumbly and lump free loamy character and shall contain no grass or weed growth of any kind or other foreign material or stones exceeding 25mm in diameter. Total stone content shall be no greater than 15% by volume. A 1 litre sample with back up soil test data is required before installation, or mixing.
 - TOPSOIL SPECIFICATION: The following criteria shall be tested at an approved laboratory before use on site.
 - pH: 5.5 - 7.8
 - Electrical conductivity: 1:2.5 (w/v)
 - Soil-water extracts not exceeding 1500 micromho/cm (1500 micro-Siemens/cm)
 - Soil texture:
 - Sand (0.05 - 2.00mm): Max. 75% Min. 20%
 - Silt (0.002 - 0.05mm): Max. 60% Min. 5%
 - Clay (less than 0.002mm): Max. 30% Min. 5%
 - Soil Conditioner shall be dried treated sludge, organic compost or other fibrous approved organic matter suitable for mixing with topsoil to make a friable growing medium for plants, resistant to rapid decay, free of soluble salts below 900ppm, pH 6-7, free of large lumps or debris.
 - Organic Compost shall be organic vegetable compost produced by a thorough horticultural or industrial composting process or Farm Yard Manure (Cow Dung Manure). Compost is to have a clean, un-decomposed smell free from any rotting substances, debris, refuse, clay or visible fungus. A sample is to be submitted for approval before usage. All composts are to be sterilised before being packed for transport and odorous materials used on site will be rejected. Any vermin resulting from use of organic composts will have to be controlled by the Contractor within 12 hours of any infestation.
 - Sand shall be a clean, coarse grained and angular material sourced from a river bed with a minimum 1mm diameter section. It shall be well graded, free from soluble salts ranging in size so that 80-100% passes the 3mm sieve and 0-50% passes the 2mm sieve, with 0% passing through a 1mm sieve.
 - Lightweight Aggregate shall be an approved low density inert material such as expanded shale or clay or volcanic scoria or other porous aggregate capable of being compacted within the soil zone to 90% compaction without being crushed, free from dust and debris, pH 6-6.5, free of soluble salts. A 2 litres sample shall be submitted and tested as part of the soil mix for physical and chemical performance. Materials are to be approved in writing before installation.
 - Soil Mixes

- The following soil mixes are to be used for different areas and for different types of planting. Minor changes to the proportions shown for particular species may be required, as specified by the Landscape Architect from time to time.
- i. Soil Mix A: for use in natural ground level areas shall comprise the components listed below, which shall be mechanically cultivated to the correct proportions, prior to placement on site or backfilling. Soil Mix A shall comprise the following proportions by volume:
 - Topsoil: 50%
 - Sand: 20%
 - Soil Conditioner: 15%
 - Organic Compost: 15%
- ii. Soil Mix B: for use in podium area shall be prepared under controlled mixing conditions such as a concrete floor to ensure even mixing. Soil Mix B shall comprise the following proportions by volume:
 - Topsoil: 30-50%
 - Sand: 10-30%
 - Conditioner: 0-20% (as required)
 - Lightweight Aggregate: 0-20% (as required)
 - Organic Compost: 20%
- iii. Soil Mix C: for use in planter boxes. Soil Mix C shall comprise the following proportions by volume:
 - Topsoil: 40%
 - Sand: 30%
 - Charcoal: 20%
 - Organic Compost: 20%

4.1.3 Soil Preparation and Application of Soil Mixes

- All subsoil areas to be topsoiled shall be cleaned free of rubbish, weeds, all stones exceeding 50mm in diameter and builders debris shall be removed from site. Any areas which are contaminated by petrol, soil or other toxic substances shall be excavated to 300mm below the contamination and have the excavated material removed from site. The excavated areas shall be back filled with imported topsoil as specified. These operations shall take place immediately before topsoiling (with soil mixes) commences.
- Where directed by the Landscape Architect, the ground shall be decompacted by ripping to a depth of 300mm. All obstructions to cultivation or deleterious material brought to the surface shall be removed from the site and any voids left by this operation shall be backfilled with imported subsoil as specified.
- Subsoil shall be formed to the finished levels and contours after settlement and with overall even compaction.

- No topsoil or soil mixes shall be spread or cultivation carried out until the subsoil operations have been approved by the Landscape Architect.
- Topsoil or soil mixes shall be spread on the designated areas to the depth shown on the drawings. The loose depth of the topsoil shall be sufficient to allow the area to conform to the levels shown on drawings after natural settlement has taken place. Soil Mixes shall not be compressed or rolled to achieve levels. Conversely if levels drop below specified levels, additional soil mixes are to be added to achieve levels.
- Soil Mixes are to be carefully spread by machine or hand in a moist condition. Very wet or dry soil mixes must not be used. Heavy compaction of soil mixes is to be prevented and compacted soil will be rejected. Soil Mixes are to be spread to the following minimum depths in open ground areas:

i. Lawn / Turf areas: 300mm

ii. Shrub areas: 450mm deep

iii. Tree pits: 1000 x 1000 x 1000mm

Unless directed otherwise or as shown on the drawings

- The prepared topsoil mix shall be compacted to 80% of maximum density to the depth shown on the drawings in 150mm layers. When planter is filled, water topsoil mix thoroughly to ensure proper and uniform compaction. After 2 weeks, fill with additional topsoil mixture and compact to level and before pavers are laid indicated on drawings.
- When in the opinion of the Landscape Architect site conditions are unsuitable for working, soiling operations shall cease and shall only be resumed when authorized by him.
- Contractor shall be responsible for soil protection and shall take preventative measures to control erosion and siltation of all areas and shall restore or replace any portion of the site which erodes, silts up or is otherwise damaged by out-washing of soil.

4.1.4 Fertilizers

- Chemical fertilizers shall be approved granular slow release compound fertilizers. They shall be stored in waterproof sealed bags under shelter away from water and direct sunlight. Samples of the same to be submitted by contractor before use at site.
- Organic fertilizers shall be organic products such as organic liquid fertilizer, pellets or granules manufactured primarily from organic materials. These products are to be from accredited sources and technical data indicating sources or origin and manufacturing process must be submitted before use. Animal by products must be sterilized before being packed for transport and odorous materials used on site will be rejected. Any vermin resulting from use of organic fertilizers will have to be controlled by the Contractor within 12 hours of any infestation. A sample shall be submitted for review by the Landscape Architect before use on site.

4.1.5 Mulches

- Mulches shall be approved friable composted organic materials. Coco-Peat will not be allowed on its own unless mixed in a proportion of 50-50 with another mulching material free from soluble salts or toxic materials and resistant to rapid decay. Mulches shall have a pH of between 5.5 - 7.0. Samples to be submitted and approved before use.
- Mulches are to be applied in a minimum 50mm layer over the entire surface of shrub and ground cover areas.
- Mulches is to be re-applied to all planting areas every 3 months after initial installation until the end of the maintenance period or until complete surface cover by vegetation is achieved.
- Initial mulching is to take place within 2 days of installation of planting.

5.0 Subsoil Drainage

5.1 Subsoil, Field Drains and Trench Drains

- Before beginning installation of drain lines establish invert elevation of city storm drains at points where tree drains will tie in and prepare schematic layout for approval of Landscape Architect before digging trench.
- Surplus material resulting from excavations shall be carted to other fill areas within the site. If no additional fill sites are available the Contractor shall remove all surplus material from site and deposit it in a Local Authority approved tip.
- The Contractor shall survey the gradient levels of all trench bases to ensure that all falls are continuous from the highest point down to the outlet point at the sump. These findings shall be submitted to the Landscape Architect for verification before any further work is undertaken, either pipe laying or backfilling.
- All trenches when completed and approved shall be lined with approved filter membrane laid over the base of the trench and up the sides with sufficient membrane to wrap over the top of the gravel backfilling with a minimum overlap of 300mm.
- The base of each drainage trench shall have a layer not less than 30mm and not more than 50mm depth of fine stone chippings 8-12mm diameter or coarse sand laid to accurate falls for bedding the perforated pipes.
- The drainage pipes to the sizes shown on the drawings shall be prefabricated subsoil drainage system or similar approved type. PVC pipes with drilled holes will not be permitted. Drainage pipes shall be laid to the lines to the falls shown on the drawings and accurately boned in to correct gradients before backfilling.
- All pipe junctions shall be as supplied by the selected manufacturer and shall be fitted to the manufacturer's instructions to provide smooth flow and to fit the correct pipe sizes. Where changes in pipe diameters occur the correct junctions shall be used to match the changed pipe diameters.
- Connect drainage system to percolation pits.
- Where subsoil drainage pipes pass under paths or structure the pipe shall be of non perforated pipe joined at either end to the perforated pipe, and be surrounded by 100mm of concrete haunching.
- Trenches shall be backfilled to within 100mm of the finished level with clean coarse grained sand or crushed stone chippings 8-12mm diameter free of any fine particles. The gravel backfill shall be lightly compacted in 100mm depth layers.
- All drains shall be tested on completion to ensure a satisfactory water flow. Any pipes that do not flow are to be taken up and re-laid at the Contractor's expense.
- After testing has been approved, remaining depth of the trench shall be filled with a layer of coarse grained sand up to the finished soil level (after final settlement). Where the top layer is specified as such, clean graded gravel 20-40mm stone chippings free from fine particles shall be placed up to the finished surface mix, free from clay lumps or any item likely to inhibit drainage.

5.2 Sub-surface drainage Layers for podium planters

- Drainage mat shall be 30mm thick mat or cell. Lay drainage mat over base of podium ensuring individual sections are close butted. Lay filter fabric over drainage mat and return 300mm up walls. Overlap filter fabric by 300mm along seams and bond with filter fabric cement. Spread 50mm sand blinding layer, over filter fabric.

- Filter fabric shall be of approved make, as specified in this document. This shall be laid over the drainage mat and turned up the sides of the planter boxes 300mm.
- Filter fabric cement shall be an approved non-solvent bonding agent that will join filter fabric together. Submit manufacturer's technical data and sample for review.
- Sand shall be coarse washed river sand. It shall be free from soluble salts ranging in size so that 80-100% passes the 3mm sieve and 0.50% passes the 2mm sieve with 0% passing through a 1mm sieve.

PART 35: Landscape Works: Softscape Works

1.0 Scope

The scope of services covers all horticultural operations and services including, labour, equipment, services and transport for all plant materials, Good earth, top soil conservation, manures, pesticides etc. completing the entire work within the scheduled time, maintaining the entire Softscaping work for one year after virtual completion of the work.

The Contractor shall refer to Specifications provided in this document for relating to formation levels, sub-bases, concrete footings, foundations and all associated works. The specifications are to be read along with necessary specifications from other PMCs.

Vendors' shop drawings shall be submitted for all such items where the Contractor will procure and install items from/by a reputed vendor. Execution of all such items shall be done after such drawings are approved by the Authority/ Authority's representative.

Contractor shall prepare and issue all required working drawings and get them approved by Authority/ Authority's representative with required number of revisions till the details provided do not satisfy the Authority/ Authority's representative.

Defects Liability Period (DLP) shall be of one year after completion of Landscape Execution. The Contractor will maintain the entire landscape development area free of cost for a period of one year after completion of all above works as certified by the Authority/ Authority's Representative's in consultation with the Landscape Architect

2.0 Special Condition

The Contractor will have to provide the following items at no extra cost to Authority:

- a. The Contractor will supply and install 3.0 metres high barricades for safeguarding landscape development area and works, as indicated in the drawing. He may also install the barricades in the landscape development area according to his own understanding if he feels that any part of the landscape area is bound to be damaged for any reason, after taking prior permission from the Authority/ Authority's Representative.
- b. The Contractor will supply, install and maintain at his own cost, the most modern, automated watering system for the landscape, which will take care of the requirement for particular plants, save water and does not waste water, including any requirements specified by the Landscape Architect appointed by contractor. He will give full details of the layout, size of the pipe, size of the sprinklers, bubblers, etc and their warranty period. All equipment must conform to international standards and / or Indian Standards if available. The design of the irrigation system has to be approved by Authority/ Authority's representative.
- c. All equipment required for development shall be made available by Contractor, and its maintenance shall be his responsibility. This includes Tagara, Phawdas, Hose Pipes, Ground Roller, Manual and/or Electric lawn Mowers, Sprinklers, etc.

- d. Contractor will ensure that all plants remain free of diseases, pests, etc during development and maintenance periods. The contractor shall, without any additional charge renew any dead or defective plant material and shall fully maintain including watering, de-weeding etc. of the whole landscape as mentioned above.
- e. The Contractor shall maintain Nursery at his own cost at designated locations as shown in the drawing or at a suitable location within the plot as directed by Authority/ Authority's Representative. The Nursery will be fenced with gates for protection from cattle. The area of Nursery will be approximately 5000sqm. The item would include construction and maintenance of Green Houses if required.
- f. Contractor shall follow pre construction and during construction soil erosion control measures as per the NBC Part 10, section 1, Chapter 4 – Protection of Landscape during Construction.
- g. The contractor in co-ordination with the Authority as applicable shall ensure conservation and storage of top soil: Topsoil shall be stripped to a depth of 200 mm from areas proposed to be occupied by buildings, roads, paved areas and external services. It shall be stockpiled to a height of 400 mm in designated areas and shall be re-applied to site during plantation of the proposed vegetation. Topsoil shall be separated from sub-soil debris and stones larger than 50 mm diameter. The stored topsoil may be used as finished grade for planting areas. It is the landscape contractor's responsibility to conserve top soil that is not disturbed by the civil contractor.
- h. The Contractor shall:
 - I. Furnish the source of top soil to Authority/ Authority's Representative.
 - II. Study the soil report provided with the tender document, providing soil details such as pH, alkalinity, total soluble salts, porosity, sodium content and organic matter. Ref. Soil Test Report
 - III. Use the restored soil at site for landscape purpose, manure mixture, Neemcake, weedicide shall be added if required.
 - IV. Not consider any external soil source unless the existing soil conserved from site is lacking in quality and/or quantity.

Soil Analysis for Top Soil fertility determination

To determine the fertility of top soil for conservation, soil investigation shall be carried out by an NABL accredited laboratory.

Adequate number of test samples of soil from a depth of 10-200mm below ground level shall be collected from at least 5 representative locations from site, preserved and transported (as per standard procedures specified by the laboratory) carefully to the laboratory for carrying out necessary tests.

All relevant Indian Standards for sampling and conducting laboratory tests shall be followed.

This soil samples shall be analyzed to determine soil type, texture, total organic content, pH, extractable nutrients such as nitrogen, phosphorus, potassium, salinity, cation exchange capacity, % base saturation and extractable heavy metals.

The soil analysis report from the laboratory shall also include a statement on the fertility and suitability of the soil for plant growth based on the analysis, in addition to the test results.

Top Soil conservation

Topsoil shall be removed for conservation to a depth of 200 mm (not more than 400 mm) and shall be separated from subsoil debris and stones larger than 50 mm diameter.

It shall be stockpiled to a height of 400 mm in designated areas. The stockpiled topsoil shall be protected from erosion during storage by installing earthen berms/solid walls, temporary seeding (using native grass), covering with mulch or plastic, etc.

The topsoil shall be protected with sand bags/solid walled enclosures (2 feet high) on all sides for containment.

Appropriate drainage channels shall be dug around the storage area to prevent flooding of the top soil storage area.

The top soil shall be reapplied to site during plantation of the proposed vegetation as finished grade for planting areas.

Seeding will take place immediately after respreading topsoil and decompacting, unless timing is inappropriate (for e.g., not in mid-summer).

- i. The contractor to identify erosion prone areas on site and protect them from construction activities throughout the construction period. Prevent / mitigate the disturbances caused to site due to construction activity.
- j. The contractor shall execute a sedimentation and erosion control plan that conforms to the best management practices highlighted in the National Building Codes of India (NBC) Part 10,

section 1, Chapter 4 – Protection of Landscape during Construction. This standard describes two types of measures that can be used to control sedimentation and erosion. Stabilization measures include temporary seeding, permanent seeding and mulching. Structural control measures include earth dikes, silt fence, sediment trap, and sediment basin. All of these measures are intended to stabilize the soil to prevent erosion.

- k. The erosion and sedimentation control plan must be approved by Authority/ Authority's Representative and the erosion sedimentation control plan must be maintained throughout the execution period.
- l. The contractor shall execute measures of protection and preservation of existing landscape on site during entire construction time.
- m. Design, execute and maintain a temporary storm water management layout for the duration of construction activity. The storm water management layout should conform to National Building Codes of India (NBC) Part 10, section 1, chapter 4 – Protection of Landscape during Construction.
- n. Contractor should take measures to prevent entry of any soluble/ insoluble construction waste to enter the water table/ water ways/ ravines on site.

3.0 General Specifications

a. Holding Nursery

- i. A piece of land has been secured within the site for use as a holding nursery as indicated on the Contract Drawing. (Ref. Dwg. No)
- ii. As a holding nursery the Contractor shall provide all necessary plant and equipment to store his plant material, machinery and equipment for the duration of the contract, including the two-year maintenance period.
- iii. The Contractor shall be required to install and establish all equipment that may be required to run a major landscape contract and ensure plant materials remains in a healthy and fit condition. The list of requirements includes, but is not limited to:
 - Provision of a 3,000 high tensioned chain link fence (with at least 2 no. lockable gates) around the extent of the holding nursery)
 - Grading and laying of crusher together with associated storm water drainage to take vehicular loading
 - Provision of all site utilities including water, telephone, electricity
 - Provision of any shade structures that may be required to maintain the plants in a healthy condition prior to planting out
 - Provision of any irrigation systems, pumps, sprinklers that may be required to maintain the plants in a healthy condition prior to planting out
 - Provision of a site office to include at least one conference/meeting room capable of comfortably accommodating 15 persons
- iv. The Contractor may wish to use the holding nursery for the purpose of propagation of plant stock for the contract. This is not a mandatory requirement since it is assumed that plant stock will need to be outsourced in order to meet the programme target dates. The decision to use the holding nursery as a propagation area rests entirely with the Contractor having taken into account the programme constraints, the nature of the site location (relatively remote) and his own commercial considerations.

b. Provision of Site Utilities

i. The Contractor is to allow for the provision at his own cost of all site utilities for the duration of the contract including but not limited to water, electricity and telephone.

c. Landscape Development Technique

i. The contractor will not be allowed to use different techniques or quality criteria or materials unless his alternative system has been confirmed in writing by the Authority/Authority's representative.

ii. No cost increases for alternative specifications will be entertained unless formally submitted in writing as an improvement in the quality of a product and accepted in writing, following Authority/Authority's Representative approval, by the Authority/Authority's representative.

d. Quality of Workmanship and Materials

i. All materials and workmanship shall be of the high standards and quality demanded by this specification. Sub-standard work and materials identified by the Authority/Authority's representative will be rejected and will be required to be rebuilt or replaced at the Contractor's costs.

ii. All plant material shall be of the genus, species and variety specified and substitutions will not be permitted unless authorized in writing by the Authority/Authority's representative. The sizes and plant description set out in the section headed Plant Material.

iii. All trees and shrubs supplied for the contract shall be free of pest, disease, discolouration and damage. Plants shall be well branched with vigorous shoots. The root system of each plant shall contain a good proportion of fibrous roots.

iv. All materials are to be approved by the Authority/Authority's representative prior to use on site. Materials shall be obtained from approved sources/manufacturers and/or suppliers. All guarantees and warranties shall be copied and submitted to the Authority/Authority's representative prior to requests for approval.

v. Where particular products are specified, the Main contractor's specialists subcontractors if he wishes to use similar products from other manufacturers must seek prior confirmation from the Authority/Authority's representative.

e. Site Responsibilities

i. From the commencement of the works until the Certificate of virtual Completion has been issued by the Authority/Authority's representative, the Main contractors specialists subcontractors shall, in respect of all areas of soft landscape works, adjacent areas and parts of the site used by him, be responsible as follows:

- For adequate protection to grassed areas, planted areas and trees and for making good Softscape works on removal of any protective measures at completion.
- For any damage to existing works and features and any necessary rectification work required to obtain approval from Authority/Authority's Representative.
- For keeping all paved surfaces used by him in a clean and tidy condition.

- For periodic removal of all surplus excavations and waste matter produced by his operations to a Local Authority registered tip off site, to be found by the Main contractors specialists subcontractors.
 - For keeping all Softscape areas in a weed-free and tidy condition and adequately watered.
- ii. The Main contractor's specialist subcontractors shall make appropriate allowance for these requirements in his rates.
- iii. The Main contractor's specialist subcontractors shall, within 24 hours of notification and as directed by the Authority/Authority's representative, undertake at his own expense any remedial works arising from the stated requirements.
- iv. Tree conservation:
- All trees to be conserved shall be protected with a 3-4 foot high enclosure constructed using brick/fencing (with an access gate for tree maintenance) at a distance indicated in the table below depending on the diameter of the tree trunk.

TRUNK DIAMETER (measured at 4.5 feet above natural grade)	DISTANCE FROM TRUNK ON ALL SIDES
Up to 6 inches	Past dripline
6-9 inches	5 feet
10-14 inches	10 feet
15-19 inches	12 feet
over 19 inches	15 feet

- This tree enclosure shall be erected before demolition, grading, or construction begins and remain until final inspection of the project. A "Warning" sign of size 8.5"x 11" shall be prominently displayed on each protective enclosure to state the following:
 - The following activities are prohibited within and in the vicinity of the tree protection zone throughout the entire duration of the construction project:
 - Cutting of tree roots by utility trenching, foundation digging, placement of curbs and trenches, or other miscellaneous excavations
 - soil disturbance or grade change
 - drainage changes
 - storage of material, topsoil, vehicles, or equipment
 - Activity including but not limited to compaction, grading, construction etc.
 - dumping of any material including but not limited to paint, petroleum products, concrete, mortar, dirty water, waste
 - use of the tree trunks as a backstop, support or anchorage as
 - a temporary power pole, signpost or other similar function
 - The following activities are permitted or required within the Tree Protective Zone with approval from Landscape Architect:

- Mulching with wood chips (unpainted/untreated) or approved material to a four to six inch depth, leaving the trunk clear of mulch to prevent inadvertent soil compaction and moisture loss.
- Irrigation, Aeration, fertilization indicated by Landscape Architect for the healthy growth/maintenance of the tree
- if tree is adjacent to or in the immediate proximity to a grade slope of 8% or more, erosion control measures shall be installed outside the Tree Protection Zone to prevent siltation and/or erosion within the zone

f. Plant Protection

- i. All plant material is to be carefully protected and if necessary wrapped in the nursery during lifting, awaiting transportation, during transportation, unloading and during storage on site.
- ii. Any evidence of unsatisfactory protection to roots, stems, branches and leaves will result in plants being rejected.
- iii. Unprotected plants must not be transported during very hot weather, and all plants must be kept moist during transportation and storage. No plant material shall be left on site unplanted for more than two days.

g. Work by Machine or Hand

- i. All operations herein described shall be carried out by suitable approved machines or by hand.
- ii. Any work around the base of existing trees, in confined spaces or which is impractical to carry out by machine for any reason shall be executed by hand and the contractor shall include for this in his rates.

h. Notice of Intentions

- i. The contractor shall give forty-eight hours written notice to the Authority/Authority's representative of his intention to commence any of the following operations:
 - Setting out,
 - Planting,
 - Topsoiling,
 - Turfing,
 - Sprigging,
 - Maintenance visits

i. Heavy Machinery

- i. Heavy machinery, which would excessively consolidate the sub-soil, shall not be used during any operations nor shall heavy machinery be taken over areas prepared for planting or grassing.

j. Substitutions

i. If the Main contractor's specialist subcontractor is unable to supply a particular species of plant he is to notify the Authority/Authority's representative in advance of his intention to make a substitution. No substitution will be allowed without prior written agreement of the Authority/Authority's representative.

ii. Notices of substitutions are to be made sufficiently in advance of installation to ensure that the substituted material conforms to specifications. Substitutions requested by the Main contractor's specialist subcontractor after work has started on site will not be entertained.

k. Setting Out

i. The Contractor shall be responsible for accurately setting out all the works prior to the commencement of the works and shall rectify errors in setting out at his own expense.

ii. Any discrepancy in site area between that shown on the drawings by Landscape Architect appointed by contractor and the actual area on the ground shall be notified to the Authority/ Authority's representative.

iii. The Contractor shall supply all necessary materials, equipment and labour to enable the Landscape Architect to check the setting out, levels and dimensions on the site along with the Authority/ Authority's representative.

l. Tools and Equipment

i. The Contractor shall use proper tools and equipment for the carrying out of the works and is to ensure that the work force is fully and properly equipped with the correct equipment and experience for the job at hand.

m. Failures of Plants (Pre-practical completion)

i. Any trees, shrubs, grass or other plants (other than those found to be missing or not in accordance with the Contract Documents as a result of theft or malicious damage and which shall be replaced), which are dead, dying, missing or found not to have been in accordance with the Contract Documents at practical completion of the Works shall be replaced by the Contractor entirely at his own cost unless the Contract Administrator shall otherwise instruct.

ii. The Contract Administrator shall certify the dates when in his opinion the Contractor's obligations under this clause have been discharged.

n. Plants Defects Liability and Post Practical Completion Care by Contractor

i. Any grass which is found to be defective within 24 months, any shrubs, ordinary nursery stock trees or other plants found to be defective within 24 months and any semi-mature, advanced or extra large nursery stock trees found to be defective within 24 months of the date of virtual completion due to materials or workmanship not in accordance with the Contract Documents shall be replaced by the Contractor entirely at his own cost unless the Contract Administrator shall otherwise instruct.

ii. The Contract Administrator shall certify the dates when in his opinion the Contractor's obligations under this clause have been discharged.

- iii. Malicious Damage or Theft (Before Practical Completion): All loss or damage arising from any theft or malicious damage prior to practical completion shall be made good by the Contractor at his own expense.
- o. Submittals
- i. The Contractor shall submit for review drawings by Landscape Architect appointed by contractor completely dimensioned, indicating any pattern layouts, special installation procedure, cutting, fitting, sinking and adjacent equipment materials for coordination.
- ii. The Contractor shall submit samples of all materials and samples of workmanship for approval by Authority/Authority's representative.
- iii. The Contractor shall be responsible for producing and submitting for comment and approval to the Authority/Authority's representative the shop drawings and samples of all elements indicated in this section. All should be based on the drawings provided by Landscape Architect appointed by contractor. All submissions should be reviewed, approved and endorsed by the Contractor.
- p. Handling, Storage And Delivery
- i. The Contractor shall:
- Coordinate delivery with suppliers, to minimize handling.
 - Handle and store equipment and materials in such a manner that no damage will be done to the materials or the work of other trades.
 - Store packaged materials, undamaged in their original wrappings, or containers with manufacturer's labels and seals intact.
 - Stack equipment and materials on wooden platforms at least 150mm clear of the ground and protect with weatherproof covers.
 - Damaged equipment, material or works will be rejected by the Authority/Authority's representative whether built-in or not.
 - For equipment, materials and work, covering shall be of suitable material containing nothing that may injure or stain the materials.
- q. Protection of Work
- i. The Contractor shall protect all equipment, materials and completed work from damage until final completion of the work.
- ii. The Contractor shall remove and replace damaged work at no extra cost.
- r. Reference Standards
- i. The Contractor shall comply with all relevant Indian Standards, ASTM, British Standard Code of Practice, Draft BS or DIN Standard applicable to elements indicated in this section, the recommendations and requirements of such documents shall be considered a minimum standard of such work described and must be complied with.
- ii. Nothing shall relieve the Contractor of his responsibility for providing a higher standard than the relevant Code or Standard where it is required to comply with other sections of the Specification.

4.0 Plant Materials and Planting Operations

The following plant descriptions cover the different categories of plant material to be used on the site.

These descriptions and their accompanying drawings requirements must be studied carefully and adhered to.

Plants that do not reach the specified dimension or quality, characteristics in this section or in the sizes and descriptions set out in the Bill of Quantities will be rejected and will have to be replaced at the Contractor's cost.

Trees and palms and large feature plants that are growing in open ground are to be prepared for transplanting at least 2 months before moving, either to containers in the nursery or direct to the site.

Preparation of in-ground trees and palms shall be by root pruning to the stated rootball dimensions.

Trenching around the outer edge of the rootball using pruning and a sharp spade shall be done in four separate stages trenching in quarters, with one quarter of the tree roots being cut and backfilled each week, the next quarter the following week, with all of the ball being cut in one month.

If roots over 25mm are encountered these are to be cleanly cut with large secateurs or pruning saw.

The trench which shall be at least 200mm wide shall be dug to the full specified depth of the rootball and undercut at the end of the root-pruning exercise to sever base roots.

The whole trench shall by this time be backfilled with sand. The tree is then to be allowed to settle for one month before final wrapping with protection and lifting. The rootball is to be well watered during this period.

For trees and palms that are to be containerised or root wrapped, the lifting and placing in containers or being wrapped is to be done immediately after the root trenching operation is complete.

Plants to be transported or moved are to be thoroughly wrapped and protected prior to transporting.

Rootballs are to be wrapped and tied with Gunny sack or hessian sacking if not containerised.

Exposed trunks are to be wrapped in rice straw including the lower parts of the branch system.

The upper branch system, especially if well furnished with leaves and twigs during transportation is to be completely wrapped in Lightweight netting or cloth tied and palms are to be laid at an angle to prevent damage from overhead structures and from buffeting and shall be covered by canvas as protection from wind.

Damaged trees will automatically be rejected on arrival at site.

All trees and palms are to be purchased, stored and grown on in suitable nursery conditions within one month of the contract and made ready for direction by the Landscape Architect appointed by Contractor.

Failure to procure within this time and to reveal the source of supply and location will result in the Authority/Authority's representative sourcing the plant materials for the Contractor, and the cost of this sourcing operation will be deducted from the Contractor's payments.

All dimensions shown with tolerances (that is 120 - 150mm) refer to maximum and minimum dimensions that will be accepted. Measurement of all plants of one species shall, as a minimum, average between the upper and lower figures (that is in the above case 135mm).

All trees and palms specified for containerising or root wrapping after root pruning operations are to be well furnished with leaves over the crown of the tree. Thinning of leaves to reduce transpiration to give a 50% cover is permissible providing due notification is given that thinning is required to ensure that the trees can be inspected before thinning work is done. Bare crowned trees will not be permitted.

Leave cover: Any trees or palms which shed their leaves within 2 weeks of transplanting are to be replaced by the Contractor at no extra charge.

4.1. Trees

a. Instant Trees

These are semi-mature trees especially prepared in advance for transplanting.

Root pruning to cleanly cut roots to the diameter of the rootball shall be carried out 3 months in advance of transplanting.

Trees shall be 300 - 450mm (12" - 18") circumference of stem when measured 1.0m (3') from ground level and shall have a clear stem of minimum 1.8 metres.

The head shall be well balanced and contain at least four main branches 500-1000mm long giving an overall height of 3 - 4m after pruning.

All saw cuts are to be painted with an approved insecticide/fungicide solution.

b. Extra Heavy Standard Trees (EHS)

These are large size nursery grown trees pruned during growth to produce a tight well rounded head and a straight stem clear of leaves or twigs.

Trees shall be 140 - 180mm circumference of stem when measured 1m above ground level and shall have a clear straight stem of minimum 2m.

The head shall be well balanced and rounded and contain at least four main branches, and a well developed secondary branch system giving an overall height of 4.5 - 4.8m at the time of planting.

Trees shall have a defined central leader. Pruning at the time of removal from the nursery will not be permitted.

In dry weather conditions trees are to be sprayed with approved Anti-transpirant.

Rootball dimensions: diameter 750mm x 600 deep minimum. Branching/leaf spread shall be of 2.2 - 2.4m diameter.

c. Heavy Standard Trees

These are large size nursery grown trees pruned during growth to produce a tight well rounded head, and a straight stem clear of leafs or twigs.

Trees shall be 120 - 150mm (5" - 6") circumference of stem when measured 1.0m (3') from ground level and shall have a clear straight stem of minimum 1.8 metres.

The head shall be well balanced and rounded and contain at least four main branches with a well developed secondary branch system and a central leader, giving an overall height of 3.5 - 4.0m (10' - 13') at the time of planting.

Pruning at the time of removal from the nursery will not be permitted.

In dry weather conditions, trees are to be sprayed with approved Anti-transpirant.

Rootball dimensions: diameter 600mm (2') x 450mm (1'6") deep minimum. Branching/leaf spread to be of 1.8 - 2.0m diameter.

d. Standard Trees

These are medium size nursery grown trees pruned during growth to produce a tight well rounded head, and a straight stem clear of leaves or twigs.

Trees shall be 100 - 120mm circumference stem when measured 0.9m from ground level and shall have a clear straight stem of minimum 1.5m.

The head shall be well balanced and rounded and contain at least four main branches with a well developed secondary branch system and a defined central leader that has not been pruned, giving an overall height of 2.5 -3.0m at the time of planting.

Pruning at the time of removal from the nursery will not be permitted.

In dry weather conditions, trees are to be sprayed with approved Anti-transpirant.

Rootball dimensions: diameter 500mm (1.6") x 300mm (1') deep minimum. Branching/leaf spread shall be of 1.5 - 1.8m diameter.

e. Standard Feathered Whips

These are medium sized nursery grown trees having a single straight stem and unbroken leader giving an overall height of 2.5 - 3m.

The stem shall be fully furnished with evenly spread and balanced lateral branches down to ground level and shall be 80 - 100 mm circumference of stem when measured 1m from ground level.

The tree shall have a strongly developed fibrous root system and shall be container grown. Leaves or branches shall not be cut off before planting.

Rootball dimensions 450 x 300mm minimum. Branching/leaf spread shall be of 1.5 - 1.8m diameter.

f. Ships/Saplings

These are young tree grown from seed or cuttings which are trimmed or pruned, furnished with branches down to ground level.

Trees shall have a single straight stem and unbroken leader between 900 - 1500mm overall height.

Stem thickness will vary between species, but a strong stem which does not bend over is required.

The tree shall have a strongly developed fibrous root system and shall be container grown. Leaves shall not be cut before planting.

Container dimensions: 250mm diameter x 250mm deep minimum.

4.2. Palms

All palms shall be single stem. Single Stem Palms shall have clear straight trunks of heights as stated in the Bill of Quantities as measured from the root collar to the base of the lowest leaf sheath. The stem girth shall be of dimension normally found for palms for the stem height and species specified.

Acceptable tolerances to variations in stem height shall be +200mm or -200mm from the height specified in the Bills of Quantities.

The heads of palms shall be well balanced with at least 7 leaves and a healthy growing apical shoot all free from pest and disease.

- a. Rootball dimensions shall be in proportion to stem heights as follows:

Stem height	Rootball diameter	Depth
1m	400mm	400mm
2m	750mm	600mm
3m	900mm	600mm
4m	1200mm	750mm

4.3. Shrubs, Herbaceous Plants and Ground Covers

- a. Shrubs

These are woody perennials of generally multi stemmed and bushy habit ranging from 3 - 4.5m down to 500mm height.

Shrubs shall have no less than three main stems and shall be well balanced and bushy, with strongly developed fibrous root systems, and shall be pruned in advance as required to achieve the specified height tolerances.

Branches shall break from the base of the plant just above the root collar, and shall be well furnished with leaves right down to ground level.

All plants are to be container grown in containers of suitable dimensions for the species.

- b. Herbaceous Plants

These are non-woody perennials usually of a clump forming habit.

Plants shall have a well developed main stem or stems with good symmetry, a healthy root system, free from pest or disease.

Clumps of herbaceous plants shall include rhizomes, corns, tubers or roots and soil undisturbed by lifting with evidence of growing shoots emerging above soil level.

All herbaceous plants are to be grown in containers unless specified as being produced by alternative method.

- c. Groundcover plants

These are low growing, 500mm or less, or prostrate shrubs or herbaceous plants whose habit is to totally cover the soil.

All groundcover species shall be evenly balanced to allow equal growth in all directions.

Plants shall have fully developed roots and leaves.

Rooted cuttings will not be accepted. All plants to be container grown.

Rooted shoots of certain spreading ground cover plants shall be used only where specified, planted as 'sprigs' as opposed to established plants in soil.

Plants shall be rooted shoots and shall have at least one and evidence of vigorous root growth.

Recent cuttings with no root development shall not be acceptable.

d. Climbers

Climbers are plants whose growth habit is to climb upwards by means of twinning stems, tendrils or clinging roots.

Plants shall be grown to reach the recommended size using stocks no less than one year old, and no more than five years old at the time of the start of the contract.

Plants shall have at least two leader shoots up to the recommended height and a vigorous root system.

All plants to be container grown.

4.4. Hedging Plants

Hedging Plants shall be shrubs such as Lawsonia, Ixoras, etc as per design requirements of Landscape Architect appointed by contractor as suited to regular clipping, previously prepared to establish a uniform height and complete foliage cover to the stem from ground level upwards.

Plants shall be a minimum overall height of 500mm with a minimum of 4 branches arising from ground level and a strongly developed fibrous root system.

Branches shall be well clothed in leaves down to ground level.

All plants to be container grown in suitably sized containers.

Hedging plants shall be prepared by root and branch pruning to achieve the 'box' shape shown, at least 3 months before transplanting.

4.5. Container Grown Plants

Container grown plants shall mean trees and shrubs which have been grown in containers sufficiently large to hold the developing root system from seed or cutting and shall be filled with suitable nutrient rich, free draining compost as per design requirements of Landscape Architect appointed by contractor.

Container grown stock shall be well watered prior to dispatch from the nursery and shall remain in the container until planted on site, whereupon the container shall be carefully removed to avoid soil disturbance.

Empty containers are to be removed from site.

4.6. Cultivation of Plant Beds

Cultivation of the completed soil mix beds shall take place only when the seeding or planting operations can begin immediately after cultivation. No cultivation shall be undertaken in weather or ground conditions in which operations may destroy soil structure or where soil mix has not been approved by the Landscape Architect.

Cultivation shall be by approved mechanical or manual means to a depth of 250mm for Ground Cover and 450mm for Shrubs to provide an even, weed free texture.

After cultivation, stone picking from the surface of soil areas shall be carried out such that all stones and lumps exceeding 50mm in diameter are collected. All stones, weeds and rubbish brought up shall be removed from the site to a tip to be found by the Contractor.

Ground cover, rooted shoot and herbaceous beds are to have 25mm solid conditioner spread over the entire area and well forked in to the top 250mm of soil during cultivation. This operation is separate from the mulching specified.

5.0 Planting Techniques and Accessories

All plants shall be planted to accommodate the spreading root system of the plant to the same soil depth as in the nursery and shall be well watered before removing them from containers. Plants are to be positioned upright and the soil firmed around the roots.

Planting shall be carried out in accordance with the schedule of plants and drawings supplied by Landscape Architect appointed by contractor. The number of each species and variety shall be evenly distributed over the area as indicated on the drawings by Landscape Architect appointed by contractor.

For large areas the outer rows are to be set out first to ensure the correct shape to the bed is established. The remaining plants are then to be evenly distributed to cover the planting area. The Landscape Architect is to be notified in advance if there are too many or too few plants to fill the area required and an assessment of setting out adjustments will be directed accordingly.

Setting out of plants is to be completed and approved by Landscape Architect appointed by contractor before planting into the soil bed can commence.

5.1. Small Shrubs, Herbaceous, Ground Cover and Root Planting in Beds

Small shrubs, ground cover and herbaceous plants shall be planted in pockets formed by a trowel or spade.

The pocket shall be deep enough and wide enough to accommodate the root of the plant.

The sides and base of the pocket shall be loosened and the plant roots lightly loosened from the rootball.

The plant shall be placed upright in the pocket and firmed into the ground by backfilling and treading or hand pressure.

The topsoil in areas to receive rooted shoots shall be brought to a fine layer 75mm deep by approved mechanical means or hand raking.

Approved slow release fertiliser shall be applied evenly over the area at a rate of 40gms per square metre and shall be lightly raked into the surface.

Rooted shoots shall be firmly bedded into the soil at 75mm centres with each shoot spread on the topsoil surface, separated from adjacent shoots.

The area shall be top-dressed with finely sifted topsoil/compost mix as approved by the Landscape Architect appointed by Contractor to lightly cover the rooted shoots after laying.

The ground shall then be firmed by lightly treading or hand pressure around the roots, taking care not to damage the shoots, to ensure good contact with the soil.

Watering shall take place immediately after planting, using a fine spray.

The firmed up area is to be tightly cultivated after completion of this operation to leave an even layer before mulching.

5.2. Shrub Pits

Shrub pits for large and medium shrubs, feature plants and climbers shall be excavated to 150mm wider on either side than the root spread, and to a depth of 150mm deeper than the root depth and shall not be less than 300mm x 300mm x 450mm deep.

The bottom 150mm of the pit is to be forked loose prior to backfilling.

Backfill material shall be topsoil Mix A for backfilling purposes. (Ref. Section 8-Part 1: 4.1.3 Soil Mixes)

The Contractor shall note that for planting into turf areas, where topsoil has not been spread topsoil mix will be required for backfilling purposes.

Climber pits shall be 150 - 200mm away from the supporting structure with the roots spread away from the wall or adjacent supporting structure.

The climbing plants shall be trained through the wire mesh with leading shoots directed upwards and tied.

Pits for shrubs and feature plants in planters shall be excavated to 150mm wider on either side than the root spread and to a total depth of the rootball.

The bottom of the pit shall be lightly formed, prior to planting taking care not to damage the terrain layer below.

After planting shrubs the area is to be watered immediately to bed the shrubs in.

Once the water has percolated away and left the surface relatively dry the soil area is to be lightly forked to loosen the surface and leave an even soil layer.

5.3. Tree Pits

Tree pits shall be excavated to the dimensions and the location shown on the drawing by Landscape Architect appointed by Contractor.

Tree pits shall be dug a minimum of 3 weeks period prior to back filling.

The bottom of the pit shall be forked to loosen the soil. In case the soil is clayey, a layer of broken bricks and stones shall be spread on the bottom of the hole and this layer shall be covered with dried leaves or straw.

No tree pit shall be less than 300mm wider on either side than the root spread, and to a depth of 150mm deeper than the root depth, and shall not be less than 1m x 1m x 1m.

The trees shall be planted to the same depth in the nursery or as in their containers.

In case the site is infested with white ants the sides of the pits shall be brushed with a mixture of BHC (10% concentration) and water in a proportion of 200 gms of BHC mixed in 5 litres of water. BHC is the common name for the insecticide.

5.4. Backfilling of Pits (trees, shrubs and climbers)

Before backfilling, imported topsoil and sand is to be thoroughly mixed with soil conditioner and organic fertiliser as specified for Topsoil Mix A. (Ref. Section 8-Part 1: 4.1.3 Soil Mixes)

The tree pit shall be backfilled with the Soil Mix A to a depth which will allow soil, after settlement to match surrounding ground level.

The filled pit shall be watered and allowed to settle. After settlement soil levels shall be topped up as required.

The centre of the backfilled tree pit shall be excavated large enough to allow placing of the rootball, and to allow even compaction all round during backfilling.

After careful removal of the container or wrapping, the rootball of trees shall be placed carefully in the pit, and soil replaced gradually into the pit.

The soil is to be consolidated during backfilling in layers to ensure that the plant is firmly held in the ground and that voids are not left around the roots.

Care shall be taken during planting to avoid damage to the root system, branches or leaves.

After careful removal of the container or wrapping, the rootball of the roots of shrubs and climbers shall be placed carefully and the soil replaced gradually in the pit.

The soil is to be consolidated during backfilling in layers to ensure that the plant is firmly held in the ground and that voids are not left around the roots.

Care should be taken during planting to avoid damage to the root system, branches or leaves.

5.5. Staking and Supports

Stakes shall always be used when planting instant trees, standards and single stem palms and for tall shrubs when directed by the Landscape Architect appointed by Contractor.

Stakes shall be in sawn timber of an approved type and be carried out according to the size of plant to be supported. The types of approved staking methods are:

a. Tripod or Quadropod staking for large trees or palms (extra heavy standard and above)

Three or four stakes each 50 x 50mm section shall be positioned equidistantly around the tree and firmly driven into the ground at angles of between 30 - 40 degrees.

The inner ends of the stakes shall extend beyond the tree stem by not more than 150mm and shall not be higher than 300mm below the lowest branch.

The tree stem shall be wrapped in hessian or gunny sacking at the point where the tree stakes are to be fastened in order to prevent bark damage.

The stakes shall be neatly and firmly fastened to the tree stem using rubber hose or cord; String are not be used.

The stakes are to be adjusted and the position of the protective wrapping is to be altered up or down every month.

The hessian wrapping is to be sprayed with an approved horticultural pesticide.

b. Multiple guying - for large trees or palms (heavy standard and above)

A minimum of three wire guys are to be used per tree.

Each guy wire is to be fastened by a loop around the lowest branches of the tree at the junction with the main trunk or branches of the tree at the junction with the main trunk or stem.

Loops are to have protective rubber or plastic hose to prevent chafing and are to be fastened back to the guy wire by means of U-clamps or bolts.

Guy wires are to be fastened at ground level to short stakes firmly driven at an angle into the ground.

Stakes shall be minimum length of 600mm and are to be driven deep enough to resist movement.

A notch is to be made near the top of each stake for the fastening of the guy wire.

Stakes shall be positioned equidistantly and equally around the tree and shall be at least 300mm beyond the extent to the tree pit.

Distance away from the tree shall be gauged on site to provide firm and secure guying.

Each guy wire is to have one turnbuckle located near the fastening to the stake.

Guy wires are to be kept in a proper tension and adjusted to maintain the tree in a vertical position without guy wires being rigid.

c. Double Staking - for trees and palms (heavy standard and smaller)

Two stakes each 50mm x 50mm cross section shall be driven into the ground in a vertical position on either side of and outside the rootball of the tree so as to form a straight line outside the rootball of the tree so as to form a straight line with the stem at the centre.

Stakes shall be driven in to penetrate the bottom of the tree pit and be deep enough to resist lateral movement when tested.

Stakes shall not extend beyond the lowest branch of the tree and if necessary are to be sawn off at the top.

Fastening or securing of the tree may be carried out by using either:

i. Cross bar

A wooden cross bar of same section as the stakes is fastened in a horizontal position to the outside of the stakes by nails or tying securely at a level below the lowest branch.

The tree is fastened to the cross bar with a single adjustable tie of an approved rubberised or plastic type with a spacer and shall be fastened to prevent any chafing or abrasion of the bark.

No nails or fixings are to be driven into the tree trunk.

ii. Wire/Hose loops

Two separate wire or rope loops are made about the stem just below the lowest branch with each being fastened back to one of the vertical stakes.

Each loop is to have a protective outer covering or sheath of rubber hose to prevent chafing or abrasion of the bark.

The wire or rope is to be fastened to the stakes in a manner that allows adjustment of the tension to be made easily.

Tension on each wire is to be equal to maintain the tree in a vertical position.

Where directed by the Landscape Architect appointed by Contractor the tree may be secured with a second set of loops at a lower level.

d. Single Staking - for trees and palms of sapling size only

A single stake of cross section 50mm x 50mm is driven vertically into the ground 150mm - 250mm away from the tree.

The stake is driven down beyond the base of the tree pit and shall be firm when tested.

The top of the stake shall be 100mm below the lowest branch.

Two ties of an approved rubberised or plastic type are to be used.

The top tie is to be located 100mm below the top of the stake; the lower tie 300mm from the base.

Ties are to have spacers to maintain the 150mm - 250mm distance between the stake and the tree.

Ties are to be fastened to avoid rubbing, chafing or abrasion of the bark.

e. Climber wires

Wires for training climbing plants against walls shall be approved lightweight PVC mesh, fixed at 600mm intervals to screw eyes supplied under the sub contract.

Maximum mesh coverage shall be 180mm high x 240mm wide.

The climbing plants shall be trained through the wire mesh with the shoots directed upwards and tied.

5.6. Turfing

a. Close Turfing

Close Turf shall be a live grass sod or mat at least 300mm square with a well developed root system growing in a minimum of 25mm soil bed, free from stones or extraneous roots, cut mechanically or by hand to give an extra thickness and texture.

A sample of one square metre of Turf shall be submitted to the Authority/Authority's representative for approval before Turf is brought in for use on site.

The source of the material shall be stated by the Contractor.

Turf shall be free from weeds, fungus, pest or disease and contamination or pollutants.

Turf sods shall be kept moist and in shade and shall be planted within 24 hours after lifting.

In exceptionally dry weather, the turf must be kept well watered at the nursery or turf farm in order to keep full green leave structure.

Dry, brown or wilting grass turf will be rejected and growth or recovery on site will not be permitted.

i. Close Turfing: Ground Preparation

Rake the topsoil mix area to a smooth and uniform grade free of any slight mounds or depressions to achieve a uniformly flat surface.

Re-grade any depressions or humps that may occur until a satisfactory grade is achieved.

The area to be turfed is to be brought to a fine tilth by approved mechanical means or by hand raking.

Any stones over 25mm in diameter shall be removed from the site of turfing.

Watering of the area shall be carried out to produce a moist condition of the soil and to consolidate the soil.

If consolidation occurs to produce any areas with topsoil depths less than 100mm these areas shall have extra topsoil spread to produce finished levels.

Fertiliser shall be applied to all areas to be turfed prior to turfing at the rate of 40gm per square meter, evenly spread over the whole area and lightly worked into the soil.

ii. Close Turfing: Operations

Close turf sods shall be laid onto the surface of the prepared ground with leaf turfs upwards, butt jointed as closely as possible to achieve a uniform cover.

The turf shall be laid off planks working over turves previously laid.

The whole area is then to be top dressed with finely sifted topsoil mix to give an evenly smooth surface. The finished close turfing shall be lightly compacted by treading or with a wooden beater to ensure even coverage and compaction.

Watering shall take place over the area that has been turfed immediately after planting. Watering shall be undertaken by use of a fine spray to avoid disturbance of soil particles.

Turfing shall be only accepted as complete after the growth of an even grass cover is evident. Any areas not covered by green healthy grass to the satisfaction of the Authority/Authority's representative within 28 days after turfing shall be re-laid as specified at the Contractor's own expense.

For the period of 28 days after turfing the vegetative cover shall:

- I. Evenly cover at least 90% of the areas with leaves and spreading shoots of specified grass variety
- II. be free of perennial weeds or disease
- III. be healthy and vigorous and showing a strongly developed root system

Should there be any settlement due to lack of even compaction this will be corrected by application of topdressing of finely sifted soil to maximum depth of 25mm.

If the depression is greater than 25mm the grass in the affected area shall be lifted, the depression filled with sifted topsoil, lightly compacted and the affected area re-turfed as specified. These operations shall be done as often as necessary to produce an even and smooth surface free from bumps and hollows.

All turfing operations shall be carried out from wooden planks or plywood boards, with the workers moving away from completed turfed areas, raking any compressed soil or footprints before laying of sods.

All access onto soil areas shall be on wooden boards or plywood sheets. Areas compacted by working are to be re-cultivated and re-laid.

iii. Maintenance of Close Turfing Before Completion

The following operations are to be carried out as often as required to achieve the specified quality of turf:

- I. Cutting before Completion shall be carried out as necessary to keep the grass to a maximum height of 30mm.
- II. Watering shall be carried out as often as necessary before Completion to allow a satisfactory green sward to develop over the whole close turfed area.
- III. One fertiliser application per month is to be carried out for before Completion.

- IV. Topdressing as specified as often as required to establish smooth even grades and levels free of hollows.
- V. If compaction or consolidation takes place or hard passing or baking of the soil occurs, the soil areas are to be well watered first and lightly loosened by mechanical means such as spiking, slitting or hollow tinning using approved equipment.
- VI. Completed close turfed areas are to be kept in a weed free insect free, fungus free and tidy condition until Completion (that is start of maintenance period).

iv. Sourcing of Turf Types

Close turfing materials are to be obtained from a bona-fide horticultural source or private land Authority.

No turf is to be removed from unauthorised locations, roadside, riverbanks or private property without permission of the Authority.

The Contractor is to inform source of all turf delivered to the Authority/Authority's representative before any turf is laid at site.

b. Fine Turf

Fine Turf shall consist of fine bladed rhizomatous grass such as Bermuda grass or cultivar specified by Landscape Architects appointed by the Contractor.

Fine Turf shall be a live grass sod or mat at least 300mm square with a well developed root system growing in a minimum of 25mm soil bed, free from stones or extraneous roots, cut mechanically or by hand to give an even thickness and texture.

A sample of one square metre of Fine Turf or both types shall be submitted to the Authority/Authority's representative for approval before fine Turf is brought in for use on site.

The source of the material shall be stated by the Contractor.

Fine Turf shall be free from weeds, fungus, pest or disease and contaminants or pollutants.

Fine Turf sods shall be kept moist and in shade and shall be planted within 24 hours after lifting.

i. Fine Turfing Operations

Subsoil mix shall be hand raked to provide an even and fine tilth to an even and accurate level matching kerb edge levels.

Any lumps or stones over 25mm in diameter brought up in this operation shall be removed from site.

Soil areas shall be lightly sprinkled with water to moisten surface in dry weather before laying turf.

Pre-Turfing fertiliser shall be applied to all areas to be turfed prior to turfing at the rate of 40gm per square metre evenly spread over the whole area and lightly worked into the soil.

The turves shall be laid on the prepared soil bed and firmed into position in consecutive rows with broken joints, closely butted and to the correct levels.

The turf shall be laid off planks working over turves previously laid.

Where necessary, the turves shall be lightly and evenly firmed with wooden beaters, the bottom of the beaters being frequently scraped clean of accumulated soil and mud.

A dressing of finely sifted topsoil/sand/compost mix shall be applied and well brushed into the joints to give an overall even surface.

Watering shall take place over the area that has been turfed immediately after planting. Watering shall be undertaken by use of a fine spray to avoid disturbance of soil particles.

Fine turving shall only be accepted as complete when new growth has caused turves to knit together and adhere by rooting to the soil bed.

Any areas not covered by green healthy grass to the satisfaction of the Landscape Architect within 28 days after fine turving shall be re-laid as specified at the Contractor's own expense.

If shrinkage occurs or the joints open, finely sifted topsoil/ sand/ compost mix shall be brushed into the gaps and shall be watered in.

Any inequalities in finished levels owing to variation in turf thickness or uneven consolidation of soil shall be adjusted by lifting turves and by re-spreading fine soil mix to correct levels and relaying turves as specified.

The finished level of the Fine Turf shall be 25mm above adjoining paved surfaces or other hard edges after allowing for final settlement.

Turf edges and margins shall be laid with whole turves and uneven edges trimmed to give an even line.

ii. Maintenance of Fine Turving before Completion

Watering shall be carried out as often as necessary before completion to allow a satisfactory green sward to develop over the whole fine turfed area.

Cutting before completion shall be carried out as necessary to keep the grass to a maximum height of 25mm.

One extra fertiliser application is to be allowed for before completion, to be used if directed by the Landscape Architect appointed by Contractor.

Completed fine turfed areas are to be kept in a weed free insect free, fungus free and tidy condition until completion (that is start of maintenance period).

Edge cutting shall be carried out as required along edges of paths, plant beds or other junctions with other materials. Only sharp edge cutting tools are to be used for this operation.

Over cutting or ragged edges will require the relaying of the turf edge strip as specified (that is 300mm wide).

iii. Specification for Sourcing of Turf Types

Fine Turf is to be specially prepared horticultural turf, re-lawn or turf-carpet, mechanically cut to specified tolerances.

c. Slope retention work with Coir Mat Turving

i. Site Preparation

Sub-grade shall be excavated to proper lines and grades based on construction plans.

The sub-grade shall be fairly smooth and free of sharp objects and debris that may damage the Coir Mat.

The soils should be proof rolled prior to Coir Mat and backfill placement.

The soils should be compacted to 95 Percent of the relative density based on the Site PMC's recommendations.

Above the compacted soil, Top soil mix 'A' to be laid upto 150 mm thick layer for planting turf.

Coir mat to be laid first and then planting operation should take place.

ii. Laying of Coir Mat

Coir Mat should be placed in correct orientation as shown on the construction plans and approved by the PMC.

The Contractor should verify the orientation. The orientation of the Coir Mat should be such that it is rolled in the direction of the slope – not perpendicular to it.

The Coir Mat should be cut to length based on construction plans using an PMC approved cutting tool.

Each sheet of Coir Mat should be pulled taut by hand to get rid of any wrinkles.

Adjacent sheets should be overlapped for minimum width of 0.30 M.

Each sheet may be secured in place using staples, pins, sandbags, backfill, or by other PMC approved methods to help prevent disruption during the installation of adjacent sheets

iii. Turfing

Turfing should be done as per procedures mentioned above once Coir mat is installed.

5.7. Watering of all Plants

After planting all plants are to be thoroughly watered to soak the ground all around the rootball.

After watering and the water has percolated away leaving the surface relatively dry the soil is to be lightly cultivated to give an even soil tilth.

5.8. Mulching

After completion of planting and watering and light cultivation operations a 50mm deep layer of approved mulch shall be spread and forked in over all cultivated planting areas.

Around each tree and palm and around the base of each climber, additional mulch is to be applied to a 50mm depth to a diameter of 600mm.

Mulching is to be done within 2 days of completing planting and watering in.

5.9. Fertilising

After a period of settling in of at least one month, all pit planted materials shall be fertilised with an approved slow release fertiliser at the rate of:

Trees	: 250gm per tree
Shrubs/climbers	: 50gm per plant

Ground Cover/Herbaceous : 100gm per square meter spread

Rooted Shoots : around the base of the plants - 40gm per square meter

All fertilised areas are to be watered immediately after fertiliser application.

5.10. Disease Control

The Contractor shall take all necessary precautions to prevent or eradicate any outbreak of disease or insect attack.

5.11. Planting into Turf Areas

Where planting is to be carried out in areas of turf, the turf shall be carefully cut to the size of the tree or shrub pit, rolled and stored for re-use, being kept moist and in shade.

After planting is complete stored turf shall be re-laid around the base of the plant.

The Contractor shall replace at his own expense, any turf which is damaged during planting operations.

5.12. Protection of Planted Areas

The contractor shall be responsible for protecting all planted areas.

If it is necessary for the Contractor to erect protective fencing, the Contractor shall be responsible for keeping the fencing in position and in good repair until the end of the maintenance period.

Fencing proposals shall be submitted to the Authority/Authority's representative for approval.

Post and string fences shall not be acceptable.

5.13. Maintenance prior to Completion

After planting and prior to the onset of the maintenance period, the Contractor shall be responsible for carrying out all necessary measures to ensure that the plant material thrives and becomes established and that the landscape areas are kept in a clean and tidy condition.

The Contractor shall allow for carrying out the following maintenance operations when necessary prior to the onset maintenance period, all as specified in section 6 of this specification:

- Replacement of dead/missing plants
- Grass cutting around trees
- Watering
- Cultivation and loosening of soil
- Weeding
- Pruning and clipping
- Firming up and adjusting stakes and ties
- Eradication of pest or insect attack
- Topdressing and mulching

- Fertilising

The Contractor shall be responsible for replacing any plants which fail to survive as a result of inadequate maintenance operations, poor workmanship or poor quality of plant material prior to completion.

The Virtual Completion Certificate will not be issued until all plants scheduled on the Drawings and Schedule of Works are installed in a healthy condition in the manner specified.

6.0 Planting on Terrace

6.1. Laying of Drain Cells

6.1.1 For planting at terraces, Drainage membrane/Drain cell matting (Colour : Black, Material: Poly Propylene, Size: 500mm x 250mm tiles of 20 mm thickness or equivalent) shall be laid over the waterproofed terrace surface as per the vendor's guidelines.

6.1.2 The surface shall be cleaned and dried before starting installation.

6.1.3 Membrane shall be laid in the direction of slope and where necessary shall be cut to desired shape and form as per the Landscape design PMC's requirement.

6.2. LAYING OF GEO TEXTILE MEMBRANE

6.2.1 Geo-textile membrane (200 gsm or equivalent) shall be laid as root barrier over the Drainage membrane surface as per the vendor's guidelines.

6.2.2 Membrane shall be laid in only one direction along the width and where necessary shall be cut to desired shape and form as per the Landscape design PMC's requirement.

6.2.3 While laying minimum overlap of 100mm shall be maintained to avoid formation of any gaps.

7.0 Maintenance Works

7.1. General

i. The Contractor shall maintain the landscape for a two-year period after the date certified by the Landscape Architect that the work has been satisfactorily completed (issue of Certificate of Completion).

ii. The extent of the landscape to be maintained by the Contractor shall be deemed to cover and include all soft landscape areas within the overall project boundaries as shown on the drawings including all existing soft landscape not affected by the contract works and retained intact or nearly so through the end of the contract period as well as all the landscape works covered in the contract scope of works. No additional maintenance charges will be allowed unless specifically agreed to by the Landscape Architect in writing.

iii. The Contractor shall ensure that a senior qualified supervisor is made available for organising and running the maintenance programme. The Contractor shall also have available an experience foreman who can supervise the workers on a day-to-day basis. An adequate

trained labour force of at least 3 workers must be available for routine work and they must be on site for at least half a working day, 5 days per week during the maintenance period. Additional grass cutting operators will be needed to ensure adequate cutting and cleaning.

- iv. The Contractor's Supervisor shall inspect the site once per week during the maintenance period and shall prepare a brief schedule of operations required for the coming week. The format for the schedule of operations will cover each distinct areas of the site such as frontage, rear, courtyard, roof, interior, etc. The schedule shall describe the operations the Contractor intends to carry out in the coming week to cover the items listed in the specification and to ensure that the current weather conditions and growing performances, insect attack, etc is taken into account.
- v. A copy of this schedule is to be submitted to the Landscape Architect and Authority every week so that a running record of proposed operations can be checked at the maintenance inspections each month. If in the opinion of the Landscape Architect the maintenance works have not been satisfactorily carried out according to site conditions and the specifications, part of the monthly payment will be withheld until the works have been satisfactorily carried out.
- vi. The contractor shall carry out all necessary measures to ensure that all pot plants, trees and shrubs and other plants shall thrive and become established within this period. All landscape areas will be inspected monthly and lists of remedial works issued after each inspection. All items on the remedial lists are to be carried out by the time of the next inspection, ie within one month.
- vii. The Contractor shall keep the landscape areas clean and tidy at all times and dispose of all waste materials arising from the cleaning.

7.2. Maintenance of Planted Areas: Trees, Shrubs, Climbers, Herbaceous and Ground Covers

- i. The Contractor shall water all trees, palms, shrubs, ground cover, rooted shoots, herbaceous plants and other planting areas as often as necessary to keep the ground moist all around and to the full depth of the roots of the plants to a minimum depth of saturation of:
 - 100mm for groundcover
 - 300mm for shrubs
 - 750mm for trees
- ii. Fresh water only shall be used for the Works. Water shall be supplied to the Contractor from agreed points on the site. However, it will be only to necessary for the Contractor to supply his own means of transport from the watering points to the plant beds.
- iii. An inspection of watering requirements is to be made by the Contractor at least two times a week in dry weather.
- iv. Water shall be supplied using an approved hose or sprinkler so as not to cause compaction or wash-outs of the soil or loosening of plants. The Contractor shall immediately make good any such damage, soil erosion or outwash and plants loosened by erosion are to replanted or if damaged, replaced.
- v. All plant beds are to be kept in a weed free condition with a weeding operation once a month. All weeds, stones and rubbish collected from this operation shall be removed from the site to a tip to be found by the Contractor. Herbicides may not be used on this site unless a specific application in writing is made by the Contractor with full back up data on the performance of the chemicals and the particular need for the chemicals use. Approval will in all cases be subject to the Landscape Architect's decision.

- vi. After weeding, at least once per month the soil surface is to be lightly broken up between plants using a pronged fork up to a maximum depth of 100mm. Contractor shall take care not to disturb the root systems of plants. After forking the soil loose, the mulch and loosened soil are to be raked to give an even re-distribution of the mulching materials.
- vii. Firming up and adjusting of stakes/ties shall be carried out monthly to ensure that the trees and shrubs are firmly held in the ground. If required, guy ropes or tree pits shall be adjusted, tightened or loosened. If tree ties or ropes are rubbing the bark of the trees, the ties are to be taken off and retied. Any damaged branches are to be carefully pruned and the wounds sealed.
- viii. All protective fencing is to be maintained and kept in good condition and in position until the end of the maintenance period.
- ix. Trees shall be pruned if dead, rotten or crossed branches are present or to maintain a clear stem up to the specified height using the methods described below. Tree pruning is to be reviewed monthly.
- x. All shrubs and ground covers are to be reviewed monthly and pruned as and when required during the Maintenance Period to promote bushy growth and good flowering characteristics. The shrubs shall be checked and all dead wood, broken, damaged or crossed branches shall be cut back, depending on species. Pruning and removal of branches is to be carried out using sharp clean implements to give a clean sloping cut with one flat face. Ragged edges of bark or wood are to be trimmed with a sharp knife.
- xi. Pruning for all plants shall be carried out as follows:
- Pruning is to be done with the cut just above and sloping away from an outward facing health bud.
 - Removal of branches is to be done by cutting flush with the adjoining stem and in such a way that no part of the stem is damaged or torn.
 - Ragged edges of bark are to be trimmed with a sharp knife.
 - Any cuts or wounds over 25mm diameter are to be painted with an approved sealant after trimmed.
 - All pruning to be cleared up and removed from site after pruning.
- xii. All hedges, mat forming herbaceous plants and ground cover plants shall be clipped with shears as often as necessary (at least monthly) to maintain a tidy appearance. Tall hedges are to be cut to forms shown on the drawings. Fertiliser is to be applied to clipped areas around 1-2 weeks after clipping.
- xiii. Selective pruning of flowering plants shall be done where special flowering characteristics are required such as for Ixoras, Hibiscus, Allamanda where flowering takes place on twig ends. Heavy clipping must not be used for these species since this will remove future flower buds. Selective pruning by clipping non-flowering twigs and leaving flowering twigs is necessary for these plants, and this operation must be done by experienced workers.
- xiv. The Contractor shall allow for monthly fertiliser operations during the Maintenance Period. An approved slow release fertiliser shall be applied to each plant at the rate of 50gm per shrub and 200gm per tree, one month after planting and thereafter monthly. After spreading the fertiliser around the base of the plant the granules shall be lightly forked into the soil, and the plant well watered. Herbaceous and ground cover areas shall receive 25mm of approved soil conditioner, evenly spread and mixed with 50gm/m² of approved slow release fertiliser, evenly spread over entire area and lightly forked into the soil to break up the top layer, and the area well watered on a month by month basis.

- xv. The horticultural requirements of different plants or areas may involve variations to those techniques (such as the use of organic liquid fertilisers for sensitive plants) and variations in method will be authorised as required.
- xvi. Heavy feeding plants such as Canna, Heliconia and Lantana shall be dressed with a 25mm mulch of approved organic compost or similar approved compost every 2 months, lightly forked in around the base of the plants.
- xvii. Additional mulching layer, 25mm deep to be spread and forked in over all planted areas at 3 monthly intervals.
- xviii. The Contractor shall make regular weekly checks to ensure that the plant material is insect and pest and fungus free. No pesticides may be used unless approval from the Landscape Architect is given from the Contractor stating the chemical intended for use; concentration, spraying programme and including full technical details of the product.

7.3. Maintenance of Lawn Areas

- i. The Contractor shall mow all lawn areas using approved cutting equipment to maintain a close sward to a height of not less than 20mm and not more than 30mm for all grass types.
- ii. Mowing shall be carried out generally weekly, except in dry weather and grass shall not be allowed to flower between cuts.
- iii. Weekly inspections are to be made to ensure adequate planning of grass cuts to suit growth and weather conditions. All clippings to be gathered up and removed from site.
- iv. All grass areas are to be watered by means of sprinklers during dry weather as often as is required to keep the grass green and the soil moist.
- v. The Contractor shall provide hoses and sprinklers for use from water points provided. Weekly inspections are to be made to determine the need for water and, in dry weather watering must be done to moisten the soil to a depth of 100mm.
- vi. Fertiliser of NPK value 10-15-15 or similar approved be spread at a rate of 40gm/sq m over all grass areas at monthly intervals, using approved spreading equipment to give an overall even spread. Grass areas that have been fertilised shall be watered if no rain falls within 24 hours.
- vii. The Contractor shall apply top-dressing of not more than 15mm depth fine sand and granulated compost raked and spread evenly over the lawn areas. The next top-dressing shall be applied only after the grass has grown through to a mowable height.
- viii. There shall be at least two applications of topdressing during the maintenance period, to be directed by the Landscape Architect appointed by Contractor.
- ix. If depressions or bumps over 25mm deep or high in turf areas during the maintenance period these are to be levelled out by lifting the turf and raising the soil level with sand/compost mix or trimming to level grades, followed by re-turfing.
- x. Grass areas are to be kept free of weeds, annual grasses, fungus and insect attack and free of stones or other debris throughout the maintenance period as often as is required.
- xi. All chemicals used shall be to the approval of the Authority/Authority's representative. Assessment of these operations is to be prepared on the basis of the weekly maintenance inspection chart.
- xii. If compaction or consolidation takes place or hard passing or baking of the soil occurs, the soil areas are to be well watered first and lightly loosened by mechanical means such as spiking, slitting or hollow tinning using equipment approved by the Authority/Authority's representative.

7.4. Replacement Planting

- i. If during the course of the Maintenance Period trees or shrubs or other plants die because of a fault by the Contractor, the Contractor shall replace the plant at no cost to the Authority.
- ii. All questions related to responsibility for the replacement planting will be subject to site inspection and agreement of the appointment of responsibility.
- iii. This will be done very month at the monthly maintenance inspections.

7.5. Final Handover

- i. Two weeks before the end of the Maintenance Period a joint inspection shall be held with the Maintenance Agency, Contractor and the Authority/Authority's representative review the requirements for alteration or replacement in order to gain approval for Final Handover.
- ii. In order to ensure satisfactory handover procedures, the site meetings held each month between the Contractor and Authority/Authority's Representative will be used to inspect and approve the maintenance works which will be reviewed to ensure adequate work has been done.
- iii. At the time of the final inspection, all areas under this contract shall be free of weeds, neatly cultivated and raked, and all plant boxes in good order.
- iv. Grass shall be neatly cut and all clippings removed. No bare patches of earth shall be visible in turf or planting areas unless specified (that is rings around tree trunks).
- v. If, after this inspection, the Authority/Authority's representative is of the opinion that all work has been performed in accordance with the drawings and specifications, the Authority/Authority's representative will give written letter of acceptance and completion of the project.
- vi. If, all or certain portions of the work are not acceptable under the terms and intent of the drawings and specifications, the formal maintenance period for all the work shall be extended at no cost to the Authority/Authority's representative until the defects in the work have been corrected and the work is accepted by the Authority/Authority's representative.

CIVIL WORKS – TECHNICAL SPECIFICATION

CIVIL AND STRUCTURAL TECHNICAL SPECIFICATIONS

PART 1 - CIVIL & STRUCTURAL DESIGN BASIS REPORT

CIVIL AND STRUCTURAL REQUIREMENTS

OBJECTIVE

This Design Basis Report (DBR) describes the methodology to be adopted for structural analysis and design of Command Control centre building, to satisfy functional requirements and ensure structural integrity of the structure as envisaged in the applicable safety standards.

SCOPE

This design basis report is intended to highlight project site description, geotechnical parameters, selection of materials, types of loads, load combinations and general guidelines for the structural analysis and design of Command Control centre building at Panjabari, Guwahati. Please note these are minimum required to be satisfied for designing of structure and not exhaustive. Contractor has to provide Detailed Design Basis Report (DBR) for approval. All structural analysis and design shall be as per approved DBR.

SITE DATA

The Guwahati city serves as capital of State of Assam. Important designs parameters considered are as follows:

- a) Wind Speed : 50 m/s as per IS: 875(Part-3)
- b) Seismic Classification : Zone V as per IS1893-(Part-1)

SOIL INVESTIGATION AND SITE SURVEY REPORT

The soil bearing capacity values along with other recommendation shall be considered as per geotechnical report enclosed as **Schedule-F**

CODES, STANDARDS AND SPECIFICATIONS

The design shall comply with the latest editions and revisions of the codes, specifications, and standards listed below as noted, supplemented, or modified herein:

IS: 875 (Part 1) -1987	Code of practice for Design Loads (Other than Earthquake) for Buildings and Structures (Dead Loads)
IS: 875 (Part 2) - 1987	Code of practice for Design Loads (Other than Earthquake) for Buildings and Structures (Imposed Loads)
IS: 875 (Part 3) - 2015	Code of practice for Design Loads (Other than Earthquake) for Buildings and Structures (Wind Loads)
IS: 875 (Part 5) - 2015	Code of practice for Design Loads (Other than Earthquake) for Buildings and Structures (Special Loads)

	and Combinations)
IS: 456 – 2000 (Reaffirmed 2016)	Plain and Reinforced Concrete – Code of Practice
IS: 1893 (Part 1) - 2016	Criteria for Earthquake Resistant Design of Structures
IS:13920 - 2016	Ductile design and detailing of reinforced concrete structures subjected to seismic forces
IS: 1786 - 2008	High Strength Deformed steel bars and wires for concrete reinforcement
IS: 432 - (Part 2) - 1982	Mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement
IS: 2950 (Part 1) - 1981	Code of practice for design and construction of Raft foundation
IS: 800 - 2007	General construction in steel - Code of practice
IS: 2062 - 2011	Hot rolled medium and high tensile structural steel
SP 7 - 2016	National Building Code of India
SP 16 - 1980	Design Aids for Reinforced Concrete to IS 456: 1978
SP 34 - 1987	Hand Book of Concrete Reinforcement and Detailing
IS 1080 - 1985	Code of practice for design and construction of shallow foundations in soils (other than raft, ring and shell)
IS 1904 - 1986	Code of practice for design and construction of foundations in soils: general requirements
IS 1905 - 1987	Code of Practice for Structural use of Un-reinforced Masonry
IS 2950 - 1981	Code of Practice for Design and Construction of Raft Foundations - Part I : Design
IS 2974 - 1982	Code of Practice for Design and Construction of Machine

	Foundations, Part (1 to 5)
IS 3370 - 2009	Code of practice for concrete structures for the storage of liquids (Part 1 & 2)
IS 3370 - 1967	Code of practice for concrete structures for the storage of liquids (Part 3 & 4)
IS 4326 - 1993	Code of practice for earthquake resistant design and construction of buildings

Note: The above list is suggestive and not exhaustive. Apart from these basic codes, any other related codes shall be followed wherever required.

DESIGN LOADS

Buildings and structures for this project shall be designed for the following loads.

DEAD LOADS (DL)

The dead loads are calculated on the basis of unit weights of materials given in IS: 875 (Part 1). The dead load considered in the structural design shall consist of the full weight of all known fixed structural and architectural elements. The weight of fixed service equipment excluding their contents such as heating, ventilating and air conditioning systems and the weight of all process equipment including all fixtures (conduit, cable tray, ductwork, etc. permanently attached to the structure) and attached piping but excluding their contents shall be considered in dead load. The data provided by the project architect and other service consultants shall be used for the specific materials/ equipments.

Dead load for a building shall be calculated in accordance to IS 875 PART-1

Unit Weight for specific materials-

- a) Dead load for common burnt clay brick : 18.85 KN/m³
- b) Density for reinforced concrete : 25.00 KN/m³
- c) Density of plain cement concrete : 24.00 KN/m³
- d) Cement Plaster : 20.40 KN/m³
- e) Granite Stone cladding : 27.45 KN/m³
- f) Glass : 23.50 KN/m³

- g) Structural steel : 78.50 KN/m³
- h) Water : 09.81 KN/m³
- i) Soil dry : 16.60 KN/m³
- j) Soil Bulk Density : 20.60 KN/m³
- k) Dead Load due to self weight of structural members (SW): As per sectional sizes of the members.
- l) Additional dead load due to non-structural elements (ADL).

Typical additional dead loads considered in the design are as follows:

Additional Dead Loads	
Due to light partitions	1.0 KN/m ²
Due to false ceiling	0.50 KN/m ²
Due to services	0.50 KN/m ²
Due to floor finishes	1.50 KN/m ²
Dead Load on Roof/Terrace	
Due to false ceiling	0.50 KN/m ²
Due to services	0.50 KN/m ²
Due to floor finishes/water proofing	3.0 KN/m ² (Avg.150 mm Thick.)
Due to MEP services	1.5 KN/m ²

LIVE LOADS (LL)

All the live loads shall be as per IS: 875 (Part 2). In general, following loads reproduced from the code by the use/ occupancy of a building or structure shall be the minimum considered in the designs.

Loading Area	Load Intensity (KN/m ²)
Inaccessible Roof	0.75

Accessible Roof	1.5
Toilets	2
Faculty rooms	2.5
Consultation rooms, Discussion rooms, Lecture halls, Pantry	3
Balconies, Corridors, passages, lobbies and staircases including fire escapes – as per the floor serviced (excluding stores)	4
Colonnade, Vestibule, Lobbies, Reception area, Admission area, Cafeteria, Auditorium (with fixed seating), Office room, Administration room	4
Pantry Store, Lockers, Library, Seminar & Conference rooms	5
Mechanical/Equipment room, Pantry Loading & Unloading	7.5
AHU, Electrical room (H T/ LT Panel room) or LV, UPS rooms/ Transformer/ Battery room, Control Panel	7.5
Elevators	10
For Sloping Roof with slope greater than 10 degrees (if applicable)	0.75 KN/m ² less 0.02 KN/m ² for every degree increase in slope over 10 degrees, subject to a minimum of 0.40 KN/m ² .

In addition to the live/imposed loads specified above, loads by dynamic effect of machinery shall be considered. The loads due to the machinery and equipment shall be as specified by the manufacturer and if it exceeds to above then actual loads shall be considered. Resonant conditions shall be avoided by suitably proportioning the supporting structural members.

WIND LOAD (WL)

All buildings and structures shall be designed to withstand the forces of wind pressure, assumed in any horizontal direction with no allowance for the effect of shielding by other adjacent structures, in accordance with the appropriate provisions of IS: 875-2015 (Part 3).

Basic Wind speed for Guwahati	$V_b = 50$	m/sec
Design Wind Speed at any height :	$V_z = K_1 K_2 K_3 K_4 V_b$	m/sec

Where; K_1 = Probability factor = 1.07	
K_2 = Terrain height & structure height factor as per IS875-2015 (Part-3)	
K_3 = Topography factor = 1.0	
K_4 = Cyclonic factor = 1.3	
Design Wind Pressure at any height:	$P_z = 0.6 \times V_z^2$

Based on the above wind pressure and exposure of the building, further load calculations shall be carried out with respect to profile of building as per IS: 875 (Part 3) 2015.

Seismic loads/parameters (EQ)

Seismic design forces shall be calculated as per IS 1893-2016 (part-1) and based upon the following parameters. Buildings of different materials of construction and lateral force resisting systems shall be investigated separately.

Item	Value	Reference
Seismic Zone:	Zone – V	Fig.1 - Map Showing Seismic Zones of India. (IS 1893 – Part 1)
Zone Factor (z):	0.36	Table 3 (IS 1893-Part 1)
Importance Factor (I):	As per IS 1893- (Part-1 to 5) for Corresponding structures, when not specified then minimum values of I shall be 1.5 for critical and lifeline structures	Table 8 (IS 1893-Part 1)
Response Reduction Factor (R):	5	Table 9 (IS 1893-Part 1) CL.No.7.2.6

Fundamental Natural Period (Ta)	$T_a = \frac{0.09h}{\sqrt{d}}$	Clause No: 7.6.2-a – IS: 1893 (Part 1).
Average Response acceleration Coefficient (Sa/g): For rock and hard soil in Equivalent Static method	$S_a/g = \begin{cases} 2.5 & 0 < T < 0.4s \\ 1/T & 0.40s < T < 4.00s \\ 0.25 & T > 4.0s \end{cases}$	Fig. 2 Response Spectra for Rock & Soil Sites for 5 percent damping. CL.No.6.4.1-(IS 1893-Part 1)
Damping Coefficient	0.05 irrespective of material of construction	Clause No: 7.2.4 – IS: 1893-2016 (Part 1).
Design Spectrum The design horizontal seismic coefficient (Ah)	$Z/2 * I/R * S_a/g$	Clause No: 6.4.2 – IS: 1893 (Part 1).
Design Seismic Base shear	$V_B = A_h W$	Clause No: 7.2.1 – IS: 1893 (Part 1).
Minimum Design Lateral force	0.7%	Clause No: 7.2.2 – IS: 1893 (Part 1).
Design Vertical Earthquake Effect	$2/3 * Z/2 * I/R * S_a/g$	Clause No: 6.4.6 – IS: 1893 (Part 1).

Contribution of permanent dead loads and live loads as specified in IS: 1893 (Part 1) shall be considered while calculating nodal masses. Live load on the roof shall not be accounted in the calculation of nodal masses.

Following IS Code clauses are specifically referred in the Dynamic Analysis

Time period: Cl. 7.6.1 of IS: 1893 - 2016

URM infill wall: Cl. 7.9 of IS : 1893 - 2016

Vertical Earthquake Shaking: Cl. 6.3.3.1 of IS: 1893 - 2016

Structural Irregularity: Table 6 of IS: 1893 - 2016

TEMPERATURE LOAD

As per Clause 27.2 of IS 456, if the length of the building is more than 45 m, the effects of thermal loading needs to be considered during the analysis of

the structure. Since the length of ICC building is not greater than 45 m, the effect of thermal loading shall not be considered during the analysis.

SURCHARGE LOAD

Minimum surcharge of 10KN/m^2 shall be considered for design of all underground structures to take in to account the construction load and vehicular traffic in the vicinity of structure. Fire tender load shall be added at applicable locations. The soil parameters and ground water table shall be considered as per soil investigation report.

EARTH PRESSURE

Earth pressure for walls of basement/ tanks etc. with propped support condition shall be calculated using coefficient of earth pressure at-rest. Earth pressure for cantilever walls like cable trenches shall be calculated based on active earth pressure. soil parameters such as cohesion and angle of internal friction shall be considered as per soil investigation report.

BLAST LOAD

Design for blast loading is not envisaged.

WATER PRESSURE

If envisaged, the ground water load shall be applied on the substructure as super imposed dead load in addition to the earth pressure. The dry density of soil shall be considered in this combination pressure is the horizontal pressure of the water acting on the structure. The water pressure shall be calculated. Pressure on wall shall be calculated for both dry and submerged conditions and maximum of both results shall taken for design.

UPLIFT PRESSURE:

Ground water table shall be considered appropriately based on findings of geotechnical investigation and considering the local conditions. Appropriate seasonal variation shall be considered while calculating ground water table. Uplift pressure due to ground water on foundation is calculated as specified in IS 875-Part-5.

WHEEL LOAD

For any structure or pipeline below the roads, Class A loading of IRC 6 shall be taken. Fire tender load shall be added at applicable locations

LOAD COMBINATIONS

Each element of a building or structure shall be provided with sufficient strength to resist the most critical effects resulting from the following combination of loads.

Minimum Primary load cases

- i Dead load (DL)
- ii Live load (LL)
- iii Earthquake in X/Y/Z direction (EQ)
- iv Wind load in X/ /Z direction (WL)
- v Temperature load (TL)

Super structure

Minimum Combinations As per IS: 456 - 2000, Table 18

- (i) $1.5DL + 1.5LL$
- (ii) $1.5DL \pm 1.5WL / 1.5EL$
- (iii) $1.2DL + 1.2LL \pm 1.2WL / 1.2EL$
- (iv) $0.9DL \pm 1.5WL / 1.5EL$

Minimum Combination as per IS : 1893 - 2016, Cl. 6.3.4.1

- (i) $1.2DL + 1.2LL \pm 1.2RSX \pm 0.36RSY \pm 0.36RSZ$
- (ii) $1.2DL + 1.2LL \pm 1.2RSY \pm 0.36RSX \pm 0.36RSZ$
- (iii) $1.5DL \pm 1.5RSX \pm 0.45RSY \pm 0.45RSZ$
- (iv) $1.5DL \pm 1.5RSY \pm 0.45RSX \pm 0.45RSZ$
- (v) $0.9DL \pm 1.5RSX \pm 0.45RSY \pm 0.45RSZ$
 $0.9DL \pm 1.5RSY \pm 0.45RSX \pm 0.45RSZ$

Sub Structure

- i (DL + LL)
- ii (DL \pm EL/WL/TL)
- iii (DL + 0.8 LL \pm 0.8 EL/WL/TL)

Where, X & Y represents the two orthogonal directions in a plane. The load combination for seismic force acting simultaneously in two directions shall be considered as per IS 1893:2016, if required.

STRUCTURAL SYSTEM

The proposed building is a RCC moment resisting framed structure with column forming vertical components while floor slab and beam forming horizontal components. The column-beam framing along with floor slab, acting as floor diaphragm, forms lateral load resisting system. Also vertical gravity load due to Self weight, super imposed load and Live load shall be completely transferred to columns through floor slab-beam framing at each level.

The Minimum grade of reinforced cement concrete shall be M25 under moderate conditions of exposure for different structures and foundations. Recommended grades for the different members are as follows:

i	Beams and Slabs	M25
ii	Columns and Shear walls	M25
iii	Footings & Raft	M25
iv	Water Tanks	M30
v	Retaining Walls	M25
vi	Storm water drain and Manholes	M25

Masonry walls are considered as "Infill Walls" along with lift shear wall

STRUCTURAL DESIGN OF RCC ELEMENTS

General

All buildings, structures, foundations, machine/equipment foundations, liquid retaining/storage structures, trenches, pits etc. of RCC shall be designed as per respective codes.

Environmental Exposure Condition

Environmental exposure condition shall be considered as Moderate as per clause 8.2.2, Table-3 of IS 456: 2000.

Design Life

The design life of the buildings and the selection of materials are based upon providing a useful working life of at least 50 years.

Materials

- a) Cement

Cement used in all types of concrete work (RCC, PCC & Plum Concrete) shall be factory blended Portland Pozzolana Cement (fly-ash based) of Grade 43/53, confirming to IS 1489 (Part-1).

b) Reinforced Cement Concrete (RCC)

Reinforced concrete conforming to Table 2; IS 456-2000 shall be used with 20mm and down size graded crushed stone aggregate unless noted otherwise. The Minimum grade of reinforced cement concrete shall be M25 under moderate conditions of exposure for different structures and foundations.

The contractor has to submit the detailed methodology including quality control measures for the manufacture and supply of ready mix concrete to the project site and take prior approval of the Engineer before proceeding.

c) Plain Cement Concrete

Concrete of minimum 75 mm thickness of Plain Cement concrete mix of grade M15 (by weight, using 20mm and down size grade crushed stone aggregate) shall be provided under all RCC foundations.

d) Aggregates: Selected aggregates of proper sizes shall conform to IS: 383.

Reinforcement Bars

- i. High Strength Deformed Steel bars of grade Fe 500D, conforming to IS: 1786 of approved make listed in the tender document shall be used.
- ii. No re-rolled reinforcement bars shall be used.
- iii. Welding of laps for bars higher than 32 mm diameter shall be done as per IS 2751.

Grouting & Minimum Grout Thickness

The minimum thickness of grout shall be 25 mm unless noted. All anchor bolt sleeves/pockets and spaces under column bases, shoe plates etc. shall be grouted with free flow, non-shrink (premix type) grout with 28-days minimum cube crushing strength of 40N/mm^2 . Ordinary cement sand (1:2) grout shall only be used under the base plates of crossover, short pipe supports (not exceeding 1.5 m height) and small operating platforms (not exceed in 2.0 m in height) not supporting any equipment. Non shrink grout and epoxy grout shall be provided as per requirement.

Expansion Joints

Expansion joints are not required as building plan is approximate 14.8m x 14.7m.

Minimum Cover

The minimum clear cover for various structural elements is to be as follows:

- a) Column 40 mm
- b) Column Pedestal 60 mm
- c) Walls 30 mm
- d) Retaining Wall, Basement and Pit Wall.
 - a) Face in contact with earth 50 mm
 - b) Free face 30 mm
- e) Foundation
 - c) Bottom 60mm
 - d) Top and Side 75mm
- f) Slabs (Top and Bottom) 30 mm
- g) Grade Slab
 - e) Singly Reinforced (Top Cover) 40 mm
 - f) Doubly Reinforced (Top and Bottom) 30 mm
- h) Beams

Beam / Cover	Top (mm)	Bottom(mm)	Sides(mm)
Plinth Beam	30	40	30
Other Beam	30	30	30

Minimum Thickness of Structural Concrete Elements

The following minimum thickness shall be followed for achieving 2hr fire rating:

S.No.	RCC Works	Minimum Thickness
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S.No.	RCC Works	Minimum Thickness
1	Beam width	200 mm
2	Rib width of slabs	125 mm
3	Floor slabs, Roof slabs	125 mm
4	Columns	300mm or 20 times the largest tension bar diameter in beams connected, whichever is more
5	Wall thickness (0.4% \leq p \leq 1.0%)	175 mm
6	Ground floor slab (non-suspended)	150 mm
7	Footings (All types including raft foundations)	300 mm
8	Liquid retaining structures	200 mm
9	Basement wall	200 mm
10	Parapets, Chajjas	75 mm
11	Cable/ Pipe trenches, under-ground pit	125 mm
12	Precast Trench Cover/ Floor Slab	50

STRUCTURAL STEEL DESIGN

The requirements for design, material and fabrication including connections of steel framing for buildings, façade, steel structures supporting equipment, pipe supports and miscellaneous structural steelwork like stairs, hand railing etc. are covered in this section.

- a) Design, fabrication and erection of all structural steel work shall be carried out in accordance with the following IS Codes as applicable to the specific structures, viz. IS: 800, IS: 814, IS: 875, IS: 1893, etc.

- b) Basic consideration of structural framework shall primarily be stability, ease of fabrication/ erection and overall economy satisfying relevant Indian Standard Codes of Practice and Specifications.
- c) Simple and fully rigid design as per IS: 800 shall be used. Where fully rigid joints are adopted they shall generally be confined to the major axis of the column member.
- d) All shop connections shall be welded (minimum structural weld 4mm throat thickness) except for shop connections for light platform framing etc. which may be bolted. Field connections may be bolted or welded. In case of welding, welders shall be certified before they are allowed to work.
- e) Galvanization shall be done in accordance with IS: 2629 and tested as per IS: 2633 and IS: 6745. Quantity of zinc coating shall be minimum 610 g/m² of surface area.

Steel Grade

- a) Structural steel shall be of yield stress of 250 MPa of Grade A/BR with V-notch energy > 27J conforming to IS: 2062.
- b) Tubular steel shall conform to Yst 310 of IS: 1161.
- c) All Holding down Bolts (HD Bolts) or threaded rods for non-post tensioned applications shall be out of Mild Carbon Steel conforming to IS 2062 with $F_y = 250$ MPa.

Anchor Bolts

Material for Anchor Bolts such as MS bars, washers, nuts, pipe sleeves and plates etc. shall be as per relevant BIS codes.

Limiting Permissible Stresses & Slenderness Ratios

Permissible stresses in structural members shall be as per respective IS codes.

Permissible Deflections

Permissible deflections in structural members shall be as per respective IS codes.

- i) Specifications Basic consideration of structural framework shall primarily be stability satisfying relevant Indian Standard Codes of Practice and specifications given herein. Ladders shall be provided with safety cages when

the top of the ladder is more than 3.0 m above the landing level. Safety cages shall start 2.1 meters above the lower landing level. Ladders shall be of 450mm clear width with 20mm diameter MS rungs spaced at 300mm (maximum). Ladders shall preferably be vertical. In no case shall the angle with the vertical exceed five degrees.

- ii Handrails, 1000mm high, shall be provided to all walkways, platforms, and staircases. Toe plate (100mmx5mm) shall be provided for all hand railing (except for staircases). Spacing of uprights shall be 1500mm (maximum).
- iii MS Gratings shall be Electro-forged/Weld forged/welded hot dip galvanized and minimum 25 mm deep. The maximum size of voids in the grating shall be limited to 30mm x 100mm. All gratings shall be fabricated as per specifications enclosed with this bid document. The minimum weld length shall be as per IS: 816. Deflection shall not be more than 6mm or span/200, whichever is lower.
- iv Grating fabricated as per specifications by conventional welding
- v The joint shall be able to sustain a minimum pullout load of 1.5 times the allowable shear capacity of the secondary member.
- vi Welded connections shall be adopted in general, except for isolated cases where bolted connections are specifically allowed with prior permission from Owner/Owner's representative. All permanent and erection connections shall have at least two 20mm diameter and 16mm diameter bolts respectively.
- vii All connections shall be designed for full moment carrying capacity of the connecting members together with 60% full shear carrying capacity for rolled steel sections or for the actual design forces, whichever is more. For members with built-up sections from rolled steel and plates, 80% of full shear carrying capacity shall be used for end connections.
- viii All fabricated structures shall be given one shop coat of primer compatible with the final painting. The final painting of steel surfaces shall be done as per specifications included elsewhere in this bid package.
- ix Minimum two nuts shall be used for all anchor bolts.

ANALYSIS AND DESIGN

SUPER STRUCTURE

The building shall be analyzed as 3-D structure with shear wall/columns as vertical members and beam, slabs as horizontal members.. Analysis is

carried out both for Vertical (DL and LL) as well as horizontal loads (EL and WL) for different load combinations. For earthquake analysis slab at each floor has been idealized as rigid diaphragm so that all frames sway equally under lateral loads. Dynamic analysis is performed for the building. All floor slabs shall be designed for Vertical loads only.

DRIFT AND DEFLECTION LIMITS FOR EARTHQUAKE AND WIND

The storey drift in any storey due to minimum specified design lateral force arrived with load factor 1.0, shall not exceed 0.004 times the storey height. The deflection at the top shall be limited to $H/500$ for wind where "H" is taken as building height.

Vertical deflection of beams/slabs shall be limited to following:

The final deflection due to all loads including the effect of temperature, creep and shrinkage and measured from the as cast level of the support of floors, roofs and all other horizontal members, should not normally exceed $span/250$.

The deflection including the effect of temperature, creep and shrinkage occurring after erection of partitions and application of finishes should not exceed $span/350$.

The deflection due to partition walls, flooring etc shall be as per IS 456.

DYNAMIC ANALYSIS

Dynamic analysis shall be performed by Response Spectrum Methods. The design base shear (V_B) shall be compared with a base shear (V_{BT}) calculated using fundamental time period T_a . In case V_B is less than V_{BT} , all response quantities are multiplied by appropriate scale factor as (V_{BT} / V_B) .

CRACK WIDTH IN WATER RETAINING STRUCTURES

For water tanks and underground sumps crack width shall be limited to 0.2 mm as per clause 35.3.2 of IS: 456.

DESIGN REQUIREMENTS FOR SPECIFIC APPLICATIONS

STAIRCASES

Staircases shall be designed as per IS456:2000 clause 33.

SOFTWARE USED FOR ANALYSIS & DESIGN

Following computer programs shall be used for analysis and design,

- i STAAD/ETABS: This is commercial general-purpose analysis and design package. It also supports design of steel structures by Indian as well as other International codes. Analysis capabilities include seismic analysis.
- ii RCDC: This is commercial general-purpose design package. It also supports design of steel structures by Indian as well as other International codes.
- iii SAFE: For the foundation and floor design analysis can be carried out using this finite element based software. The isolated footings/combined footings/RAFT shall be designed through this software using Indian as well as international codes.

PART 2 – CIVIL AND STRUCTURAL WORKS - TECHNICAL SPECIFICATIONS

1.0 EARTHWORK IN GRADING, EXCAVATION & BACKFILLING

1.1 SCOPE

This specification covers the general requirements of earthwork in excavation in different materials, site grading, filling in areas as shown in drawing, filling back around foundations and in plinths, conveyance and disposal of surplus soils or stacking them properly as shown on the drawings by the Contractor and all operations covered within the intent and purpose of this specification.

1.2 APPLICABLE CODES

The following Indian Standard Codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to.

- | | |
|-----------|---|
| IS 783 | - Code of practice for laying of concrete pipes. |
| IS 1200 | - Method of measurement of building and civil engineering works. |
| (Part 1) | Part 1 - Earthwork |
| (Part 27) | Part 27 - Earthwork done by mechanical appliances. |
| IS 3764 | - Excavation work-code of safety. |
| IS 2720 | - Methods of test for soils: |
| (Part 1) | - Preparation of dry soil samples for various tests. |
| (Part 2) | - Determination of water content. |
| (Part 4) | - Grain size analysis. |
| (Part 5) | - Determination of liquid and plastic limit. |
| (Part 7) | - Determination of water content-dry density relation using light compaction. |
| Part (9) | - Determination of dry density - moisture content relation by constant weight of soil method. |
| (Part 14) | - Determination of density index (relative density) of cohesionless soils. |
| (Part 28) | - Determination of dry density of soils in place, by the sand replacement method. |
| (Part 33) | - Determination of the density in place by the ring and |

water replacement method.

(Part 34) - Determination of density of soil in place by rubber balloon method.

(Part 38) - Compaction control test (HILF Method).

1.3 DRAWINGS

The Contractor will furnish drawings wherever, in his opinion, such drawings are required to show areas to be excavated/ filled grade level, sequence of priorities etc. The Contractor shall follow strictly such drawings.

1.4 GENERAL

The Contractor shall furnish all tools, plants, instruments, qualified supervisory personnel, labour, materials any temporary works, consumables, any and everything necessary, whether or not such items are specifically stated herein for completion of the job in accordance with the specification requirements.

The Contractor shall carry out the survey of the site before excavation and set properly all lines and establish levels for various works such as earthwork in excavation for grading, basement, foundations, plinth filling, roads, drains, cable trenches, pipelines, etc. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to established reference/ grid lines at 8 m. intervals or nearer as determined by the based on ground profile.

The excavation shall be done to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night for ensuring safety.

The rates quoted shall also include for dumping of excavated materials in regular heaps, bunds, riprap with regular slopes by the Contractor, within the lead specified and levelling the same so as to provide natural drainage. Rock/ soil excavated shall be stacked properly by the Contractor. As a rule, all softer material shall be laid along the centre of heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Rock shall be stacked separately.

1.5 CLEARING

The area to be excavated filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation, rubbish, slush, etc. and other objectionable matter.

If any roots or stumps of trees are met during excavation, they shall also be removed. The material so removed shall be burnt or disposed off by the Contractor at no extra cost. Where earthfill is intended, the area shall be stripped of all loose/ soft patches, top soil containing objectionable matter/ materials before fill commences.

1.6 PRECIOUS OBJECTS, RELICS, OBJECTS OF ANTIQUITY, ETC.

All gold, silver, oil, minerals, archaeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the Authority and the Contractor shall duly preserve the same to the satisfaction of the Authority and from time to time deliver the same to such person or persons as the Authority may from time to time authorise or appoint to receive the same.

1.7 CLASSIFICATION

All materials to be excavated shall be classified by the Contractor, into one of the following classes and shall be paid for at the rate tendered for that particular class of material. No distinction shall be made whether the material is dry, moist or wet. The decision of the Authority/PMC (if require) regarding the classification of the material shall be final and binding on the Contractor and not be a subject matter of any appeal or arbitration.

Any earthwork will be classified under any of the following categories:

(a) Ordinary and Hard Soils

These shall include all kinds of soils containing kankar , sand, silt, murrum and/ or shingle, gravel, clay, loam, peat, ash, shale, etc., which can generally be excavated by spade, pick axes and shovel, and which is not classified under "Soft and Decomposed Rock" and "Hard Rock" defined below. This shall also include embedded rock boulders not longer than 1 metre in any one direction and not more than 200 mm in any one of the other two directions.

(b) Soft and Decomposed Rock

This shall include rock, boulders, slag, chalk, slate, hard mica schist, laterite and all other materials, but does not need blasting and could be removed with picks, hammer, crow bars, wedges, and pneumatic breaking equipment. The mere fact that the Contractor resorts to blasting for reasons of his own, shall not qualify for classification under 'Hard Rock'.

This shall also include excavation in macadam and tarred roads and pavements. This shall also include rock boulders not longer than 1 metre in any direction and not more than 500 mm in any one of the other two directions. Masonry to be dismantled will also be measured under this item.

(c) Hard Rock

This shall include all rock occurring in large continuous masses which cannot be removed except by blasting for loosening it. Harder varieties of rock with or without veins and secondary minerals which, require blasting shall be considered as hard rock. Where hard rock is met with and blasting operations are not permitted, the Contractor shall use other methods such as use of chemicals or any other method for loosening the rock mass, developing cracks, etc. The loosened material shall be thereafter removed either by mechanical means or manually. Boulders of rock occurring in such sizes and not classified under (a) and (b) above shall also be classified as hard rock. Concrete work both reinforced and unreinforced to be dismantled will be measured under this item, unless a separate provision is made in the Schedule of Quantities.

1.8 EXCAVATION

All excavation work shall be carried out by mechanical equipment unless, in the opinion of the Authority/PMC (if require), the work involved and time schedule permit manual work.

Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades. Rough excavation shall be carried out to a depth 150 mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed even below the final level and extra excavation filled up by the Contractor. The final excavation if so instructed by the Authority/PMC (if require) should be carried out just prior to laying the mud-mat.

The Contractor may, for facility of work or similar other reasons excavate, and also backfill later, if so approved by the Authority/PMC (if require), at his own cost outside the lines shown on the drawings. Should any excavation be taken below the specified elevations, the Contractor shall fill it up, with concrete of the same class as in the foundation resting thereon, upto the required elevation. No extra shall be claimed by the Contractor on this account.

All excavation shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Authority/PMC (if require) shall be obtained by the Contractor in each individual case, for the method he proposes to adopt for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval, however, shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips. Should slips occur, the slipped material shall be removed and the slope dressed to a modified stable slope. Removal of the slipped earth will not be paid for and Contractor shall take adequate precautions to avoid slips in view of the restricted plot and presence of buildings/ structures in nearby vicinity.

Excavation shall be carried out with such tools, tackles and equipment as described herein before. Blasting or other methods may be resorted to in the case of hard rock; however not without the specific permission of the Authority/PMC (if require).

1.9 STRIPPING LOOSE ROCK

All loose boulders, semi-detached rocks (along with earthy stuff which might move therewith) not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of the Authority/PMC (if require), to fall or otherwise endanger the workmen, equipment, or the work, etc., shall be stripped off and removed away from the area of the 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 material not requiring removal as contemplated in the work, but which is likely to become loose or unstable later, shall also be promptly and satisfactorily removed by the Contractor. The cost of such stripping will be paid for at the unit rates accepted for the class of materials in question.

1.10 FILL, BACK FILLING AND SITE GRADING

10.0 General

If any fill material is rejected by the Authority/PMC, the Contractor shall remove the same forthwith from the site at no extra cost to the Authority. Surplus fill material shall be deposited/ disposed off by the Contractor after the fill work is completed.

No earthfill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by the Contractor.

10.1 Material

To the extent available, selected surplus soils from excavated materials shall be used as backfill. Fill material shall be free from clods, salts, sulphates, organic or other foreign material. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murrum or earth to fill up the voids and the mixture used for filling.

If any selected fill material is required to be borrowed, the Contractor shall make arrangements for bringing such material from outside borrow pits. The borrow pit area shall be cleared of all bushes, roots of trees, plants, rubbish, etc. top soil containing salts/ sulphate and other foreign material shall be removed. The materials so removed shall be burnt or disposed off by the Contractor. The Contractor shall make necessary access roads to borrow areas and maintain the same, if such access road does not exist, at his cost.

Filling with excavated earth shall be done in regular horizontal layers each not exceeding 20 cm in depth. All lumps and clods exceeding 8 cm in any direction shall be broken. Each layer shall be watered and consolidated with steel rammer or half ($\frac{1}{2}$) tonne roller. Where specified, every third and top most layer shall also be consolidated with power roller of minimum 8 tonnes. Wherever depth of filling exceeds 1.5 metres, vibratory power roller shall be used to consolidate the filling by the Contractor. The Contractor shall make good all subsidence and shrinkage in earth fillings, embankments, traverses, etc. during execution and till the completion of work unless otherwise specified.

10.2 Filling In Pits And Trenches Around Foundations Of Structures, Walls, Etc.

As soon as the work in foundations has been accepted and measured, the spaces around the foundations, structures, pits, trenches, etc. shall be cleared of all debris, and filled with earth in layers not exceeding 15 cm., each layer being watered, rammed and properly consolidated, before the succeeding one is laid. Each layer shall be consolidated. Earth shall be rammed with approved mechanical compaction machines. Usually no manual compaction shall be allowed unless the Authority/PMC (if require) is satisfied that in some cases manual compaction by tampers cannot be avoided. The

final backfill surface shall be trimmed and levelled to proper profile by the Contractor or indicated on the drawings.

10.3 Plinth Filling

Plinth filling shall be carried out with approved material as described herein before in layers not exceeding 15 cm, watered and compacted with mechanical compaction machines. The Authority/PMC may however permit manual compaction by hand tampers in case he is satisfied that mechanical compaction is not possible. When filling reaches the finished level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours allowed to dry and then the surface again compacted as specified above to avoid settlements at a later stage. The finished level of the filling shall be trimmed to the level/ slope specified.

Where specified in the schedule of works, compaction of the plinth fill shall be carried out by means of 12 tonne rollers smooth wheeled, sheep-foot or wobbly wheeled rollers. In case of compaction of granular material such as sands and gravel, vibratory rollers shall be used. A smaller weight roller may be used only if permitted by the Authority/PMC. As rolling proceeds, water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fill.

The thickness of each unconsolidated fill layer can in this case be upto a maximum of 300 mm. The Contractor will determine the thickness of the layers in which fill has to be consolidated depending on the fill material and equipment used.

Rolling shall commence from the outer edge and progress towards the centre and continue until compaction, but in no case less than 10 passes of the roller will be accepted for each layer.

The compacted surface shall be properly shaped, trimmed and consolidated to an even and uniform gradient. All soft spots shall be excavated and filled and consolidated.

At some locations/ areas it may not be possible to use rollers because of space restrictions, etc. The Contractor shall then be permitted to use pneumatic tampers, rammers, etc. and he shall ensure proper compaction.

10.4 Sand Filling in Plinth and Other Places

At places backfilling shall be carried out with local sand by the Contractor. The sand used shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. Any temporary work required to contain sand under

flooded condition shall be to the Contractor's account. The surface of the consolidated sand shall be dressed to required level or slope. Construction of floors or other structures on sand fill shall not be started until the Authority/PMC (if require) has inspected and approved the fill.

10.5 Filling in Trenches

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. The backfilling material shall be properly consolidated by watering and ramming, taking due care that no damage is caused to the pipes.

Where the trenches are excavated in soil, the filling from the bottom of the trench to the level of the centre line of the pipe shall be done by hand compaction with selected approved earth in layers not exceeding 8 cm; backfilling above the level of the centre line of the pipe shall be done with selected earth by hand compaction or other approved means in layers not exceeding 15 cm.

In case of excavation of trenches in rock, the filling upto a level 30 cm above the top of the pipe shall be done with fine materials, such as earth, murrum etc. The filling up of the level of the centre line of the pipe shall be done by hand compaction in layers not exceeding 8 cm whereas the filling above the centre line of the pipe shall be done by hand compaction or approved means in layers not exceeding 15 cm. The filling from a level 30 cm above the top of the pipe to the top of the trench shall be done by hand or other approved mechanical methods with broken rock filling of size not exceeding 15 cm mixed with fine material as available to fill up the voids.

Filling of the trenches shall be carried simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

1.11 **GENERAL SITE GRADING**

Site grading shall be carried out as indicated in the drawings by the Contractor. Excavation shall be carried out as specified in the specification. Filling and compaction shall be carried out as specified under Clause 10.0 and elsewhere unless otherwise indicated below.

If no compaction is called for, the fill may be deposited to the full height in one operation and levelled. If the fill has to be compacted, it shall be placed in layers not exceeding 225 mm and levelled uniformly and compacted as indicated in Clause 10.0 before the next layer is deposited.

To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out by the Contractor at his cost.

Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed. This shall hold good for embankments as well.

The Contractor shall protect the earthfill from being washed away by rain damaged in any other way. Should any slip occur, the Contractor shall remove the affected material and make good the slip at his cost.

The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the desired compaction has not been obtained.

If specifically permitted by the Authority/PMC (if require), compaction can be obtained by allowing loaded trucks conveying fill or other material to ply over the fill area. Even if such a method is permitted, it will be for the Contractor to demonstrate that the desired/ specified compaction has been obtained. In order that the fill may be reasonably uniform throughout, the material should be dumped in place in approximately uniform layers. Traffic over the fill shall then be so routed to compact the area uniformly throughout.

If so specified, the rock as obtained from excavation may be used for filling and levelling to indicated grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 tonne roller. No less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.

1.12 FILL DENSITY

The compaction, only where so called for, in the schedule of quantities/ items shall comply with the specified (Standard Proctor/ Modified Proctor) density at moisture content differing not more than 4 percent from the optimum moisture content. The Contractor shall demonstrate adequately at his cost, by field and laboratory tests that the specified density has been obtained.

1.13 LEAD

Lead for deposition/ disposal of excavated material, shall be as specified in the respective item of work. For the purpose of measurement of lead, the

area to be excavated or filled or area on which excavated material is to be deposited/ disposed off shall be divided into suitable blocks and for each of the blocks, the distance between center lines shall be taken as the lead which shall be measured by the shortest straight line route on the plan and not the actual route taken by the Contractor. No extra compensation is admissible on the grounds that the lead including that for borrowed material had to be transported over marshy or 'katcha' land/ route.

2.0 REINFORCED CONCRETE & ALLIED WORKS

2.1 SCOPE

This Specification covers the general requirements for ready mixed concrete and for concrete using on-site production facilities including requirements in regard to the quality, handling, storage of ingredients, proportioning, batching, mixing, transporting, placing, curing, protecting, repairing, finishing and testing of concrete; formwork; requirements in regard to the quality, storage, bending and fixing of reinforcement; as well as grouting. It shall be very clearly understood that the specifications given herein are brief and do not cover minute details. However, all works shall have to be carried out in accordance with the relevant standards and codes of practices or in their absence in accordance with the best accepted current engineering practices. The decision of Authority (if require) as regards the specification to be adopted and their interpretation and the mode of execution of work shall be final and binding on Contractor and no claim whatsoever will be entertained on this account.

2.2 APPLICABLE CODES AND SPECIFICATIONS

The following specifications, standards and codes, including all official amendments/revisions and other specifications & codes referred to therein, should be considered a part of this specification. In all cases the latest issue/edition/revision shall apply. In case of discrepancy between this specification and those referred to herein below or other specifications forming a part of this bid document, this specification shall govern.

Materials

- (a) IS:269 Specification for 33 grade Ordinary Portland Cement.
- (b) IS:455 Specification for Portland Slag Cement.

- (c) IS:1489 Specification for Portland Pozzolana Cement (Parts 1 & 2)
- (d) IS:8112 Specification for 43 grade Ordinary Portland Cement.
- (e) IS:12330 Specification for Sulphate resisting Portland Cement.
- (f) IS:383 Specification for coarse and fine aggregates from natural sources for concrete.
- (g) IS:432 Specification for mild steel and medium tensile (Parts steel bars and hard drawn steel wires for 1 & 2) concrete reinforcement.
- (h) IS:1786 Specification for high strength deformed steel bars and wires for concrete reinforcement.
- (i) IS:1566 Specification for hard drawn steel wire fabric for (Parts II) concrete reinforcement.
- (j) IS:9103 Specification for admixtures for concrete.
- (k) IS:2645 Specification for integral cement waterproofing compounds.
- (l) IS:4900 Specification for plywood for concrete shuttering work.
- (m) IS:4926 Ready Mixed Concrete.
- (n) IS:12269 Specification for 53 grade Ordinary Portland Cement.
- (o) IS:8041 Specification for rapid hardening cement.
- (p) IS:12600 Specification for low heat cement.
- (q) IS:6909 Specification for Supersulphated Cement.
- (r) IS:12089 Specification for Granulated Ground Blast Furnace Slag.
- (s) BS:6699 Specification for Granulated Ground Blast Furnace Slag.
- (t) BS:6073 Specifications for precast concrete masonry units (Part 1)
Methods for specifying precast concrete masonry (Part 2)

Material Testing

- (a) IS:4031 Methods of physical tests for hydraulic cement. (Parts 1 to 15)
- (b) IS:4032 Method of chemical analysis of hydraulic cement.

- (c) IS:650 Specification for standard sand for testing of cement.
- (d) IS:2430 Methods for sampling of aggregates for concrete.
- (e) IS:2386 Methods of test for aggregates for concrete (Parts 1 to 8)
- (f) IS:3025 Methods of sampling and test (physical and chemical) water used in industry.(Part 1 to 51)
- (g) IS:6925 Methods of test for determination of water soluble chlorides in concrete admixtures.

Material Storage

- (a) IS:4082 Recommendations on stacking and storing of construction materials at site.

Concrete Mix Design

- (a) IS:10262 Recommended guidelines for Concrete Mix Design.
- (b) SP:23 Handbook on Concrete Mixes.

Concrete Testing

- (a) IS:1199 Method of sampling and analysis of concrete.
- (b) IS:516 Method of test for strength of concrete.
- (c) IS:9013 Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.
- (d) IS:8142 Method of test for determining setting time of concrete by penetration resistance.
- (e) IS:9284 Method of test for abrasion resistance of concrete.
- (f) IS:2770 Methods of testing bond in reinforced concrete.

Equipment

- (a) IS:1791 Specification for batch type concrete mixers.
- (b) IS:2438 Specification for roller pan mixer.
- (c) IS:4925 Specification for concrete batching and mixing plant.
- (d) IS:5892 Specification for concrete transit mixer and agitator.
- (e) IS:7242 Specification for concrete spreaders.
- (f) IS:2505 General Requirements for concrete vibrators: Immersion type.

- (g) IS:2506 General Requirements for screed board concrete vibrators.
- (h) IS:2514 Specification for concrete vibrating tables.
- (i) IS:3366 Specification for pan vibrators.
- (j) IS:4656 Specification for form vibrators for concrete.
- (k) IS:11993 Code of practice for use of screed board concrete vibrators.
- (l) IS:7251 Specification for concrete finishers.
- (m) IS:2722 Specifications for portable swing weigh batchers for concrete (single and double bucket type).
- (n) IS:2750 Specifications for steel scaffoldings.

Codes of Practice

- (a) IS:456 Code of practice for plain and reinforced concrete.
- (b) IS:457 Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
- (c) IS:3370 Code of practice for concrete structures for storage of liquids (Parts 1 to 4)
- (d) IS:3935 Code of practice for composite construction.
- (e) IS:2204 Code of practice for construction of reinforced concrete shell roof.
- (f) IS:2210 Criteria for the design of reinforced concrete shell structures and folded plates.
- (g) IS:2502 Code of practice for bending and fixing of bars for concrete reinforcement.
- (h) IS:5525 Recommendation for detailing of reinforcement in reinforced concrete works.
- (i) IS:2751 Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.
- (j) IS:9417 Specification for welding cold worked bars for reinforced concrete construction.
- (k) IS:3558 Code of practice for use of immersion vibrators for consolidating concrete.

- (l) IS:3414 Code of practice for design and installation of joints in buildings.
- (m) IS:4326 Code of practice for earthquake resistant design and construction of buildings.
- (n) IS:4014 Code of practice for steel tubular scaffolding. (Parts 1 & 2)
- (o) IS:2571 Code of practice for laying in situ cement concrete flooring
- (p) IS:7861 Part1 - Recommended practice for hot weather concreting
Part2 – Recommended practice for cold weather concreting
- (q) IS:3370 Code of practice for concrete structures for the storage of liquid (Part I to IV)

Construction Safety

- (a) IS:3696 Safety code for scaffolds and ladders.(Parts 1 & 2)
- (b) IS:7969 Safety code for handling and storage of building materials.
- (c) IS:8989 Safety code for erection of concrete framed structures.

Measurement

- (a) IS:1200 Method of measurement of building and engineering works (Part 1 to 12) (Part 2 and 5)

2.3 GENERAL

Authority shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and Authority's approval obtained (if require), prior to starting of concrete work. This shall, however, not relieve Contractor of any of his responsibilities. All materials, which do not conform to this specification, shall be rejected.

Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due regards to the functional requirements and the environmental conditions to which the structure will be subjected. Materials complying with codes/standards shall only be used. Other materials may be used if require and after establishing their performance suitability based on previous data, experience or tests.

2.4 MATERIALS

- i. Cement

Unless otherwise specified, cement shall be Ordinary Portland Cement conforming to IS: 269, IS: 8112 or IS: 12269.

The Portland Pozzolana Cement shall conform to IS: 1489 and it shall be used. Where Portland Pozzolana or slag cements are used, it shall be ensured that consistency of quality is maintained and there will be no adverse interactions between the materials and the finish specified is not marred.

Only one type of cement shall be used in any one mix. The source of supply, type or brand of cement within the same structure or portion thereof shall not be changed. Cement, which is not used within 90 days from its date of manufacture, shall be tested at a laboratory and until the results of such tests are found satisfactory, it shall not be used in any work.

Fly Ash Blended Cements conforming to IS: 1489 (Part I) may be used in RCC structures as per the guidelines given below:

ii. General

IS: 456 - 2000 Code of Practice for Plain and Reinforced Concrete (as amended up to date) shall be followed in regard to Concrete Mix Proportion and its production as under:

- a. The concrete mix design shall be done as “Design Mix Concrete” as prescribed in clause 9 of IS: 456 mentioned above.
- b. Concrete shall be manufactured in accordance with clause 10 of above mentioned IS: 456 covering quality assurance measures both technical and organisational, which shall also necessarily require a qualified Concrete Technologist to be available during manufacture of concrete for certification of quality of concrete.
- c. Minimum M25 grade of concrete shall be used in all structural elements made with RCC both in load bearing and framed structure.
- d. The mechanical properties such as modulus of elasticity, tensile strength, creep and shrinkage of fly ash mixed concrete or concrete using fly ash blended cements (PPCs) are not likely to be significantly different and their values are to be taken same as those used for concrete made with OPC.
- e. To control higher rate of carbonation in early ages of concrete both in fly ash admixed as well as PPC based concrete, water/ binder ratio shall be kept as low as possible, which shall be closely monitored during concrete manufacture.

- f. If necessitated due to low water/binder ratio, required workability shall be achieved by use of chloride free chemical admixtures conforming to IS 9103. The compatibility of chemical admixtures and super plasticizers with each set OPC, fly ash and/ or PPC received from different sources shall be ensured by trials.
- g. In environment subjected to aggressive chloride or sulphate attack in particular, use of fly ash admixed or PPC based concrete is recommended. In cases, where structural concrete is exposed to excessive magnesium sulphate, flyash substitution/ content shall be limited to 18% by weight. Special type of cement with low C3A content may also be alternatively used. Durability criteria like minimum binder content and maximum water /binder ratio also need to be given due consideration in such environment.
- h. Wet curing period shall be enhanced to a minimum of 10 days or its equivalent. In hot and arid regions, the minimum curing period shall be 14 days or its equivalent.

iii. Use of Fly Ash Admixed Cement Concrete (FACC) in RCC Structures

There shall be no bar on use of FACC in RCC structures subject to following additional conditions.

- (a) Fly ash shall have its chemical characteristics and physical requirements, etc. conforming to IS: 3812 (Parts I and II) and shall be duly certified.
- (b) To ensure uniform blending of fly ash with cement in conformity with IS: 456, a specific facility needs to be created at site with complete computerised automated process control to achieve design quality or with similar facility from Ready Mix Concrete (RMC) plants.
- (c) As per IS: 1489 (Part-I) maximum 35% of OPC by mass is permitted to be substituted with fly ash conforming to IS: 3812 (Part-I) and same is reiterated.
- (d) Separate storage for dry fly ash shall be provided. Storage bins or silos shall be weather proof and permit a free flow and efficient discharge of fly ash. The filter or dust control system provided in the bins or silos shall be of sufficient size to allow delivery of fly ash maintained at specified pressure to prevent undue emission of fly ash dust, which may interfere weighing accuracy.

- iv. Use of Fly Ash Blended Cements in Cement Concrete (PPCC) in RCC Structures
- (a) Subject to General Guidelines detailed out as above, PPC manufactured conforming to IS: 1489 (Part-I) shall be treated at par with OPC for manufacture of Design Mix concrete for structural use in RCC.
 - (b) Till the time, BIS makes it mandatory to print the percentage of fly ash on each bag of cement, the certificate from the PPC manufacture indicating the same shall be insisted upon before allowing use of such cements in works.
 - (c) While using PPC for structural concrete work, no further admixing of fly ash shall be permitted.
- v. Aggregates
- a. Aggregates shall consist of naturally occurring stones and gravel (crushed or uncrushed) and sand. They shall be chemically inert, strong, hard, clean, durable against weathering, of limited porosity, free from dust/silt/organic impurities/deleterious materials and conform to IS: 383. Aggregates such as slag, crushed over burnt bricks, bloated clay ash, sintered fly ash and tiles shall not be used.
 - b. Aggregates shall be washed and screened before use where necessary. Aggregates containing reactive materials shall be used only after tests conclusively prove that there will be no adverse affect on strength, durability and finish, including long term effects, on the concrete.
 - c. The fineness modulus of sand shall neither be less than 2.2 nor more than 3.2. If use of sand having fineness modulus more than 3.2 is unavoidable then it shall be suitable blended with crusher stone dust.
 - d. The maximum size of coarse aggregate shall be as stated on the drawings, but in no case greater than 1/4 of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of the form. For most work 20 mm aggregate is suitable. Where there is no restriction to the flow of concrete into sections, 40 mm or larger size is permitted.
 - e. In concrete elements with thin sections, closely spaced reinforcements or small cover, consideration should be given to the use of 10mm nominal maximum size.

- f. Plums 160 mm and above of a reasonable size may be used where directed. Plums shall not constitute more than 20% by volume of concrete.
- vi. Water
 - a. Water used for both mixing and curing shall conform to IS: 456. Potable water is generally satisfactory. Water containing any excess of acid, alkali, sugar or salt shall not be used.
 - b. The pH value of water shall not be less than 6.
 - c. Seawater shall not be used for concrete mixing and curing.
 - d. The proposed admixtures shall comply with requirements of specification part 9- Water sealing materials.
- vii. Reinforcement
 - a. Reinforcement bars shall conform to IS: 432 and/ or IS: 1786 and welded wire fabric to IS: 1566 as shown on the drawing.
 - b. All reinforcement shall be clean, free from pitting, oil, grease, paint, loose mill scales, rust, dirt, dust or any other substance that will destroy or reduce bond.
 - c. Special precaution like coating of reinforcement may be provided.
- viii. Wastage
 - a. Wastage allowance for cement and steel (supplied by Authority) shall be as specified under Instruction to Bidders.
- ix. Samples and Tests
 - a. All materials used for the works shall be tested before use. The frequency of such confirmatory tests shall be decided by Contractor.
 - b. Manufacturer's test certificate shall be furnished for each batch of cement/steel and when directed by Authority (if require) samples shall also be got tested by the Contractor in a laboratory at no extra cost to Authority. However, where material is supplied by Authority, all testing charges shall be borne by Authority, but transportation and preparation of material samples for the laboratory shall be done by Contractor at no extra cost.
 - c. Sampling and testing of aggregates shall be as per IS: 2386 The cost of all tests, sampling, etc. shall be borne by Contractor. For coarse aggregate crushing value shall be tested.
 - d. Water to be used shall be tested to comply with clause 5.4 of IS: 456.

- e. Contractor shall furnish manufacturer's test certificates and technical literature for the admixture proposed to be used. If directed, the admixture shall be got tested at an approved laboratory at no extra cost.
- x. Storing of Materials
 - a. All material shall be stored in a manner so as to prevent its deterioration and contamination, which would preclude its use in the works. Requirements of IS: 4082 shall be complied with.
 - b. Contractor will have to make his own arrangements for the storage of adequate quantity of cement even if cement is supplied by Authority. If such cement is not stored properly and has deteriorated, the material shall be rejected. Cost of such rejected cement, where cement is supplied by Authority, shall be recovered at issue rate or open market rate whichever is higher. Cement bags shall be stored in dry weatherproof shed with a raised floor, well away from the outer walls and insulated from the floor to avoid moisture from ground. Not more than 15 bags shall be stacked in any tier. Storage under tarpaulins shall not be permitted. Each consignment of cement shall be stored separately and consumed in its order of receipt. Contractor shall maintain record of receipt and consumption of cement.
 - c. Each size of coarse and fine aggregates shall be stacked separately and shall be protected from dropping leaves and contamination with foreign material. The stacks shall be on hard, clean, free draining bases, draining away from the concrete mixing area.
 - d. Contractor shall make his own arrangements for storing water at site in tanks of approved capacity. The tanks shall be cleaned at least once a week to prevent contamination.
 - e. The reinforcement shall be stacked on top of timber sleepers to avoid contact with ground/ water. Each type and size shall be stacked separately.

2.5 CONCRETE

i. General

Concrete grade shall be as designated on drawings. Concrete in the works shall be "DESIGN MIX CONCRETE" OR "NOMINAL MIX CONCRETE". All concrete works of upto grade M15 shall be NOMINAL MIX CONCRETE whereas all other grades, M20 and above, shall be DESIGN MIX CONCRETE.

ii. Design Mix Concrete

Design Mix Concrete are classified in three categories, viz. "Normal Concrete (M)", "Heavy Concrete (H)", "Super Heavy Concrete (SH)". Each class of concrete shall be identified by a prefix and two numbers. Prefix "M" would denote Normal Concrete, prefix "H" would denote heavy concrete and prefix "SH" would denote super heavy concrete. The two numbers e.g. 25 - 40 would denote the crushing strength of cube at 28 days in N/sqmm and maximum size of the coarse aggregates in millimetres respectively.

Normal concrete shall have a net dry unit weight of not less than 25 kN/cum, for the finished structure after curing, Heavy concrete shall have a net dry unit weight of not less than 36.30 kN/cum, for the finished structure after curing and special heavy concrete shall have a net dry unit weight of not less than 41 kN/cum for the finished structure after curing.

iii. Mix Design and Testing

For Design Mix Concrete, the mix shall be designed as per any of four methods given in SP: 23 to provide the grade of concrete having the required workability and characteristic strength not less than appropriate values given in IS: 456. The design mix shall in addition be such that it is cohesive and does not segregate during placement and should result in a dense and durable concrete capable of giving the specified finish. For liquid retaining structures, the mix shall also result in watertight concrete. The Contractor shall exercise great care while designing the concrete mix and executing the works to achieve the desired result.

The minimum grade of concrete shall be as per Table 5 of IS: 456 for various exposure conditions of concrete. For various environmental conditions, refer Table 3 of IS: 456.

The minimum cement content for Design Mix Concrete shall be as per Table 5 of IS: 456 or as given below, whichever is higher.

Grade of Concrete, M	Minimum Cement Content in kg/cum of Concrete
20	300
25	320
30	340
35	360

40

360

45

400

The minimum cement content stipulated above shall be adopted irrespective of whether the Contractor achieves the desired strength with less quantity of cement. The Contractor's quoted rates for concrete shall provide for the above eventuality and nothing extra shall become payable to the Contractor on this account. Even in the case where the quantity of cement required is higher than that specified above to achieve desired strength based on an approved mix design, nothing extra shall become payable to the Contractor.

It shall be Contractor's sole responsibility to carry out the mix designs at his own cost. He shall furnish to Authority for approval at least 30 days before concreting operations, a statement of proportions proposed to be used for the various concrete mixes and the strength results obtained. The strength requirements of the concrete mixes ascertained on 150 mm cubes as per IS: 516 shall comply with the requirements of IS: 456.

Grade of Concrete	Minimum Compressive Strength N/mm² at 7 days	Specified compressive strength N/mm² at 28 days	Characteristic strength
M15	10.0	15.0	
M20	13.5	20.0	
M25	17.0	25.0	
M30	20.0	30.0	
M35	23.5	35.0	
M40	27.0	40.0	
M45	30.0	45.0	

A range of slumps recommended for various types of construction, shall be as given below:

Structure/ Member	Slump in millimetres	
	Maximum	Minimum
Reinforced foundation walls and footings	75	25

Structure/ Member	Slump in millimetres	
	Maximum	Minimum
Plain footings, caissons and substructure walls	75	25
TG and massive compressor foundations	50	25
Slabs, Beams and reinforced walls	50	25
Pumps and miscellaneous Equipment Foundations	75	25
Building columns	50	25
Pavements	50	25
Heavy mass construction	50	25
Liquid retaining/ conveying structures	50	25

(NOTE: These values are not meant for pumped concrete placed using slip formed technique.)

Where single size graded coarse aggregate are not available, aggregates of different sizes shall be properly combined. The Contractors mix design shall show that combined grading of coarse aggregate meets the requirements of Table 2 of IS: 383 for graded aggregates.

iv. Batching and Mixing Of Concrete

Proportions of aggregates and cement, as per approved concrete mix design, shall be by weight. These proportions shall be maintained during subsequent concrete batching by means of weigh batchers capable of controlling the weights within $\pm 2\%$ for cement and $\pm 3\%$ for aggregate. The batching equipment shall be calibrated at the frequency decided by Contractor.

Amount of water added shall be such as to produce dense concrete of required consistency, specified strength and satisfactory workability and shall be so adjusted to account for moisture content in the aggregates. Water-cement ratio specified for use by Contractor shall be maintained. Each time the work stops, the mixer shall be cleaned out, and while recommencing, the first batch shall have 10% additional sand and cement to allow for sticking in the drum.

Arrangement should be made by Contractor to have the cubes tested at his own expense in an approved laboratory or in field. Sampling and testing of strength and workability of concrete shall be as per IS: 1199, IS: 516 and IS: 456. It is preferable to cast additional cubes (minimum 3 specimen) for testing at 7 days and 14 days.

2.6 NOMINAL MIX CONCRETE

i. Mix Design and Testing

Mix Design and preliminary tests are not necessary for Nominal Mix Concrete. However works tests shall be carried out as per IS: 456. Proportions for Nominal Mix Concrete and water-cement ratio may be adopted as per Table 9 of IS: 456. However, it will be Contractor's sole responsibility to adopt appropriate nominal mix proportions to achieve the specified characteristic strength.

ii. Batching and Mixing Of Concrete

Based on the adopted nominal mixes, aggregates shall be measured by volume. However cement shall be by weight only. Appropriate correction shall be made for bulking of sand after testing.

2.7 READY MIXED CONCRETE

All specification as per IS: 4926 – "Specification for Ready Mixed Concrete" shall be used.

The Contractor shall identify at least two sources of ready mix concrete supplier prior to start of the Works. Any change in the source of the RMC, shall be got approved by the Authority (if require).

The design mix prepared by the RMC supplier shall be the responsibility of the Contractor. The testing of concrete as per Codal provisions and the specifications shall be done by the Contractor same as the normal concreting works.

2.8 PRECAST CONCRETE

i. General

Precast concrete shall comply with the preceding Sections relating to Concrete as far as they are applicable. Precast concrete blocks shall comply with the requirements and recommendations of BS: 6073.

ii. Precasting Bed

All precast units shall be cast on, or their shutters supported from a suitably prepared level unyielding paved area.

iii. Marking

All units shall be suitably marked in a clean and legible manner with a reference number and the date of casting, which information shall be clearly visible when units are stacked. Reinforced precast members shall be clearly marked to indicate the upper face.

iv. Formwork

The formwork shall be either steel or lined with steel, waterproof/ laminated board or such other material. Forms shall be strongly constructed, closely jointed and smooth and shall be such as to ensure true sharp arises and a perfect surface. Forms shall be so designed that they can be taken apart and reassembled readily.

v. Surface Finish

Surface Finish of precast units shall comply with requirements of clause 21.0 of this specification and clause 5.17 of specification Part 3-Formwork. The class of Finish shall generally be of F2 type unless detailed differently on the drawings. No construction joints will be permitted within any precast work.

vi. Casting Tolerance

The casting tolerance, unless otherwise ordered or directed, shall be within +3 mm of true dimensions.

vii. Striking Forms

The method and time of striking the side shutters after casting the units will normally be left to the discretion of the Contractor, but the Authority (if require) may specify minimum time in which case the Contractor must comply with the Authority directions (if require). In the event of any damage resulting from premature removal of shutters, or from any other cause, the unit will be liable to rejection and replacement by the Contractor at his own cost, whether the Authority (if require) has specified a minimum striking time or not.

viii. Lifting, Stacking and Removal

Precast units shall not be lifted, transported or used in the Works until they are sufficiently mature. The crushing tests on the test cubes, which are to be kept along with relevant the precast units, will be used to assess the maturity of the units.

Lifting, stacking and removal of precast units shall be undertaken without causing shock, vibration or undue stress to or in the units. The Contractor shall satisfy the Authority (if require) that the methods he proposes for lifting, transporting and setting precast units will not overstress or damage the units in any way. In the event of overstress or damage due to whatever cause, the unit or units concerned will be liable to rejection. Rejected units shall be immediately broken up and removed from the site. The Contractor shall replace such rejected units at his own cost.

ix. Curing

The top and sides of all precast units shall be kept covered constantly and in a damp condition with clean, potable fresh water for at least seven days after casting. It is preferable to have a curing pond for this purpose.

x. Precasting Records

Complete records shall be maintained of all precast work. Every unit shall have a reference number, date of casting, date of removal from bed and date and position of placing shall be recorded together with corresponding test cube reference number and results.

Contractor shall submit a method statement to Authority (if require) for approval, furnishing details of each stage of operation.

2.9 FORMWORK

Formwork shall be all inclusive and shall consist of but not limited to shores, bracings, sides of footings, walls, beams and columns, bottom of slabs, etc. including ties, anchors, hangers, inserts, falsework, wedges, etc.

The design and engineering of the formwork as well as its construction shall be the responsibility of Contractor. However, if require, the drawings and calculations for the design of the formwork shall be submitted to Authority for approval if require.

Formwork shall be designed to fulfil the following requirements:

- (a) Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and appropriate to the methods of placing and compacting.
- (b) Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.
- (c) Capable of withstanding without deflection the worst combination of self weight, reinforcement and concrete weight, all loads and dynamic

effects arising from construction and compacting activities, wind and weather forces.

- (d) Capable of easily striking without shock, disturbance or damage to the concrete.
- (e) Soffit forms capable of imparting a camber if required.
- (f) Soffit forms and supports capable of being left in position if required.
- (g) Capable of being cleaned and/or coated if necessary immediately prior to casting the concrete; design temporary openings where necessary for these purposes and to facilitate the preparation of construction joints.

The formwork may be of lined timber, waterproof / plastic coated plywood, steel, plastic depending upon the type of finish specified. Sliding forms and slip form may be used. Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps and other surface defects. Joints between formwork and formwork and between formwork and structure shall be sufficiently tight to prevent loss of slurry from concrete using foam and rubber seals.

The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before fixing reinforcement. All rubbish, particularly chippings, shavings, sawdust, wire pieces, dust etc. shall be removed from the interior of the forms before the concrete is placed. Where directed, cleaning of forms shall be done by blasting with a jet of compressed air at no extra cost.

Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced. Contractor shall equip himself with enough quantity of shuttering to allow for wastage so as to complete the job in time.

Permanent formwork shall be checked for its durability and compatibility with adjoining concrete before it is used in the structure. It shall be properly anchored to the concrete.

Wire ties passing through beams, columns and walls shall not be allowed. In their place bolts passing through sleeves may be used. Formwork spacers left in situ shall not impair the desired appearance or durability of the structure by causing spalling, rust staining or allowing the passage of moisture.

For liquid retaining structures sleeves shall not be provided for through bolts nor shall through bolts be removed if provided. The bolts, in the latter case, shall be cut at 25 mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.

Where specified or shown on drawings all corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm x 20 mm size.

Forms for substructure may be omitted when, the open excavation is firm enough (in hard non-porous soils) to act as a form. Such excavation shall be slightly larger, than that required as per drawing to compensate for irregularities in excavation.

Contractor shall provide adequate props of adjustable steel pipes carried down to a firm bearing without overloading any of the structures.

The shuttering for beams and slabs shall be so erected that the side shuttering of beams can be removed without disturbing the bottom shuttering. If the shuttering for a column is erected for the full height of the column, one side shall be built up in sections as placing of concrete proceeds or windows left for placing concrete from the side to limit the drop of concrete to 1.5 m. Contractor shall temporarily and securely fix items to be cast (embedments/inserts) in a manner that will not hinder the striking of forms or permit loss of grout.

Formwork showing excessive distortion, during any stage of construction, shall be removed. Placed concrete affected by faulty formwork, shall be entirely removed and formwork corrected prior to placement of new concrete at Contractor's cost.

The striking time for formwork shall be determined based on the following requirements:

- (a) Development of adequate concrete strength;
- (b) Permissible deflection at time of striking form work;
- (c) Curing procedure employed - its efficiency and effectiveness;
- (d) Subsequent surface treatment to be done;
- (e) Prevention of thermal cracking at re-entrant angles;
- (f) Ambient temperatures; and Aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete).

Before removing formwork of soffit of slabs/ beams compressive strength at 7/14/21 days shall be checked.

Under normal circumstances (generally where temperatures are above 20 Deg. C) forms may be struck after expiry of the period given in IS: 456. For Portland Pozzolana / slag cement the stripping time shall be suitably modified. It is the Contractor's responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not undergo excessive deformation and resists surface damage and any stresses arising during the construction period.

In addition to the above clauses, Specification Formwork enclosed with this tender is also applicable and should be referred.

2.10 REINFORCEMENT FABRICATION AND PLACEMENT

Reinforcing bars supplied in the form of bent coils shall be straightened cold without damage at no extra cost. No bending shall be done when ambient temperature is below 5 Deg C. Suitable preheating may be permitted if steel bar bending is to be done at below 0 Deg C. Bars supplied in bent coils shall be straightened only by machine.

All bars shall be accurately bent gradually and according to the sizes and shapes shown on the drawings/ schedules. Bar bending machines shall be used to achieve desired accuracy.

Re-bending or straightening incorrectly bent bars shall not be done.

Reinforcement shall be accurately fixed and maintained firmly in the correct position by the use of blocks, spacers, chairs, binding wire, etc. to prevent displacement during placing and compaction of concrete. The tied in place reinforcement shall be checked prior to concrete placement. Spacers (PVC or Concrete) shall be of such material and design as will be durable, not lead to corrosion of the reinforcement and not cause spalling of the concrete cover.

Binding wire shall be 16 gauge soft annealed wire. Ends of the binding wire shall be bent away from the concrete surface and in no case encroach into the concrete cover.

Substitution of reinforcement, laps/splices not shown on drawing shall be proposed by Contractor. If permitted by Authority (if require), welding of reinforcement shall be done in accordance with IS: 2751, IS: 9417 and SP: 34 as applicable.

Tolerance on placement of reinforcement shall be as per Cl. 12.3 of IS: 456.

2.11 TOLERANCES

Tolerance for formed and concrete dimensions shall be as per IS: 456 and/ or ACI-117-90, ACI-347 unless specified otherwise.

Tolerance specified for horizontal or vertical building lines or footings shall not be construed to permit encroachment beyond the legal boundaries.

Tolerance for top of concrete of equipments and structural steel foundations shall be as under:

- (a) Where grout thickness is less than or equal to 25 mm: +5 mm and -10 mm.
- (b) Where grout thickness is more than 25mm: ± 15 mm.

2.12 PREPARATION PRIOR TO CONCRETE PLACEMENT

Before concrete is actually placed in position, the inside of the formwork shall be cleaned and mould oil applied, inserts and reinforcement shall be correctly positioned and securely held, necessary openings, pockets, etc. provided.

All arrangements-formwork, equipment and proposed procedure, shall be checked by Contractor. Contractor shall maintain separate Pour Card for each pour.

2.13 TRANSPORTING, PLACING AND COMPACTING CONCRETE

Concrete shall be transported from the mixing plant to the formwork with minimum time lapse by methods that shall maintain the required workability and will prevent segregation, loss of any ingredients or ingress of foreign matter or water.

In all cases concrete shall be deposited as nearly as practicable directly in its final position. To avoid segregation, concrete shall not be rehandled or caused to flow. For locations where direct placement is not possible and in narrow forms, Contractor shall provide suitable drops and "Elephant Trunks". Concrete shall not be dropped from a height of more than 1.5 m as stipulated in clause 9.13.

Concrete shall not be placed in flowing water. Under water concrete shall be placed in position by tremie or by pipeline from the mixer and shall never be allowed to fall freely through the water.

While placing concrete the Contractor shall proceed as specified below and also ensure the following:

- (a) Continuously between construction joints and predetermined abutments.

- (b) Without disturbance to forms or reinforcement.
- (c) Without disturbance to pipes, ducts, fixings and the like to be cast in; ensure that such items are securely fixed. Ensure that concrete cannot enter open ends of pipes and conduits, etc.
- (d) Without dropping in a manner that could cause segregation or shock.
- (e) In deep pours only when the concrete and formwork is designed for this purpose and by using suitable chutes or pipes.
- (f) Do not place if the workability is such that full compaction cannot be achieved.
- (g) Without disturbing the unsupported sides of excavations; prevent contamination of concrete with earth. Provide sheeting if necessary. In supported excavations, withdraw the linings progressively as concrete is placed.
- (h) If placed directly onto hardcore or any other porous material, dampen the surface to reduce loss of water from the concrete.
- (i) Ensure that there is no damage or displacement to sheet membranes.
- (j) Record the time and location of placing structural concrete.

Concrete shall normally be compacted in its final position within thirty minutes (Initial setting time) of leaving the mixer. Concrete shall be compacted during placing with approved vibrating equipment without causing segregation until it forms a solid mass free from voids, thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn slowly till air bubbles cease to come to the surface, leaving no voids. When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration, blending and melding of the concrete between successive layers. Vibrators shall not be allowed to come in contact with reinforcement, formwork and finished surfaces after start of initial set. Over-vibration leads to segregation and shall be avoided.

Concrete may be conveyed and placed by mechanically operated equipment after getting the complete procedure. The slump shall be held to the minimum necessary for conveying concrete by this method. When concrete is to be pumped, the concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

Contractor shall submit a method statement to Authority (if require) for approval, furnishing details of pour sequence, thickness of each layer, mixing and conveying equipments proposed etc. preferably with a sketch.

Except when placing with slip forms, each placement of concrete in multiple lift work shall be allowed to set for at least 24 hours after the final set of concrete before the start of subsequent placement. Placing shall stop when concrete reaches the top of the opening in walls or bottom surface of slab, in slab and beam construction, and it shall be resumed before concrete takes initial set but not until it has time to settle. Concrete shall be protected against damage until final acceptance.

2.14 PLACING OF CONCRETE BY PUMPING METHODS

i. General

Placing of concrete by pumping will be as specified to achieve the required speediness of construction and maintain targeted schedules.

Pumping of concrete shall be done only after conducting pumpability trials to ascertain the performance of fresh concrete on pumping. During pumping, concrete shall be conveyed either through rigid pipe or through flexible hose and discharged directly into the desired area. A steady supply of pumpable concrete is necessary for satisfactory pumping. Pumpable concrete requires properly graded aggregates, material uniformity, consistent batching and thorough mixing. Concrete pumps used shall be able to deliver concrete over a horizontal distance of about 400 m or of about 100 m in a vertical direction, (with intermediate figures for a combination of horizontal and vertical movements). They shall be used for concreting densely reinforced structures, internal structural elements of buildings and for large pours of concrete.

Placement of normal concrete by pumping will be permitted as specified The decision, whether or not to pump any particular mix shall rest entirely with the Authority (if require) and no extra claims for payment on this account will be entertained. The pumping equipment, pipe lines and accessories as well as proportioning of pumpable concrete shall generally confirm to the recommendations of ACI-304.2 (latest revision) – Placing of concrete by pumping method - Proportioning of pumpable mixes gives certain guide lines on concrete mix. However, final selection of mix shall be as decided by the Contractor.

ii. Pumping Equipment

Requisite numbers of modern dependable concrete pumps capable of pumping concrete of specified quality at a rate required to meet the construction schedules, together with a balanced complement of pipelines, accessories, spare parts, power controlled placing booms, and experienced pump operators and maintenance staff shall be provided at locations. The pumping plant shall be completely installed on each occasion, with preliminary mock operation for a sufficient length of time prior to scheduled placement of a particular concrete pour, to enable the Authority (if require) to conduct pumpability tests and necessary adjustments for the concrete mix (if require), prior to use of the pumping for placement of concrete.

iii. Type of Pump

The selection of the concrete pump shall be done as per the project requirement. The Contractor shall submit the concrete pump data sheets proving the suitability for the given project to Authority for information.

The concrete pump shall be selected on its best pumping capacity and the speediness to be achieved in the project. The piston pumps of a net horizontal pumping capacity of 30 m³/hr or 20 m³/hr or 15 m³/hr or 10 m³/hr can be utilised. The combination of various pumps to be used shall be decided by Contractor and shall submit the necessary documents and targeted progress to be achieved in line with the Time Period and Milestones.

These pumps shall have capacity to pump the concrete upto at a horizontal distance of 400 m and capable of generating a minimum pressure of 80 bar. These parameters shall depend upon the building sizes, manoeuvrability and other construction features. These pumps shall consist of a receiving hopper with a bolted grill at top of capacity not less than 600 litres. The hoppers shall be provided with hydraulically driven re-mixing blades or other agitating devices to keep the concrete mixed continuously and maintain consistency and uniformity. The pumps shall be provided with two cylinders with max. diameter not less than 150 mm, stroke of about 1200 mm and the number of strokes not exceeding 25 per minute. The outlet valves shall be located on the discharge lines. Type of inlet and outlet valves may vary depending on the manufacturer, but they shall preferably be of sliding-rod-flat-gate type. The piston shall be hydraulically driven. Primary power shall be supplied by gasoline, diesel or electric motor of requisite power rating. Care shall be taken by the Contractor to ensure uninterrupted operation of the pumps during the entire period of concreting by providing adequate standby

arrangements. The primary power and pump equipment shall be either truck or trailer mounted, and not skid mounted.

iv. Pipelines and Accessories

Rigid Pipelines

Concrete transported to the placement area by pumping methods shall be pumped thorough rigid pipes or a combination of rigid and heavy-duty flexible hoses. Rigid pipe shall be made available in minimum 125 mm diameter size. Aluminium alloy lines shall not be used for delivery of concrete. Rigid pipes shall be furnished in such lengths as can be manually handled by a single person.

Flexible Conduit (Hose)

Flexible conduit shall be made of rubber, or spirally wound flexible metal, and plastic flexible conduits generally present greater resistance to movement of concrete and their performance is not the same as that of a rigid pipe and also larger sizes (100 mm to 123 mm) have a tendency to leak. Flexible conduits provided, shall be interchangeable with rigid pipes and their use restricted to curves, difficult placement areas, and as connection to moving cranes or to water borne lines.

Couplings

The couplings provided to connect both flexible and rigid pipe sections shall be adequate in strength to withstand handling during erection of the pipe system, misalignments, and poor support along the lines. They should be nominally rated for at least 3.45 MPa and greater for rising over 30 m. The strength and tightness of joints shall be guaranteed. Couplings shall be designed to allow replacement of any pipe section without moving other pipe sections, and shall provide a full internal cross-section with no obstructions or crevices to disrupt the smooth flow of concrete.

Accessories

The pump and the distribution system for a particular concreting job shall use the accessories as listed below. Rigid and flexible pipes in varying lengths, such as 3, 1.5, 0.9, 0.6 and 0.3 m lengths.

- (a) Curved sections of rigid pipes such as large radius elbows at angles of 90 Deg, 45 Deg, 22 Deg 30 min. and 11 Deg 15 min.
- (b) Swivel joints and rotary distributors.

- (c) Pin and gate valves to prevent back-flow in the pipe line.
- (d) Switch valve to direct flow into another pipe line.
- (e) Connection devices to fill forms the bottom up.
- (f) Temporary supports, rollers and other devices for protection of conduit over rock, concrete, reinforcement, steel and forms. Lifting and leashing points.
- (g) Extra strong coupling for vertical runs in inaccessible areas.
- (h) Transition for connecting different sizes of pipes.
- (i) Air vents for downhill pumping.
- (j) Clean-out equipment.
- (k) Adequate numbers of separate placement booms of various radius and reach, either stationary steel column mounted or tower crane mast mounted moving on rail tracks, or truck mounted shall be provided by the Contractor to match within concrete placement schedule and pumps. For maximum flexibility of operation the separate placement boom shall be such that they can be easily lifted by the tower cranes provided. Their mounting arrangements shall be quick connecting type and interchangeable between tower crane masts, steel columns and truck mountings etc. The placement booms shall consist of three hinged parts incorporating a concrete pipe line with articulated inserts at boom joints and ending in a flexible hose. The boom shall be remote controlled.

v. The Pumping Plant and the Pipe Distribution System

The concrete pumping plant apart from the receiving hopper and the pump shall also be provided with a water pressure valve, connecting pipes with needle valve, cleaning rods, outlets for drainage water and a high pressure pumps for flushing out the concrete in pipe line.

The shortest way shall be selected in planning the direction of the concrete pipeline, and the number of bends (elbows) shall be as small as possible. Should a change be made of the direction in plan of the pipe lines or a change of their vertical profile, these shall be arranged with easy transitions.

Before the pipeline is assembled all pipe flanges shall be tested and carefully cleaned, packing rings cleaned or replaced, and the internal surfaces of all pipe section cleaned. Horizontal lengths of concrete pipe lines shall be laid on supports, wooden trestles, scaffolding, staging etc. Vertical and inclined

lengths of pipe shall be fastened by clamp irons or stirrups to masts, or to the frame of the structure being erected. It is recommended to replace vertical sections of the pipeline by inclined sections where possible. Sharp turns and bends at an angle of 90 deg. shall be avoided. Pipes shall be supported in such a manner that they do not disturb the forms during concreting.

A vertical section of the concrete pipeline shall not be arranged closer than 8 to 9 m from the concrete pump. Before a vertical section a valve shall normally be placed, to prevent back flow of the concrete when the pump stops or when the pipe is cleaned or replaced. When pumping vertically through the placer boom, a thrust block shall be provided at the base of the vertical riser to resist the forces in the pipeline due to the pumping of concrete.

When pumping downwards, 15 m or more, it is desirable to provide an air release valve at the middle of the top bend.

vi. Line Resistance and Lubrication

When concrete is pumped through a straight section of a pipe or hose, it moves as a cylinder riding on a thin lubricant film of a grout or mortar. At changes in direction or cross-section some re-mixing occurs. In all cases at the start of pumping operation lubricating mortar is required, and this shall be a properly designed mortar of cement-sand grout (1:1) or a batch of the regular concrete with the coarse aggregate omitted. Except for a small portion of this mortar which may be used for bedding at the construction joint, it shall be wasted and not used in the concrete placement. It can be assumed that about 0.35 cu. m of mortar will lubricate a 125 mm diameter horizontal pipeline of about 300 m length and the lubrication shall be maintained as long as the pumping continues. For vertical or smaller lines less mortar will be required. The mortar shall have the same cement content as that of the concrete. The water cement ratio shall be determined by the placing condition and finally decided by the Contractor. In order to ensure that only minimum quantity of grout mortar is used to lubricate the pipeline, a rubber sponge ball shall be allowed to pass through the pipeline immediately before the first batch of grout mortar is pumped. This rubber ball shall be pushed by the following mortar along the pipeline slowly and allowed to emerge at the open end. The cost of the lubricating mortar to be used, shall be deemed to have been included in the general rate structure for works in the schedule of items and nothing extra shall be payable.

It shall be taken into account when planning the pipeline that, in straight horizontal and vertical section of pipe and at bends the resistance to the movements of concrete differ. For convenience in calculating the resistance of a concrete pipeline experimental co-efficient of equivalent length shall be used by means of which the equivalent length of a horizontal concrete pipeline is to be obtained. In absence of the pump manufacturer's data, equivalent lengths of concrete pipeline as indicated in Table-8 may be used.

EQUIVALENT LENGTH OF CONCRETE PIPELINES

Characteristic of a length of concrete pipeline	Equivalent length of horizontal concrete pipeline in metre
Bend in pipeline at an angle of 90 Deg.	12
Bend in pipeline at an angle of 45 Deg.	7
Bend in pipeline at an angle of 22 Deg. 30 min.	4
1 m of vertical concrete pipeline	8

The equivalent length of the concrete pipeline must be less than or equal to the range of feed in horizontal direction as specified by the pump manufacturer for the same rate of pumping. To obtain the least line resistance, the layout of the pipeline system shall contain a minimum number of bends and preferably with no change in pipe size. If two sizes of pipes are required to be used, the smaller diameter shall be used at the pump end and the larger at the discharge end. The Contractor shall exercise care in handling of the pipeline, during assembly, cleaning and dismantling so as to lower the line resistance by preventing the formation of rough surfaces, dents in pipe section and crevices in couplings. If any pipe, bend, coupling and other accessories are considered to be defective or damaged by the Authority (if require), the same shall not be used in the concrete pipeline till such time the defect has been removed and the damage repaired. Qualified chemical admixtures shall be used effectively to get workable concrete.

vii. Proportioning Pumpable Concrete

Basic Consideration

Although the ingredients of concrete to be placed both by pumping and by other means are the same, more emphasis shall be laid on the quality control and proportioning of a dependable pumpable mix. Dependability is affected

by the equipment and the operator, with the control of all of the ingredients in the mixture, the batching and mixing operations, and the knowledge and experience of all the personnel from beginning to end.

Concrete mixes for pumping shall be “plastic” at all times. Stiff mixes shall not be used for pumping as they do not pump well. Particular attention shall be given to the mortar (cement, sand and water) and the amounts and sizes of coarse aggregates.

viii. Normal Weight Aggregates

Coarse Normal Weight Aggregates

The maximum size of angular coarse aggregate shall be limited to one-third of the smallest inside diameter of the hose or pipe based on simple geometry of cubical shape aggregates. For well-rounded aggregates, the maximum size shall be limited to 40% of the pipe or hose diameter. Adequate provisions shall be made to eliminate over size particles in the concrete by screening or by careful selection of aggregate. Gradation of sizes of coarse aggregates shall correspond to Grades A and B of Table-9 and shall meet IS: 2386 requirements. If required, certain fractional sizes shall be combined and blended to produce the required gradation. Greater emphasis shall be laid on uniformity of gradation throughout the entire job.

The maximum size of the coarse aggregate has a significant effect on the volume or amount of coarse aggregate that may be effectively used in a mix. As will be seen from Table-10 the quantity of coarse aggregate must be substantially reduced as the maximum size become smaller. Mixes consisting of too large a portion of coarse aggregate with less cement shall be avoided.

Grading Requirement of Coarse Aggregates for Pumped Concrete

Grade – A (Maximum Size 40 mm) Grade – B (Maximum Size 20 mm)

Sieve Size	Percent Passing By Weight	Sieve Size	Percent Passing By Weight
50 mm	100	25 mm	100
40 mm	95 to 100	20 mm	90 to 100
20 mm	35 to 70	12.50 mm	20 to 55

10 mm	10 to 30	10 mm	0 to 15
4.75 mm	0 to 5	4.75 mm	0 to 5

Table-10

Volume of Coarse Aggregate per unit of Volume of Concrete

Grade – A (Maximum Size 40 mm) **Grade – B** (Maximum Size 20 mm)

Maximum Size	Volume of Dry-rodded Coarse Aggregate per Unit Volume of Aggregates of Concrete for different fineness modulii of sand			
	FMS = 2.40	FMS = 2.60	FMS = 2.80	FMS = 3.00
10	0.50	0.48	0.46	0.44
12.50	0.59	0.57	0.55	0.53
20	0.66	0.64	0.62	0.60
25	0.71	0.69	0.67	0.65
40	0.76	0.74	0.72	0.70
50	0.78	0.76	0.74	0.72

Note:

- Volumes are based on aggregates in dry-rodded condition.
- These volumes are selected from empirical relationships to produce concrete with a degree of workability suitable for usual reinforced construction. When placement is to be by pump, they shall be reduced by about 10 percent.
- FMS = Fineness Modulus of Sand.

Fine Normal Weight Aggregate

Fine aggregate shall consist of natural sand, manufactured sand or a combination thereof and shall be graded within the following limits.

Sieve Size	Percent passing by Weight
9.50 mm	100
4.75 mm	95 to 100
2.36 mm	80 to 100

1.18 mm	50 to 85
600 microns	25 to 60
300 microns	10 to 30
150 microns	2 to 10

Fine aggregates shall conform to the requirements of IS: 2386. Particular attention shall be given to those passing through finer screen sizes. For small line system (less than 150 mm) 15 to 30 percent shall pass 300 micron sieve and 5 to 10 percent shall pass 150 micron sieve. Sands which are deficient in either of these two sizes shall be blended with selected finer sands or inert material such as quarry dust to produce these desired percentages.

The fineness modulus of sand meeting the above grading limits will fall between 2.13 and 3.37 with the median being 2.75. Pumpability of mixes will generally improve with a decrease in the fineness modulus value or in other words with the use of finer sands. Sands having a fineness modulus between 2.40 and 3.00 are generally satisfactory provided that the percentages passing 300 micron and 150 micron sieves meet the previously stated requirements. It shall also be emphasised that for uniformity, the fineness modulus of the sand shall not vary more than 0.20 from the average value used in proportioning.

Table-10 is suggested as a guide to determine the amounts of coarse aggregate to be combined with sand of different fineness modulus. The foot note of Table-10 requires a reduction in the volume of coarse aggregate by 10 percent for pumping. This margin shall be considered as a safety margin for variations in sand gradation to reduce pumping pressure. Under conditions of good materials control and uncomplicated line systems, this reduction may not be required.

Although in practice it may not be possible to duplicate this recommended sand gradation exactly, sands having a gradation closer to the upper limit (fine sand) are more desirable for pumping than those near the lower limit (coarse sand). The fineness modulus of sand according to the recommended curve is 2.68 and the gradation meets all the requirements stated earlier.

ix. Water and Slump

Water requirements and slump control for pumpable normal weight concrete are interrelated and extremely important considerations. The mixing water

requirements for a particular mix shall be determined by the Contractor and modified to suit the fineness of sands, quality of admixtures, additives, cement replacements or other special materials being used in the concrete.

The Contractor shall establish the optimum slump for a pumpable mix at the discharge hose end and shall maintain control of that particular slump throughout the course of a job. Excess water shall not be added in the receiving hopper to make the concrete mix pumpable; instead attempt shall be made to obtain 'truly plastic mix' by proper proportioning.

Slump of concrete may undergo change between initial mixing and final placement. If the slump at the discharge hose end is to be maintained within specified limits, it will be necessary for the concrete to enter the pump at a higher slump to give the required mobility during transport. Slump adjustments by re-proportioning of the constituents as may be required shall be carried out by the Contractor for every type of mix and for every new placement and set up of pump and pipelines.

x. Cement Content

The determination of the cement content for a normal weight pump mix shall follow the same basic principles used for conventionally placed concrete. The water cement ratio shall be established by the Contractor on the basis of exposure conditions, strength requirements or minimum cement consumption, whichever governs. However, because of slightly higher ranges of slump and ratios of fine to coarse aggregates, the pump mix may require an increase in the amount of cement above those pumpable concrete mass. The total quantity of fines passing through the 300 micron sieve including cement, fine sand, stone dust etc. shall be in the range of 380 to 450 kg/cum of concrete.

Cement content in case of M50 shall be maximum 425 kg/cum, and shall be a mix with high range of workability i.e. 175 mm +/- 25 mm. All the contents shall be mixed based on the mix design and trial studies.

While establishing the cement content for normal weight trial mixes, it will be necessary to take into account the capabilities of the particular pump and its operator for over strength proportioning in the laboratory to provide for field variations.

In case of pumping difficulties, it is desirable and economical to correct any deficiencies in the aggregates, especially in the sand instead of using extra quantities of sand. With well graded coarse and fine aggregates properly

combined, the cement requirement for pumpable mixes shall closely resemble to those used in conventionally placed concrete.

xi. Admixtures

The use of poor aggregate grading or aggregate with continuous change in overall grading of the 'combinations' during concreting operation will make special admixtures quite useful in overcoming the main difficulty like blockage in pumping. These admixtures shall be incorporated in pumpable concrete to aim the following.

- (a) Increase in the range of mix designs which may be successfully pumped using water reducing admixtures/ super plasticisers.
- (b) Reducing the risk of pipeline blockages by preventing segregation of concrete mix.
- (c) To have satisfactory/ specified performance both in fresh and hardened state.

Any admixture that increases workability in normal weight concrete may usually improve pumpability. The choice of type of admixture and the advantage gained from its use in concrete to be pumped will depend on the characteristics of the pump mix and will be finally decided by the Contractor in consultation with the admixture manufacturer.

For improvement of pumpability the following admixtures are generally recommended. Such admixtures used shall be conforming to ASTM C-494/ IS: 9103:

(a) Water Reducing Admixtures/ Super Plasticisers

These cause reduction in water requirements at constant slump or an increase in slump at constant water-cement ratio. They can be designed to have no apparent effect on setting time, or alternately to achieve varying degrees of acceleration or retardation in rate of hardening of the mixture. Most water reducing admixtures increase the pumpability of the concrete mix through plasticising action.

(b) Air Entraining Admixtures

Air entrained concrete is considerably plastic and more workable than non air entrained concrete. It can be pumped with less coarse aggregate segregation and has less tendency for concrete to bleed. Start-up after shut down is also generally easier due to reduced bleeding. For pumped concrete these limits shall be obtained at the

point of placement in the structure. To compensate for air content loss in the air entrained concrete higher entrainment of air may be required at the batching plant. The required adjustment of admixture dose shall be carried out by the Contractor after carrying out necessary air loss tests. An air content in the range of 3 to 5% shall be preferred as higher ranges reduces the delivery capacity of pump systems due to increased compressibility of the concrete and also reduces strength of concrete.

If air-entraining plasticizer is used, typically 13% minimum water reduction is possible. Therefore, strength loss due to air entrainment will be compensated by using such air-entraining plasticizer.

(c) Finely Divided Mineral Admixtures

Contractor, can use mineral admixture. In concrete mixtures, deficient in fines, the addition of a finely divided inert mineral admixture generally improves workability, pumpability, reduces the amount of bleeding and increases the strength. The effect on strength depends on the type of mineral admixture used, conditions under which the concrete is cured, and the amount of admixture used. Water soluble polymers obtained from cellulose derivations may also be used as an admixture with a small dose of 60 to 150 gms/cum to increase viscosity of the mixing water and reduce the frictional resistance to flow and bleeding in the pipe system.

xii. Trial Mixes

The trial mixes for pumping shall be prepared and tested in the Site laboratory by Contractor in accordance with clause 17.7 of this specification. The ingredients, particularly the coarse and fine aggregates shall also be checked for the conformance to the desired properties described, by the Contractor. Table-10 may be used to select the volume of coarse aggregate per cu. m. of concrete. In using this table it is recommended that the highest probable fineness modulus of sand be used rather than the average fineness modulus to ensure consistent performance during pumping. For additional plasticity, 10% reduction in coarse aggregate quantities shall be considered. Experience with the use of local aggregate and their uniformity shall also be considered in the proportioning concepts.

xiii. Mix Design for Pumpable Concrete

Taking the above factors into account, the concrete shall first be designed for normal placement conditions and then modified as necessary to suit pumping. The following procedure shall be adopted:

- (a) Design the mix for specified characteristic strength and workability.
- (b) Check and ensure combined grading of aggregates i.e. as uniform grading as possible. This requirement is vital as gaps or partial gaps are the basic reasons for poor water retention property and segregation under pressure.
- (c) Determine the optimum sand content for the required workability and increase sand content by reducing volume of coarse aggregate per unit volume of concrete by about 10% as a degree of protection against under sanding due to batch variations.
- (d) Recheck the minimum cement content for durability.
- (e) Examine the total fines content i.e. cement and fine aggregates passing through 300 micron sieve and readjust the mix, if necessary. A very rich mix with fine sand will be as problematic as a coarse sand with lean mix.
- (f) Re-appraise the grading if the particle shape of any particular fraction is such as may cause excessive voids. Re-adjust as required, if necessary examining the void ratio of various combinations, using void meter to achieve minimum voids at the expense of 'sufficient fines' content.
- (g) If dissatisfied with (a) to (f) as above, consider what remedial action may be taken to overcome the troublesome factor. For example, the following two situations may occur :
- (h) If the sand has more coarser fraction it is worth considering the addition of a proportion of finer sand, or alternately if the sand has more of finer fraction, the addition of coarse fraction may be considered. Addition or reduction of cement may help, but the correct solution is to overcome the gap in overall grading as stated above.
- (i) In a 20 mm aggregate maximum size, if there is an excess of 10 to 4.75 mm fraction, and this fraction is flaky with unduly large surface area, either increase the sand content to reduce the possibility of segregation and to reduce the inter-practical stresses, or (better) re-grade using single sized aggregates.

- (j) At the trial mix stage small variations can be made preferably in the light of the pressures registered and observed performances through the pump. In certain cases admixtures may be economically and beneficially used to improve or eliminate circumstances that cannot readily be overcome by other means.

xiv. Testing For Pumpability

No mix shall be accepted for use on a pumping job until an actual test under field condition has been completed. Testing a mix for pumpability involves duplication of the anticipated job condition from beginning to end. The batching and conveying by truck mixers shall be the same as will be used; the same pump and operator shall be present. The pipe and hose layouts shall simulate the actual condition as far as practicable. Prior use of a mix on another job may furnish evidence of pumpability but only if conditions are duplicated. Before commencing a new concreting job, the Contractor shall carry out pumpability tests. Concrete used in such tests shall not be used in the actual construction.

Following parameter shall be established by pumpability trials:

- (a) In-situ compressive and split tensile strength of concrete by.
- (b) Curing the sample at Site by sprinkling water.
- (c) Curing the sample at Laboratory in curing tanks.
- (d) Wet sieve analysis of concrete to ensure that proportions of ingredients before and after pumping are same.

xv. Field Practices

Proper planning of concrete supply, pump location, line layout, placing sequence and the entire pumping operation shall be done by the Contractor. The pump shall be as near the placing area as practicable, and the entire surrounding area must have adequate bearing strength to support the concrete delivery trucks, thus assuring a continuous supply of concrete. For important concrete placements and large jobs, adequate standby power and pumping equipment shall be provided as replacement, should break down occur.

Direct communications shall be maintained between the pump operator, concrete placing crew and batching plant. The placing rate shall be estimated so that concrete can be operated at an appropriate delivery rate. As a final check, the pump shall be started and operated without concrete to ascertain

that, all moving parts are operating properly. As stated previously, the grout mortar shall be pumped into the line to provide initial lubrication for the concrete. As soon as concrete is received, the pump shall be run slowly until the lines are completely full and the concrete is slowly moving. Once the pumping is started, the operator shall ensure that the hopper of the pump is not emptied beyond a certain level, as air may enter the pipeline and cause choking. Continuous pumping should be ensured. If a delay occurs because of concrete delivery, form repairs, or other factors, the pump shall be slowed down to maintain some movement of the concrete till normal supply is resumed. For longer delays, the concrete in the receiving hopper shall be made to last as long as possible by moving the concrete in the lines occasionally with one stroke of the pump. In confined areas, attempt shall be made by the Contractor to run a return line back to the pump, so that concrete can be re-circulated during delays.

The Contractor shall ensure that obstructions are not found in the pipe due to interruption in the feed of the concrete by more than 30 to 45 minutes.

Minor blockages shall be cleared by operating a few strokes of the pump in reverse momentarily and then by returning to normal forward pumping. If this fails, a succession of reverse and forward strokes shall be carried out to remove the blockage. Should this fail also, the blockage may be due to air-lock and the entrapped air has to be removed.

Attempt to push through the obstructions by repeatedly starting the pump will result in compaction of the concrete and complicate the removal of the concrete in the pipe. Blockages in the pipe are usually discovered by the sound when the pipe is struck. To remove the obstruction, the concrete pipe shall be taken apart at the assured position and cleaned. Then the pumping process shall be started all over again.

This method of checking the blockage and setting it right shall be done with great speed as excessive delay will cause setting of concrete in the pipeline downstream of the choke and will lead to further blockage. When the blockage is being found out and remedied, the pump shall periodically be given one or two strokes forward to keep the concrete in motion. If blockage occurs in the placer boom, a pipe joint near the base of the placer boom shall be opened and the boom made vertical to drain the pipeline by gravity.

Cleaning blockages are time consuming and as such major blockages shall best be avoided by ensuring a pumpable mix. Concrete that is either under or

over sanded, short of fines, gap graded, has an excess of a particular size, or excessively wet or dry will be rejected by the pump either by blockage or by hard pumping involving excessive pressures.

The termination of pumping operations shall be carefully planned to utilize the concrete dormant in the pipeline and the hopper when the pump is stopped and to avoid wastage.

When the form is nearly full, and there is enough concrete in the line to complete the placement, the pump shall be stopped and a go-devil be inserted and forced through the line to clear it out. Water under pressure shall be used to push the go-devil. The go-devil shall be stopped about one metre from the end of the line, so that the water in the line will not spill over into the placement area. After flushing, water in the pipe shall be removed by drain cock which shall be located for this purpose in the lowest part of the line. After all concrete has been removed from the lines, all lines and equipment shall be immediately cleaned thoroughly.

xvi. Quality Control

Contractor shall ensure that workmanship and plant shall be maintained at peak efficiency. Degree of control on all the concrete operation from selection of the ingredients to the final testing of specimen shall be in line with the assumptions made in mix design with respect to the standard deviation and co-efficient of variation.

The Contractor shall ensure that any compromise in quality is not done for the pumped concrete. To be pumpable, a high level of quality control for the assurance of uniformity must be maintained. Sampling at both the truck discharges and point of final placement shall be done by the Contractor and desires to determine, if any change in the slump air content, and other significant mix characteristics occur take necessary corrective actions.

The Contractor shall engage experienced supervision at all levels. The placing crew shall be experienced and qualified and each operation shall be well planned and properly scheduled.

All the crew engaged in each of the concrete activities shall demonstrate in the presence of the Authority (if require), their skills and capabilities to produce the final product as specified.

2.15 MASS CONCRETE WORKS

Sequence of pouring for mass concrete works shall be done by Contractor. Contractor shall exercise great care to prevent shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

2.16 PLACING TEMPERATURE OF CONCRETE

Placing temperature of concrete should be maintained as specified in Bill of Quantities, to avoid shrinkage cracking.

Mixing water shall be kept cool by storing it under cover. Chilled water or crushed ice as part of the mixing water to achieve the specified placing temperature shall be used. For chilled water, it is recommended that the Contractor install and maintain refrigeration facility of required capacity. The Contractor shall also build and maintain well insulated adequate capacity storage tank for cold water with insulated connected piping. To supplement this refrigeration facility, the Contractor will have to have ice plant or use commercial ice. subject The full quantity of crushed ice shall be stored in cold storage 24 hours in advance of the start of concreting. The temperature in cold storage shall not be more than -2°C . The Contractor should study the placing temperature condition and work out plant capacity commensurate with the construction schedule requirements and submit his scheme along with the tender.

Ice when used as replacement for a portion or all the mixing water shall be produced from water which meets the requirements of clause vi. Ice when used shall be in flakes of size 3 mm or below or crushed condition and the crushed ice shall be such as to pass completely, 10 mm sieve.

2.17 CURING

Curing and protection shall start immediately after the compaction of the concrete to protect it from:

- (a) Premature drying out, particularly by solar radiation and wind;
- (b) leaching out by rain and flowing water;
- (c) rapid cooling during the first few days after placing;
- (d) high internal thermal gradients;
- (e) low temperature or frost;
- (f) Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

All concrete, shall be cured by use of continuous sprays or ponded water or continuously saturated coverings of sacking, canvas, hessian or other

absorbent material for the period of complete hydration with a minimum of 7 days. The quality of curing water shall be the same as that used for mixing.

Where a curing membrane is to be used by the Contractor, the same shall be of a non-wax base and shall not impair the concrete finish in any manner. The curing compound to be used shall be got approved from the Authority (if require) before use and shall be applied with spraying equipment capable of a smooth, even textured coat.

Curing may also be done by covering the surface with an impermeable material such as polyethylene, which shall be well sealed and fastened.

Extra precautions shall be exercised in curing concrete during cold and hot weather as per Clause no. 8.3 of IS: 7861 (Part II) and Clause no. 8.2 of IS: 7861 (Part I) respectively.

Curing arrangement shall be subjected done by Contractor.

2.18 CONSTRUCTION JOINTS AND KEYS

Construction joints (location and type) shall be as shown on the drawing. Concrete shall be placed without interruption until completion of work between construction joints. If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made by the Contractor. Dowels for concrete work, not likely to be taken up in the near future, shall be coated with cement slurry and encased in lean concrete as indicated on the drawings.

Before resuming concreting on a surface which has hardened all laitance and loose aggregates shall be thoroughly removed by wire brushing and/ or hacking, the surface washed with high pressure water jet and treated with thin layer of cement slurry for vertical joints and a 15 mm thick layer of cement sand mortar for horizontal joints, the ratio of cement and sand being the same as in the concrete mix.

When concreting is to be resumed on a surface, which has not fully hardened, all laitance shall be removed by wire brushing, the surface wetted, free water removed and a coat of cement slurry applied. On this a layer of concrete not exceeding 150 mm thickness shall be placed and well rammed against the old work. Thereafter work shall proceed in the normal way.

Approved epoxy Bonding agent, for bond between old (say 28 days or more) and new concrete may also be used as per manufacturer's specifications.

2.19 FOUNDATION BEDDING

All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft or spongy area shall be cleaned out and back filled with either soil-cement mixture, lean concrete or clean sand compacted by Contractor. The surfaces of absorptive soils shall be moistened.

Concrete shall not be deposited on large sloping rock surfaces. The rock shall be cut to form rough steps or benches by picking, barring or wedging. The **rock surface shall be kept wet for 2 to 4 hours before concreting.**

2.20 BASE CONCRETE

The thickness and grade of concrete and reinforcement shall be as specified in the item of work.

Before placing the blinding concrete of 1:4:8 mix, 50/75mm thick as per the item of work, the sub-base of rubble packing shall be properly wetted and rammed. Concrete for the base shall then be deposited between the forms, thoroughly tamped and the surface finished level with the top edges of the forms. Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surface of the base concrete shall be left rough to provide adequate bond for the floor finish to be provided later.

Measurement

Measurement shall be in sqm correct to two places of decimal. This work could be either separate or combined along with the floor finish as indicated in the respective items of work.

2.21 FINISHES

General

The formwork for concrete works shall be such as to give the finish as specified. The Contractor shall make good as directed any unavoidable defects consistent with the type of concrete and finish specified; defects due to bad workmanship (e.g. damaged or misaligned forms, defective or poorly compacted concrete) will not be accepted. Contractor shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

Integral Cement Finish On Concrete Floor

In all cases where integral cement finish on a concrete floor has been specified, the top layer of concrete shall be screeded off to proper level and tamped with tamper having conical projections so that the aggregate shall be forced below the surface. The surface shall be finished with a wooden float and a trowel with pressure. The finish shall be continued till the concrete reaches its initial set. No cement or cement mortar finish shall be provided on the surface. Where specified, a floor hardener of appropriate thickness shall be supplied and used as recommended by the manufacturer.

2.22 REPAIR AND REPLACEMENT OF UNSATISFACTORY CONCRETE

Immediately after the shuttering is removed, all the defective areas such as honeycombed surfaces, rough patches, etc. shall be brought to the notice of Authority who may permit patching of the defective areas or reject the concrete work. Authority's decision on rejection of concrete work shall be final.

All through holes for shuttering shall be filled with cement mortar for full depth and neatly plugged flush with surface.

Rejected concrete shall be removed and replaced by Contractor at no additional cost to Authority.

For patching of defective areas all loose materials shall be removed and the surface shall be prepared as per requirement.

Bonding between hardened and fresh concrete shall be done either by placing cement mortar or by applying epoxy. The decision of the Authority as to be the method of repairs to be adopted shall be final and binding on the Contractor and no extra claim shall be entertained on this account. The surface shall be saturated with water for 24 hours before patching is done with 1:5 cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out by Contractor.

Contractor shall submit a method statement for such repairs.

2.23 VACUUM DEWATERING OF SLABS

Where specified floor slabs, either on grade or suspended, shall be finished by vacuum dewatering including all operations such as poker vibration, surface vibration, vacuum processing, floating and trowelling as per equipment manufacturer's recommendation.

2.24 HOT WEATHER REQUIREMENT

- a. Concreting during hot weather shall be carried out as per IS: 7861 (Part I).
- b. Adequate provisions shall be made to lower concrete temperatures which shall not exceed 40^o C at the time of placement of fresh concrete.
- c. Contractor shall spray non-wax based curing compound on unformed concrete surface at no extra costs.

2.25 COLD WEATHER REQUIREMENTS

- a. Concreting during cold weather shall be carried out as per IS: 7861 (PART 2).
- b. The ambient temperature during placement and upto final set shall not fall below 5^o C. Approved anti-freeze/ accelerating additive shall be used where directed.

For major and large scale concreting works the temperature of concrete at times of mixing and placing, the thermal conductivity of the formwork and its insulation and stripping period shall be closely monitored.

2.26 LIQUID RETAINING STRUCTURES

The Contractor shall take special care for concrete of liquid retaining structures, underground structures and those other specifically called for to guarantee the finish and water tightness.

The minimum level of surface finish for liquid retaining structures shall be of smooth type. All such structures shall be hydro-tested.

The Contractor shall include in his price hydro-testing of structure, all arrangements for testing such as temporary bulk heads, pressure gauges, pumps, pipe lines, etc.

Any temporary arrangements that may have to be made to ensure stability of the structures shall also be considered to have been taken into account while quoting the rates.

Any leakage that may occur during the hydro-test or subsequently during the defects liability period or the period for which the structure is guaranteed shall be effectively stopped either by cement/epoxy pressure grouting, guniting or such other method as may be used. All such rectification shall be done by the Contractor at no extra cost to the Authority.

2.27 TESTING CONCRETE STRUCTURES FOR LEAKAGE

Hydro-static test for water tightness shall be done at full storage level or soffit of cover slab, as described below:

In case of structures whose external faces are exposed, such as elevated tanks, the requirements of the test shall be deemed to be satisfied if the external faces show no sign of leakage or sweating and remain completely dry during the period of observation of seven days after allowing a seven day period for absorption after filling with water.

In the case of structures whose external faces are submerged and are not accessible for inspection, such as underground tanks, the structures shall be filled with water and after the expiry of seven days after the filling, the level of the surface of the water shall be recorded. The level of water shall be recorded again at subsequent intervals of 24 hours over period of seven days. Backfilling shall be withheld till the tanks are tested. The total drop in surface level over a period for seven days shall be taken as an indication of the water tightness of the structure. The Contractor shall decide on the actual permissible nature of this drop in the surface level, taking into account whether the structures are open or closed and the corresponding effect it has on evaporation losses. Unless specified otherwise, a structure whose top is covered shall be deemed to be water tight if the total drop in the surface level over a period of seven days does not exceed 40 mm.

Each compartment/ segment of the structure shall be tested individually and then all together.

For structures such as pipes, tunnels, etc. the hydrostatic test shall be carried out by filling with water, after curing as specified, and subjecting to the specified test pressure for specified period. If during this period the loss of water does not exceed the equivalent of the specified rate, the structure shall be considered to have successfully passed the test.

2.28 OPTIONAL TESTS

If Authority feels that the materials i.e. cement, sand, coarse aggregates, reinforcement and water are not in accordance with the specifications or if specified concrete strengths are not obtained, he may order tests to be carried out on these materials in laboratory, as per relevant IS Codes. Authority shall pay only for the testing of material supplied by the Contractor, otherwise Contractor shall have to pay for the tests. Transporting of all material to the laboratory shall however be done by the Contractor at no extra cost to Authority.

In the event of any work being suspected of faulty material or workmanship requiring its removal or if the works cubes do not give the stipulated strength,

Authority reserves the right to order the Contractor to take out cores and conduct tests on them or do ultrasonic testing or load testing of structure, as per relevant IS specifications. All these tests shall be carried out by Contractor at no extra cost to the Authority. Alternately Authority also reserves the right to ask the Contractor to dismantle and re-do such unacceptable work at the cost of Contractor.

If the structure is certified by Authority as having failed, the cost of the test and subsequent dismantling/reconstruction shall be borne by Contractor.

The quoted unit rates/prices of concrete shall deemed to provide for all tests mentioned above.

2.29 GROUTING

For details of grouting, refer Specification clause 4 – Grouting.

2.30 QUALITY CONTROL

PMC Limited have over the years developed in house quality control formats for concrete works. Contractor shall note that it is required to adopt all such formats. A copy of formats shall be furnished to Contractor by PMC/ Authority after the contract is awarded.

Alternatively, if Contractor has his own QC formats he may adopt them subjected to such modifications considered necessary by PMC.

In either case Contractor shall submit his detailed Quality Assurance Plan along with the bid. This would be reviewed, appropriately modified and approved by PMC after the award of contract.

2.31 INSPECTION

All materials, workmanship and finished construction shall be subject to continuous inspection. Materials rejected by Authority shall be expressly removed from site within 3 working days and shall be replaced by Contractor immediately at no extra cost to Authority.

2.32 CLEAN-UP

Upon the completion of concrete work, all forms, equipment, construction tools, protective coverings and any debris, scraps of wood, etc. resulting from the work shall be removed and the premises left clean.

2.33 ACCEPTANCE CRITERIA

Any concrete work shall satisfy the requirements given below individually and collectively for it to be acceptable.

- (a) properties of constituent materials;
- (b) characteristic compressive strength;
- (c) specified mix proportions;
- (d) minimum cement content;
- (e) maximum free-water/cement ratio;
- (f) workability;
- (g) temperature of fresh concrete;
- (h) density of fully compacted concrete;
- (i) cover to embedded steel;
- (j) curing;
- (k) tolerances in dimensions;
- (l) tolerances in levels;
- (m) durability;
- (n) surface finishes;
- (o) special requirements such as :
 - i. Water tightness
 - ii. resistance to aggressive chemicals
 - iii. resistance to freezing and thawing
 - iv. very high strength
 - v. improved fire resistance
 - vi. wear resistance
 - vii. resistance to early thermal cracking

Authority's decision as to the acceptability or otherwise of any concrete work shall be final and binding on the Contractor.

For work not accepted, Authority (if require) may review and decide whether remedial measures are feasible so as to render the work acceptable. Authority shall in that case direct the Contractor to undertake the remedial measures. These shall be expeditiously and effectively implemented by Contractor. Nothing extra shall become payable to Contractor by Authority for executing remedial measures.

3.0 FORMWORK

3.1 SCOPE

This specification covers the general requirements for formwork. This specification shall be read in conjunction with Specification of Reinforced concrete and allied works. It shall be very clearly understood that the specifications given herein are brief and do not cover minute details. However, all works shall have to be carried out in accordance with the relevant standards and codes of practices or in their absence in accordance with the best accepted current engineering practices. The decision of Authority/PMC (if require) as regards the specification to be adopted and their interpretation and the mode of execution of work shall be final and binding on Contractor and no claim whatsoever will be entertained on this account.

3.2 APPLICABLE CODES AND SPECIFICATIONS

The following specifications, standards and codes, including all official amendments/ revisions and other specifications and codes referred to therein, should be considered a part of this specification. In all cases the latest issue/ edition/ revision shall apply. In case of discrepancy between this specification and those referred to herein below or other specifications forming a part of this bid document, this specification shall govern.

Codes of Practice

- | | | |
|----|---------------------------|--|
| a) | IS: 303 | Specification for plywood for general purpose |
| b) | IS: 456 | Code of practice for plain and reinforced concrete. |
| c) | IS:1200
(Part 1 to 12) | Method of measurement of building and engineering works
(Parts 2 and 5). |
| d) | IS: 2750 | Specifications for steel scaffoldings. |
| e) | IS:3370 | Code of practice for concrete structures for storage of liquids
(Parts 1 to 4). |
| f) | IS: 3696 | Safety code for scaffolds and ladders (Parts 1 & 2). |
| g) | IS: 4014 | Code of practice for steel tubular scaffolding. (Parts 1 & 2). |
| h) | IS: 4082 | Recommendations on stacking and storing of construction materials at site. |
| i) | IS: 4900 | Specification for plywood for concrete shuttering work. |
| j) | IS: 7969 | Safety code for handling and storage of building materials. |

- c) IS: 8989 Safety code for erection of concrete framed structures.

3.3 GENERAL

Authority/PMC shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials and the quality control system. Such an inspection shall be arranged and Authority/PMC's approval obtained (if require), prior to starting of concrete work. This shall, however, not relieve the Contractor of any of his responsibilities. All materials, which do not conform to this specification, shall be rejected.

Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due regards to the functional requirements and the environmental conditions to which the structure will be subjected. Materials complying with codes/ standards shall only be used. Other materials may be used after approval of the Authority/PMC (if require) and after establishing their performance suitability based on previous data, experience or tests.

3.4 MATERIALS

Storing Of Materials

All material shall be stored in a manner so as to prevent its deterioration and contamination, which would preclude its use in the works. Requirements of IS: 4082 shall be complied with.

Contractor will have to make his own arrangements for the storage of adequate quantity of formwork/ shuttering material

3.5 FORMWORK

Formwork shall be all inclusive and shall consist of but not limited to shores, bracings, sides of footings, walls, beams and columns, bottom of slabs, etc. including ties, anchors, hangers, inserts, falsework, wedges, etc.

The design and engineering of the formwork as well as its construction shall be the responsibility of Contractor. However, if so directed by Authority/PMC, the drawings and calculations for the design of the formwork shall be submitted to Authority/PMC for approval (if require).

Formwork shall be designed to fulfil the following requirements:

- a) Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and appropriate to the methods of placing and compacting.

- b) Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.
- c) Capable of withstanding without deflection the worst combination of self weight, reinforcement and concrete weight, all loads and dynamic effects arising from construction and compacting activities, wind and weather forces.
- d) Capable of easily striking without shock, disturbance or damage to the concrete.
- e) Soffit forms capable of imparting a camber, if required.
- f) Soffit forms and supports capable of being left in position, if required.
- g) Capable of being cleaned and/ or coated, if necessary, immediately prior to casting the concrete; design temporary openings where necessary for these purposes and to facilitate the preparation of construction joints.

The formwork may be of lined timber, waterproof/ plastic coated plywood, steel, plastic depending upon the type of finish specified. Sliding forms and slip form may be used with the approval of Authority/PMC (if require). Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps and other surface defects. Joints between formwork and formwork and between formwork and structure shall be sufficiently tight to prevent loss of slurry from concrete using foam and rubber seals.

The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before fixing reinforcement. All rubbish, particularly chippings, shavings, sawdust, wire pieces, dust, etc. shall be removed from the interior of the forms before the concrete is placed. Where directed, cleaning of forms shall be done by blasting with a jet of compressed air at no extra cost.

Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced. Contractor shall equip himself with enough quantity of shuttering to allow for wastage so as to complete the job in time.

Permanent formwork shall be checked for its durability and compatibility with adjoining concrete before it is used in the structure. It shall be properly anchored to the concrete.

Wire ties passing through beams, columns and walls shall not be allowed. In their place bolts passing through sleeves may be used. Formwork spacers left in situ shall not impair the desired appearance or durability of the structure by causing spalling, rust staining or allowing the passage of moisture.

For liquid retaining structures sleeves shall not be provided for through bolts nor shall through bolts be removed, if provided. The bolts, in the latter case, shall be cut at 25 mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.

Where specified or shown on drawings all corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm x 20 mm size.

Forms for substructure may be omitted when, in the opinion of Authority/PMC (if require), the open excavation is firm enough (in hard non-porous soils) to act as a form. Such excavation shall be slightly larger, than that required as per drawing to compensate for irregularities in excavation.

Contractor shall provide adequate props of adjustable steel pipes carried down to a firm bearing without overloading any of the structures.

The shuttering for beams and slabs shall be so erected that the side shuttering of beams can be removed without disturbing the bottom shuttering. If the shuttering for a column is erected for the full height of the column, one side shall be built up in sections as placing of concrete proceeds or windows left for placing concrete from the side to limit the drop of concrete to 1.5 m. Contractor shall temporarily and securely fix items to be cast (embedment/ inserts) in a manner that will not hinder the striking of forms or permit loss of grout.

Formwork showing excessive distortion, during any stage of construction, shall be removed. Placed concrete affected by faulty formwork, shall be entirely removed and formwork corrected prior to placement of new concrete at Contractor's cost.

The striking time for formwork shall be determined based on the following requirements:

- (a) Development of adequate concrete strength;
- (b) Permissible deflection at time of striking form work;
- (c) Curing procedure employed - its efficiency and effectiveness;
- (d) Subsequent surface treatment to be done;

- (e) Prevention of thermal cracking at re-entrant angles;
- (f) Ambient temperatures; and Aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete).

Before removing formwork of soffit of slabs/ beams compressive strength at 7/ 14/ 21 days shall be checked.

Under normal circumstances (generally where temperatures are above 20 Deg C) forms may be struck after expiry of the period given in IS: 456. For Portland Pozzolana / Slag Cement the stripping time shall be suitably modified. It is the Contractor's responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not undergo excessive deformation and resists surface damage and any stresses arising during the construction period.

I. Finishes

a. General

The formwork for concrete works shall be such as to give the finish as specified. The Contractor shall make good any unavoidable defects as approved consistent with the type of concrete and finish specified; defects due to bad workmanship (e.g. damaged or misaligned forms, defective or poorly compacted concrete) will not be accepted. The Contractor shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

b. Surface Finish Type F1

The main requirement is that of dense, well compacted concrete. No treatment is required except repair of defective areas, filling all form tie holes and cleaning up of loose or adhering debris. For surfaces below grade which will receive waterproofing treatment the concrete shall be free of surface irregularities which would interfere with proper and effective application of waterproofing material specified for use.

c. Surface Finish Type F2

The appearance shall be that of a smooth dense, well compacted concrete showing the slight marks of well fitted shuttering joints. The Contractor shall make good any blemishes.

d. Surface Finish Type F3

This finish shall give an appearance of smooth, dense, well-compacted concrete with no shutter marks, stain free and with no discolouration, blemishes, arises, air holes, etc. Only lined or coated plywood with very tight joints shall be used to achieve this finish. The panel size shall be uniform and as large as practicable. Any minor blemishes that might occur shall be made good by the Contractor.

e. Unformed Surfaces

Finishes to unformed surfaces of concrete shall be classified as U1, U2, and U3, 'spaded or bonded concrete'. Where the class of finish is not specified the concrete shall be finished to Class U1.

Class U1 finish is the first stage for Class U2 and U3 finishes and for a bonded concrete surface. Class U1 finish shall be a levelled and screeded, uniform plain or ridged finish which (unless it is being converted to Class U2, U3, or bonded concrete) shall not be disturbed in any way after the initial set and during the period of curing, surplus concrete being struck off immediately after compaction.

Where a bonded concrete surface is specified, the laitance shall be removed from the Class U1 finished surface and the aggregate exposed while the concrete is still green.

A spaded finish shall be a surface free from voids and brought to a reasonably uniform appearance by the use of shovels as it is placed in the Works.

Class U2 finish shall be a wood float finish. Floating shall be done after the initial set of the concrete has taken place and the surface has hardened sufficiently. The concrete shall be worked no more than is necessary to produce a uniform surface free from screed marks.

Class U3 finish shall be a hard smooth steel-trowelled finish. Trowelling shall not commence until the moisture film has disappeared and the concrete has hardened sufficiently to prevent excess laitance from being worked into the surface. The surfaces shall be trowelled under firm pressure and left free from trowel marks.

The addition of dry cement, mortar or water shall not be permitted during any of the above operations.

ii. Re-Use of Forms, etc.

Forms required to be used more than once shall be maintained in serviceable condition and shall be thoroughly cleaned and repaired before reuse.

Where metal sheets are used for lining forms the sheets shall be placed and maintained in the forms with minimum amount of wrinkles, lumps or other imperfections. All forms shall be checked for shape and strength before reuse. Steel forms shall be cleaned by buffing before reuse.

iii. Execution and Removal of Forms

Before placing concrete the surface of all forms shall be coated with suitable non-staining form releasing agents such as raw linseed oil so as to prevent adhesion of concrete and to facilitate removal of forms.

The form releasing agent shall cover the forms fully and evenly without excess over drip. Care shall be taken to prevent form releasing agents from getting on the surface of the construction joints and on reinforcement bars. Special care shall be taken to thoroughly cover form strips for narrow grooves, so as to prevent swelling of the forms and the consequent damage to concrete prior to or during removal of forms.

Immediately before concrete is placed care shall be taken to see that all forms are in proper alignment and the supports and fixtures are properly secured and tightened.

Where forms for continuous surfaces are placed in successive units, the forms shall lap and fit tightly over the completed surface so as to prevent leakage of cement slurry from the fresh concrete and to maintain accurate alignment of the surface.

Forms shall be left in place until their removal is authorised and shall then be removed with care so as to avoid injury to concrete.

Removal of forms shall never be started until the concrete is thoroughly set and adequately hardened such that it can carry its own weight, besides the live load which is likely to come on the work during construction. The length of time for which the forms shall remain in place shall be decided by the Contractor, with reference to weather conditions, shape and position of the structure or structural member and nature and amount of dead and live loads.

In normal circumstances and where ordinary Portland cement is used, forms can be allowed to be struck as under:

1. Beam sides, walls, unloaded columns - after 24 hours
2. Slabs and arches (props left under) - after 4 days

- | | |
|-----------------------------------|-----------------|
| 3. Props to slabs and arches | - after 10 days |
| 4. Beam soffit (props left under) | - after 8 days |
| 5. Props to beams | - after 21 days |
| 6. Lean concrete (sides) | - after 2 days |

Note: Time shall be measured from last batch concreted in respect to the structural member under consideration.

In no case shall forms be removed until there is an assurance that removal can be accomplished without damaging the concrete surface. Heavy loads shall not be permitted until after the concrete has reached its design strength. The forms shall be removed with great caution and without causing any jerks to the structure.

Re-propping shall be done to the below floor to carry the construction load transferred through props/equipments etc. during construction of upper floor and props left under till the period of removal of props supported to or any other load due to construction load on the upper floor. Re-propping shall be part of shuttering/formwork for concrete without any claim for extra cost.

iv. Settlement of Formwork and Camber

Due to various reasons such as closure of form joints, shrinkage of timber, dead load deflections, elastic shortening of form members or formwork, deflections, settlement may occur. The Contractor shall take precautions, including using adequately rigid formwork, in order to prevent excessive settlement/ deflection; the usual acceptable limit being $1/500$ of the spans of the formwork.

In the absence of any specified camber on the drawings, soffit of all beams more than 5 m in span and other than pre-stressed concrete beams shall be laid to a camber, the amount of which at mid span shall not be less than $1/500$ of the span of the structure. The profile of soffit shall be parabolic.

v. Mock-Ups

The method for pouring difficult zones of concrete will be pre-studied on mock-ups. Mock-ups will be particularly necessary for the following:

- (a) Zones around penetrations and openings.
- (b) Behind anchorage of pre-stressed members.
- (c) Dome and shell in general requiring single and double forms.

- (d) Various zones of large thickness for studying placement temperatures in relation to internal temperature build-ups.

Work involved in mock-up pours will be paid for at the rates entered under relevant items of work. Sampling and testing of all samples will be done by the Contractor. Unsuccessful mock-ups may have to be repeated in full or in part.

Pockets, duct, cut-outs or any kind of holes in/ at ends/ edges of slabs/ beams kept for pre-stressed post tensioning operations shall be finished to the mark of formwork finish by the CONTRACTOR with the same grade of concrete without any claim for extra costs.

vi. Tolerance

Tolerance is a specified permissible variation from lines, grade or dimensions given in drawings. No tolerance specified for horizontal or vertical building lines or footings shall be construed to permit encroachment beyond the legal boundaries. Tolerance for formed and concrete dimensions shall be as per IS: 456 unless specified otherwise.

vii. Tolerances for RC Buildings

(a) Variation from the Plumb

i. In the lines and surfaces of columns, piers, walls and in arises
5 mm per 2.5 m or 25 mm, whichever is less.

ii. For exposed corner columns and other conspicuous lines

In any bay or 5 m maximum - 5 mm

In 10 m or more - 10 mm

(b) Variation from the level or from the grades indicated on the drawings

i. In slab soffits, ceilings, beam soffits and in arises

In 2.5 m - 5 mm

In any bay or 5 m maximum - 10 mm

In 10 m or more - 15 mm

ii. For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines

In any bay or 5 m maximum - 5 mm

In 10 m or more - 15 mm

(c) Variation of the linear building lines from established position in plan and related position of columns, wall and partitions

In any bay or 5 m maximum	-	10 mm
In 10 m or more	-	20 mm

(d) Variation in the sizes and locations of sleeves, openings in walls and floors - 5 mm except in the case of and for anchor bolts.

(e) Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls

Minus	-	5 mm
Plus	-	10 mm

(f) Footings

i. Variation in dimension in plan

Minus	-	5 mm
Plus	-	50 mm

ii. Misplacement or eccentricity

2% of footing width in the direction of misplacement but not more than 50 mm

iii. Reduction in thickness

Minus	-	5% of specified thickness subject to a maximum of 50 mm
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(g) Variation in steps

i. In a flight of stairs

Rise	-	3 mm
Tread	-	5 mm

ii. In consecutive steps

Rise	-	1.5 mm
Tread	-	2 mm

f. Tolerances in Other Structures

(a) All structures

i. Variation of the construction linear outline from established position in plan

In 5 m	-	10 mm
In 10 m or more	-	15 mm

- ii. Variation of dimensions to individual structure features from established positions
- | | | |
|------------------------|---|-------|
| In 20 m or more | - | 25 mm |
| In buried construction | - | 50 mm |
- iii. Variations from plumb, from specified batter or from curved surfaces of all structures
- | | | |
|------------------------|---|------------------------|
| In 2.5 m | - | 10 mm |
| In 5 m | - | 15 mm |
| In 10 m or more | - | 25 mm |
| In buried construction | - | Twice the above values |
- iv. Variations from level or grade indicated on drawings in slabs, beams, soffits, horizontal grooves and visible arrises
- | | | |
|------------------------|---|------------------------|
| In 2.5 m | - | 5 mm |
| In 7.5 m or more | - | 10 mm |
| In buried construction | - | Twice the above values |
- v. Variation in cross-sectional dimensions of columns, beams, buttresses, piers and similar members
- | | | |
|-------|---|-------|
| Minus | - | 5 mm |
| Plus | - | 10 mm |
- vi. Variation in the thickness of slabs, walls, arch sections and similar members.
- | | | |
|-------|---|-------|
| Minus | - | 5 mm |
| Plus | - | 50 mm |

(b) Footing for Columns, Piers, Walls, Buttresses and Similar Members

- i. Variation of dimension in plan
- | | | |
|-------|---|-------|
| Minus | - | 10 mm |
| Plus | - | 50 mm |
- ii. Misplacement or eccentricity
- 2% footing width in the direction of misplacement but not more than 50 mm

iii. Reduction in thickness

5% of specified thickness subject to a maximum of 50 mm

(c) Tolerance in fixing Anchor Bolts shall be as follows:

- | | | | |
|------|---|---|------------------------|
| i. | Anchor bolts without sleeves | : | 1.5 mm in plan |
| ii. | Anchor bolts with sleeves | : | 5.0 mm in elevation |
| | - for bolts upto and including 28 mm dia. | : | 5 mm in all directions |
| | - for bolts upto 32 mm dia. | : | 3 mm in all directions |
| iii. | Embedded parts | : | 5 mm in all directions |

(d) Tolerances in Formwork

The formwork shall be designed and constructed to the shapes, lines and dimensions shown on the drawings within the tolerances given below:

- | | | |
|-----|---|---|
| 1. | Deviation from specified dimensions of cross section of columns and beams | -6 mm |
| 2. | Deviations from dimensions of footings (tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel or dowels) | +12 mm |
| (a) | Dimension in plan | -12 mm
+50 mm |
| (b) | Eccentricity | 0.02 times the width of the footing in the direction of deviation but not more than 50 mm |
| (c) | Thickness | ± 0.05 times the specified thickness |

Pre-stressed concrete cables will be laid such that their profile is a smooth curve unless otherwise specified.

The alignment tolerances shall be as under:

- | | |
|------------------------|--|
| Member with a depth of | Tolerance in direction of depth 'd' of members |
|------------------------|--|

Up to 200 mm	±d/40
200 - 1000 mm	±5 mm
more than 1000 mm	±10 mm

Tolerance in direction of width of member @ the level of tendon

Up to 200 mm wide	±5 mm
200 - 1000 mm wide	±10 mm
Slabs and beams of more than 1000 mm wide	±10 mm

Tendon extensions will be measured up to 1 mm accuracy. The total prestressing force applied to a beam shall not vary more than +3% from the design force specified and measured in terms of the total elongation of all the tendons in that member.

In the case of slabs this variation shall be measured and restricted over a range of 5 consecutive tendons.

4.0 GROUTING

4.1 SCOPE

The works covered by this specification consists of supplying all materials; furnishing all equipment, labour, etc.; performing all operations; for placing grouts at locations such as under column base plates, anchor bolt pockets, under machine or equipment bases, etc. The works shall be carried out in conjunction with other Contractors/ vendors who are responsible for erection of their structures and equipments and maintaining the levels, alignments, etc. of their bases.

4.2 TYPE OF GROUTS

There are three types of grouts to be used:

- (a) Standard dry pack grouts.
 - (b) Non-shrink cementitious grouts.
- i. Non-shrink epoxy grouts. The type of grout to be used shall be as specified in the drawings.
 - ii. Standard Dry Pack Grouts

Standard dry pack grouts are prepared by mixing of cement and sand. The proportion of grout shall be one part of Portland Cement to 3 parts of sand. Quantity of water shall be such so that it is just enough for compaction and hydration and shall have the consistency of damp sand. Sand used shall meet the usual grading specification for concrete.

iii. Non-Shrink Cementitious Grouts

These shall be a pre-proportioned product, obtained from approved manufacturers, containing a mixture of aggregate, cement and admixtures; pre-blended and pre-packaged requiring only the addition of water at site. Unless mentioned otherwise, it shall be used below all structural base plates and associated anchor bolt pockets. It can also be used below all static and rotating equipment bases having no or low impact loads. It should not be used in areas where the grouts are subjected to corrosive atmosphere and chemical attacks. The material shall be chloride free and must not contain expansive cements or metallic particles such as aluminium powder or iron fillings.

iv. Non-Shrink Epoxy Grouts

These are two components epoxy bonding systems mixed with oven dry aggregate and other proprietary materials. It shall be obtained from approved manufacturers. The components shall be mixed in complete units in accordance with manufacturer's recommendations. If not specifically mentioned, it shall be used in areas where the grouts are subjected to corrosive atmosphere or aggressive chemicals and/ or shock or heavy impact loads below equipment bases, such as reciprocating machines, crushers, crane rails, etc. Where epoxy grouts are subjected to temperature more than 50° C, manufacturer's advice shall be sought before its use, as its stiffness and strength get affected under high temperature.

4.3 PREPARATION

Concrete surfaces to be grouted shall be thoroughly roughened by sand blasting or other mechanical means and all loose materials from the surface shall be removed.

Anchor bolts, anchor bolt holes and the bottom of equipment and column base plates shall be cleaned of all oil, grease, dirt and loose material.

The hardened concrete surfaces on which the cementitious grouts are to be placed shall be saturated with water. All standing water shall be removed from the concrete surface as well as from anchor bolt holes, just prior to

grouting. However, surface shall be absolutely dry before placing epoxy grouts.

Forms must be rigid to completely confine and withstand the pressure of grout during placement, without any deformation. It should be tight to prevent any leakage. All cracks and joints in the formwork shall be caulked with an elastomeric sealant. It shall be lined with polyethylene or such material for easy removal. Forms shall be 100 to 150 mm higher than base plates, on one side, when hydrostatic head is used for placement of liquid grouts, This is to ensure full contact of grout with underside of the plates. Air relief holes must be provided, to remove any entrapped air below the plates during grouting. Chamfer edges shall be built in with the form works, for epoxy grouts.

Water used for mixing of grout shall be clean and free from oils, acids, alkalies, organics and other deleterious materials.

4.4 INSTALLATION

Ready mixed grouts shall be mixed in the manner and in accordance with manufacturer's recommendations and shall be used in the form of liquid. Consistency of grout shall be such so that it can maintain its flowability within the gap provided below the base plates, during its entire period of placement. Grouts shall be placed from one end to the other. Grouting, once started, shall be finished quickly and continuously to prevent segregation, bleeding and starting of initial set. No water or solvent shall be added to change the consistency, if the grout stiffens during placement. The stiffened grouts along with other grout, in place but not completed, shall be removed.

All equipment and tools shall be cleaned thoroughly before use. For cementitious grouts, the mixer shall be wetted and excess water removed, before mixing begins.

After the bases of structures and equipment are levelled and aligned by other vendors, by using shims, the liquid grouts shall be placed by flowing or by pumping. Standard dry pack grouts, if used, shall be placed by rodding. Extreme care shall be taken to see that alignment and levels of bases are not disturbed during grouting.

The grouts shall be prepared only to the extent it can be used within the specific pot life by the manufacturer. Any leftover grout or grouts not consumed within the pot life time shall not be used and shall be discarded. The shelf life of the grout shall also be checked before they are used. Grouts having expired date shall not be used under any circumstances.

The cementitious grouts shall be cut back at an angle of 45° or vertical, as shown in the drawing, after the grout has reached its initial set.

Forms and shims shall not be removed and the anchor bolts shall not be tightened for at least twenty four hours after placing the grout. After removal of forms and peripheral shims, area occupied by shims shall be filled and the area between the base and the edge of the foundation shall be finished smooth to allow drainage away from the base. Interconnecting piping and machinery shall not be attached to the machinery before anchor bolts are tightened. It is desirable to make these connections at least after a minimum of seven days from the date of grouting. During this period, the grout shall be properly cured.

Grout shall be cured in accordance with manufacturer's specification and recommendation.

4.5 INSPECTION

All materials, workmanship and finished construction shall be subject to the continuous inspection.

All materials supplied by Contractor and all works or construction performed by Contractor and rejected - as not in conformity with the specifications and drawings - shall be immediately replaced at no additional expense to the Authority.

Preliminary approvals of any materials or phase of work shall in no way relieve the Contractor from the responsibility of supplying grouting materials and or producing finished grout in accordance with the specifications and drawings.

All grouting shall be protected against damage.

Upon the completion of grouting work, all forms, equipment, construction tools, protective coverings and any debris shall be removed from the area.

4.6 GENERAL

The thickness of standard dry pack grouts shall be minimum 75 mm. However, thickness of flowable grout can be anywhere between 20 to 50 mm.

Generally, the type of grout selected shall have twice the strength of the base concrete on which the grout is placed.

All materials shall be delivered to site in original unopened packages, clearly labelled with the manufacturer's identification and printed instructions. The Contractor must submit the manufacturer's certified test data on the grout's

constituents, 24 hour compressive strength and its flowability, from approved test laboratory, prior to placement of order. Manufacturers shall also give warranty saying that the nonshrink grout supplied shall never go below its initial placement volume.

Prior to grouting, the hardened concrete surfaces to be grouted shall be saturated with water.

Water in anchor bolt holes shall be removed before grouting is started.

Forms around base plates shall be reasonably tight to prevent leakage of the grout. When the base is to be flow grouted, forms shall be built and securely anchored outside the base plate so as to completely confine and withstand the pressure of liquid grout under working and rodding condition without leaking and high enough to ensure the grout is in contact with the underside of the base plate, and provide a head of minimum 100 mm above the underside of the base plate. Provisions of grout holes in base plates, rodding, arrangements shall be checked prior to commencement of grouting.

Adequate clearances shall be provided between forms and base plate to permit grout to be worked properly into place.

Grouting, once started, shall be done quickly and continuously to prevent segregation, bleeding and break down of initial set. Grout shall be worked from one side of one end to the other to prevent entrapment of air. To distribute the grout and to ensure more complete contact between base plate and foundation and to help release of entrapped air, link chains or doubled over flexible steel strapping's may be used to work the grout into place.

Grouting through holes in base plates shall be by pressure grouting. The pressure to be used for grouting shall be as directed by Contractor.

5.0 SUPPLY AND FABRICATION OF STRUCTURAL STEEL

5.1 SCOPE

This specification covers the general requirements for supply of all steel items where specified, fabrication, inspection, testing and delivery at site of all fabricated structural steel items. This specification also covers design of all connections and substituted members, preparation of all shop fabrication drawings, inspection of fabricated items.

The scope of work also includes, but is not limited to proper stacking and storage of fabricated materials, transport from place of storage to place

of erection, wherever required. All the works shall be carried as per approved QA procedures.

This specification covers the general requirements for erection of structural steel. In

Addition to provision of erection and transport equipment, the scope of work includes supply of tools and tackles, consumables, materials, labour and supervision and shall cover the following:

This specification covers the general requirements for shop and field painting for

Structural Steel works using hot/ cold rolled steel sections joined by using bolting and/ or welding.

5.2 APPLICABLE CODES STANDARDS AND SPECIFICATIONS

The pertinent clauses of the following Indian Codes, Standards and Specification (latest editions including all applicable official amendments, reaffirmations and revisions) shall apply to the material and workmanship covered by this specification. In the event of the conflict of certain requirements between this specification and the codes referred herein, this specification shall govern.

It is not the intent to specify herein all the codes and standards required for the satisfactory completion of work. The list of codes and standards indicates certain primary codes and standards and not all the codes required for the work under the contract. It is understood that all the pertinent codes and standards shall form the part of this specification whether explicitly indicated or not.

Reference codes and standards:

IS: 800	General Construction in Steel - Code of Practice
IS: 803	Code of Practice For Design, Fabrication and Erection of Vertical Mild Steel Cylindrical Welded Oil Storage Tanks
IS 806	Code of Practice For Use of Steel Tubes In General Building Construction
IS: 808	Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections
IS: 813	Scheme of symbols for welding

IS: 814	Covered Electrodes for Manual Metal Arc Welding of Carbon and Carbon Manganese Steel-Specification
IS 822	Code of Procedure for Inspection of Welds - Reaffirmed 2003
IS: 1024	Code of practice for use of welding in bridges and structures subjected to dynamic loading
IS: 1161	Steel Tubes for structural purposes-Specification
IS: 1182	Recommended Practice for Radiographic examination of Fusion Welded Butt Joints in Steel Plates
IS: 1239	Steel Tubes, Tubular and other Wrought Steel Fittings – Specification - Part 1: Steel Tubes
IS: 1363	Hexagon Head Bolts, Screws and Nuts of Product Grade 'C' Part 1: Hexagon Head Bolts (Size range M5 to M64) Part 2: Hexagon Head Screws (Size range M5 to M64) Part 3: Hexagon Nuts (Size range M5 to M64)
IS: 1367	Technical Supply Conditions for Threaded Fasteners (All Parts)
IS: 1395	Low and medium alloy steel covered electrodes for manual metal arc welding
IS: 1852	Rolling and Cutting Tolerances for Hot Rolled Steel Products(4 th Rev)
IS: 2062	Hot Rolled low, medium and High tensile structural steel
IS: 2595	Code of Practice for Radiographic Testing
IS: 3502	Steel Chequered Plates-Specification.
IS: 3600	Method of testing fusion welded joints and weld metal in steel (All parts)
IS: 3658	Code of Practice for Liquid Penetrant Flaw Detection
IS: 3757	Specification for High Strength Structural Bolts
IS: 4000	Code of Practice High strength bolts in Steel Structures (1 st Rev) - Reaffirmed 2003
IS: 4260	Recommended practice for ultrasonic testing of butt

	welds in ferritic steel
IS: 4353	Submerged arc welding of mild steel and low alloy steels – Recommendations
IS: 5334	Magnetic Particle Flaw Detection of Welds-Code of Practice
IS: 6339	Specification for Hexagon Bolts for Steel structures
IS 7205	Safety Code for erection of structural steelwork.
IS: 7215	Tolerances for Fabrication of Steel Structures
IS 7969	Safety Code for handling and storage of building materials.
IS: 9595	Metal Arc Welding of Carbon and Carbon Manganese Steels - Recommendations
IS 12843	Tolerances for erection of steel structures.
SP 6(1)	Structural Steel Sections
AWS D1.1	Structural Welding Code: Steel

5.3 REGULATORY REQUIREMENTS

The work covered in this specification, shall comply with all relevant government and local laws, regulations and standards. For subjects not covered by regulations, codes, standards or specifications, the materials and construction shall be based on good engineering practice, subject to approval by Authority (if require).

Contractor shall ensure that all health and safety regulations are observed for the erection of scaffolding and use of the selected paint material.

All necessary precautions shall be taken to ensure the safety of personnel and property. Extreme caution shall be used when working with oil or oil-based paints, cleaning fluids, etc., especially in close proximity to oxygen piping or oxygen equipment. Heavy concentrations of volatile or toxic fumes must be avoided and in confined areas, blowers or exhaust fans shall be used.

Rags and other waste material soiled with paints, thinners or solvents shall be kept in tightly closed metal containers while on the job site and not in use. Legal disposal of waste materials outside plant site premises is Contractor's responsibility.

5.4 STEEL MATERIALS

Steel materials shall comply with the specifications laid down under clause 2.0 and/or as called for on the design drawings. All materials used shall be new, unused and free from defects.

i. Steel Supply – Not used

ii. Steel Supply – By Contractor

All steel and other material shall be procured and supplied by the Contractor, from the reputed manufacturers like SAIL, TATA STEEL, ESSAR and JINDAL. Steel proposed to be procured from other sources shall have prior approval from the Authority (if require) before placement of procurement order. However Authority reserves the right to accept material from other manufacturers. Steel procured shall confirm to the following:

Contractor shall use materials for fabrication as specified in the approved drawings. All materials supplied by the Contractor shall be in sound condition, of recent manufacture, free from defects such as mill scales, slag intrusions, laminations, pitting, flaky, rust, etc. and be of full weight and thickness as specified.

Contractor shall furnish the mill/ manufacturer's test reports, along with the materials and satisfactorily demonstrates the specific grade and quality. Material test certificate shall be original.

All materials required for the work shall be correlated with manufactures test certificates. In the absence of test certificates, Contractor shall test materials through reputed laboratory for establishing quality, at Contractor's cost. Material supplied against this Test Certificates (TC) should have identification stamped or stenciled on them. All such identification markings shall be authenticated by the inspection agency, which has inspected and approved the material.

The Contractor shall furnish to the Authority duplicate copies of all purchase order copies covering the material ordered by him for the project under reference and also test reports.

The Authority (if require) shall have the right to test random samples to prove authenticity of the test certificates produced by the Contractor at the Contractor's cost. Any material found not meeting the required specification would be rejected.

Whenever the Contractor desires to substitute structural members / shapes, plates for the sizes shown on the drawings, for want of availability of requisite materials, such substitutions shall be made by the Contractor. Contractor may also direct that substitution be made, when he considers such substitution to be necessary.

5.5 DRAWINGS

i. Contractors' Drawings

Contractor will issue the drawings and data as specified in Contract which may include, depending on Contract:

- (a) Preliminary Drawings and Data along with Tender/ Enquiry.
- (b) Any additional basic engineering details to enable detailed engineering by Contractor as required by Contract.
- (c) Interface particulars with other Contracts and
- (d) Detailed engineering drawings in Contractors Scope.

Design drawings will be furnished by the Contractor and all drawings so furnished shall form a part of this specification. These design drawings prepared by the Contractor will show all the levels, forces on members where necessary, size and orientation of each member, location/ size of openings, to enable to prepare drawings for fabrication and erection. It shall be clearly understood that Contractor's drawings are design drawings and are not intended to show connection details, thickness of members, cuts, notches, bends and other such details.

The Schedule of release of drawings shall be mutually agreed to, based on project schedules, unless such dates of drawing release are specified in Contract.

Authority reserves the right to make changes, revisions to drawings, even after release for preparation of shop drawings, is very likely to be made to reflect additional data/details received and updated requirements. Revisions to drawings and any new drawings made to include additional work by the Authority shall be considered as part of this specification and contract without additional cost implication to the Authority. The Authority shall not entertain any extra claims on this account.

Where the fabrication drawings are to be furnished by the Contractor, he will issue to the Authority the required copies of such drawings in the sequence required for the fabrication of the components.

In case of variations in drawings and specifications, the decision of the Authority shall be final. Should the Contractor find discrepancies in the

information furnished by the Authority, he shall refer these to the Authority before proceeding with such work.

Unless otherwise specified, the drawings and specifications are intended to include everything obviously requisite and necessary for proper and entire completion of the work and shall be carried out accordingly for completeness as required.

ii. Contractor's Drawings (Fabrication Drawings)

Fabrication drawings shall be prepared by the Contractor or through an agency approved by PMCs at his own cost based on the Design drawing "Released for Construction" and their subsequent revisions. All the drawings for the entire work shall be prepared in metric units. The drawings shall preferably be of one standard size and the details shown there in shall be clear and legible. Drawings shall be prepared in AUTOCAD and the details shall be drawn to the minimum scale as specified under.

- (a) Marking Plan: 1:75
- (b) Joint Details: 1:5; 1:10; 1:15
- (c) Elevations: 1:20

Contractor shall commence detailing as per drawings which are officially released for preparation of shop drawings. The Contractor shall be responsible for the correctness of all fabrication drawings. Fabrication drawings shall be revised by the Contractor to reflect all revisions in design drawings as and when such revisions are made. Key plan prepared by the Contractor shall indicate the fabrication/ erection marking of each members and a table showing the corresponding fabrication drawing number where these members are detailed. Also each drawing prepared by Contractor shall indicate corresponding design drawing number with revisions.

Each member shall be detailed separately unless members are identical in all respects with no deviation whatsoever. Shop detail drawings shall show all shearing, punching, drilling, level cutting, bending, and all welding in complete detail. All connections and splices shall be designed and detailed by the Contractor and clearly shown on the drawings. Bill of material shall show number, size, length, weight and assembly work of each erection piece. Bill of material for each drawing shall include fasteners/bolts, nuts, washers and other accessories complete with specification, size, length, numbers, etc for each erection mark and proper identification for each joint. Bill of material shall be prepared erection mark wise, showing weight of each component part

and total weight of each erection mark. All revisions after initial issue of a drawing shall be clearly indicated with issue number and date of revision.

Each drawing prepared by the Contractor shall clearly indicate Names of Authority, PMC, Contractor, Project Title, Title of drawing, Scale, Notes, Details of revisions carried out, etc; All titles, noting, markings and writings on the drawing shall be in English and all dimensions shall be in metric units. Before the commencement of preparation of fabrication drawings, Contractor shall discuss with the Authority (if require) any specific requirement to be followed for fabrication drawing preparation.

No detailed shop drawings will be accepted unless they are complete and checked and approved by Contractor's qualified Structural Engineer and accompanied by an erection plan showing the location of all pieces detailed.

Contractor should check for erection clearance and ensure that detailing of connections is carefully planned to obtain ease in erection of structures including field-welded connection and bolting. Field connections/ splices may be welded or bolted type.

Contractor shall submit design calculations for each and every connection detail proposed by him and also for any substitution for members, desired by him. Fabrication drawings not accompanied by calculation for connection details are liable for rejection.

Each lot of drawings sent by Contractor shall contain a limited number of drawings and shall be in an order and manner, which follows erection sequence based on priorities allocated. Contractor shall furnish the required number of prints of all approved drawings for field use and record purpose.

Authority may review/ approve the fabrication drawing (if require) at his option some, all or none of the fabrication drawings. Wherever such review is carried out the same shall be restricted to the following:

- (a) Review/ approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and other details.
- (b) Correctness of overall dimensions, centre to centre distance, elevations. Important/ typical connection details (adequacy of number of bolts/ weld length for few connections only will be checked), working points for bracing members and orientation and sizes/ sections of members.
- (c) Sequence of erection in the light of project requirements.

- (d) Whether the fabrication drawings broadly conform to details shown on design drawings and comply with technical specifications, general notes, any specific notes made on design drawings and generally with the requirement of good engineering practice.

It shall be clearly noted by the Contractor that even where review is done by the PMC, the following shall be the sole responsibility of the Contractor.

- (a) Provision for erection.
- (b) Marking of members.
- (c) Cutting Lengths of members.
- (d) Matching of Joints and holes.
- (e) Provision kept in the member for all other interconnected members.
- (f) Bill of materials.
- (g) Gusset sizes.

Approval by PMCs (if require) of any of the fabrication drawings shall not relieve the Contractor from the responsibility for correctness of engineering, design of connections, workmanship, and fit of parts, details, material, errors or omissions of any and all work shown thereon. PMC's (if require) approval shall not invalidate any claim for damages of any kind for incorrectly detailed/fabricated steel, notwithstanding any approval of such drawings by Engineer.

On completion of fabrication and erection, the Contractor shall update his fabrication drawings, incorporating all site changes and substitutions and shall submit two (2) sets of hard copies of such "as built " drawings to Authority for record purpose. The Contractor shall also furnish two sets of soft copies of all final approved Contractors' drawings in the form of CDs.

Time consumed by the Contractor in securing approval of drawings should not be added to the time allowed for completion of contract. A period of four (4) weeks from the dates of receipt of drawings by the PMC should be anticipated for this item of procedure in the schedule.

All these fabrication drawings submitted by the Contractor will remain the property of the Authority. Authority reserves the right to use them in any manner whatsoever.

5.6 FABRICATION

i. General

Any work done prior to approval (if require) of Contractor's fabrication drawings will be at the Contractor's risk. The Contractor shall make such

changes in the design when so directed, which are considered necessary to make the structures conform to the provisions and intent of the specifications, without any additional cost to the Authority.

All workmanship and finish shall be of the best quality and shall conform to good engineering practice and the best-approved method of fabrication. All materials shall be finished straight and shall be machined / ground smooth, true and square where so specified.

All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Standard fabrication clearances as detailed in the American Institute of Steel Construction Manual/ BIS Codes shall generally be followed unless otherwise directed/ approved.

Materials at the shop shall be kept clean and protected from weather. Cutting, punching, drilling, welding and fabrication tolerances shall be generally as per relevant Codes and Standards. In addition the Contractor shall strictly adhere to the following:

- (a) All care should be taken to avoid undue welding distortions.
- (b) Complete layout shall be prepared by the Contractor before actual fabrication is started. If needed, mock-ups may also be prepared.
- (c) All fit ups shall be in Contractor's scope

ii. Connections

All shop connections shall be welded unless otherwise specified in design drawing. Field connections can be either welded or bolted and as shown in design drawings. Bolts used for erection shall conform to IS: 6639 and as specified in the design drawings.

All connections shall be designed for forces indicated on the design drawings. The Contractor shall be responsible for selection of standard connections from AISC Manual of Steel Construction.

In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts as necessary. In case of high strength friction grip bolts, hardened washers are used under the nuts or the bolt heads whichever are turned to tighten the bolts. The length of the bolt shall be such that at least one thread of the bolt projects beyond the nut, except in case of high strength friction grip bolts where this projection shall be at least three times the pitch of the thread.

In all cases where bearing is critical, the unthreaded portion of bolt shall bear

on the members assembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose.

Not more than one shop splice shall be provided to make up the full length of a member. Shop splices to make the full member lengths shall be of full penetration butt welded type and radiographically tested.

Transportation or the Contractor's erection methods may require additional splices not shown on the drawings. The Contractor shall be responsible for the design and detailing of such splices or joints.

All bolts, nuts, screws, washers, electrodes, etc. shall be supplied/ brought to site 10% in excess of the requirement in each category and size. Rates shall cover the cost of this extra quantity and no additional payment will be made for this extra quantity supplied.

All members likely to collect rain water shall have drain holes provided.

iii. Straightening

Rolled material, before being worked, shall be straightened, unless otherwise specified. If straightening or flattening is necessary, it shall be done by methods that will not injure the material. Long plates shall be straightened by passing through a mandrel or leveling rolls and structural shapes by the use of mechanical or hydraulic bar/ section straightening machines. Heating or forging shall not be resorted. In case of site fabrication, Contractor shall check and confirm on the straightening method proposed to be adopted before commencing the work.

Checking of the straightness of the structural members like angles, channels, beams etc. shall be done by using the thread. For checking of the straightness of the column sections piano wire shall be used. The sections, which are twisted beyond repairs, shall not be used for fabrication. Heating or hammering shall not be permitted. After removal of bends structural members shall be submitted for inspection.

iv. Cutting

Cutting may be done by shearing, cropping, sawing or machine flame cutting. All re-entrant corners shall be shaped notch free to a radius of at least 12 mm. Sheared or cropped edges shall be dressed to a neat workmanlike finish and shall be free from distortion and burrs.

Hand flame cutting shall be undertaken and shall only be carried out by an

expert in such work. Hand flame cut edges shall be ground smooth and straight.

Edges of flange cover plates and plates used to form any sections shall be ground smooth.

v. Punching And Drilling

Holes in secondary members such as purlins, girts, lacing bars, etc. may be punched full size through material not over 12 mm thick. Holes should be clean cut, without burr or ragged edges. Holes for all other connections shall be drilled accurately and the burrs removed effectively. Where several parts are to be connected to very close tolerances such parts shall be first assembled, tightly clamped together and drilled through.

Sub-punching may be permitted before assembly, provided the holes are punched 3 mm smaller in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall not in such cases exceed 16 mm.

When match drilling is carried out in one operation through two or more separate parts, these parts shall be separated after drilling and the burrs removed.

Holes for turned and fitted bolts shall be drilled to a slightly smaller diameter and reamed to a diameter equal to the nominal diameter of the shank or barrel subject to tolerance specified in IS: 919. Holes for turned and fitted bolts shall be drilled to a slightly smaller diameter and reamed to a diameter equal to the nominal diameter of the shank or barrel subject to tolerance specified in IS: 919.

Where reamed members are taken apart for transporting or handling, the respective pieces reamed together shall be so marked that they may be reassembled in the same position in the final setting up. No interchange of reamed parts will be permitted. Poor matching, over drilling and ovality in holes shall be a cause for rejection. Burning holes with gas is strictly prohibited.

Holes may be required to be drilled by the Contractor at no extra cost at site for installing equipment or steel furnished by other agencies. The information for this will be supplied by the Contractor to the other agencies (if require) before or after erection of the steel. Holes should be by drilling or other machining process and not by gas cutting sets.

vi. Rolling And Forming

Plates, Channels, Rolled Steel Joists, etc., for circular bins, bunkers, hoppers, gantry girders, etc., shall be accurately laid off and rolled or formed to required profile/ shape as called for on the drawings. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection in the field.

vii. Grinding

Column ends bearing on each other, resting on base plates, compression joints designed for bearing, base plates coming in contact with column end and cap plate shall be ground smooth to ensure 90% contact with local gap not exceeding 0.10 mm (filler gauge shall be used to check this gap). All ground surfaces shall be protected from dirt and mechanical damages till the assembly is completed. However the underside of base plate bearing on grout need not be machined.

viii. Welding

Before the start of the work, welding procedure shall be confirm by Contractor. Welding shall be entrusted to only qualified and experienced welders who shall be periodically tested and graded as per relevant standards.

Welding procedure specification (WPS) shall be established and Qualification of weld procedure (QWP) shall be done as per approved standards. Welders employed shall also be qualified as per above standards prior to taking up fabrication. Contractor shall check all the procedure of welding before the start of the work.

Following pre-qualified welding process shall be employed for fabrication, erection and repair before adopting the welding process on the job:

- (a) Submerged Arc Welding (SAW).
- (b) Shield Metal Arc Welding (SMAW).
- (c) Gas Metal Arc Welding (GMAW).
- (d) Gas Tungsten Arc Welding (GTAW)

All welds shall be free from defects like blowholes, lack of penetration, undercutting, cracks, etc. All welds shall be cleaned of slag or flux and show sections, smoothness of weld metal, feathered edges without overlap and freedom from porosity.

50 mm on either side of the surfaces on which weld metal is to be deposited shall be smooth, uniform, free from fins, tears, burrs, cracks and absolutely

free from grease, paint, loose scale, moisture or any other substance which would adversely affect quality and strength of weld.

Machining, thermal cutting or grinding may be employed for joint preparation or removal of unacceptable work or metal. The weld edges shall be smooth and regular surface, free from cracks and notches. Flame cut material above 50 mm thick shall be pre-heated as per relevant standards prior to flame cutting.

All weld fit-up shall comply with tolerances specified in the relevant standards. The parts to be joined by fillet welds shall be brought into close contact as practicable and within the tolerable limits as per relevant codes and standards.

All tack welds shall be made using qualified procedure and qualified welders. Any preheat requirement specified in the welding procedure shall also apply to tack welds. All tack welds shall be examined visually for defects and if found defective, shall be removed and re-welded. Throat thickness, leg length and length of tack weld shall be as per IS: 9595-1996.

Welding of temporary attachment/fixtures to retain fit up is permitted in case the parts have a nominal thickness of at least 10 mm. Temporary attachments are welded at the minimum distance of at least 50 mm from the weld seam. Welding of temporary attachments/fixtures into the joint slot is not allowed. All temporary fixtures shall be removed after welding, by grinding them to weaken the welded portion and hammering thereafter followed by grinding the portion of any weld remaining on the base metal. A dye check at the discretion of the quality surveyor shall be done to detect any crack/defect at the point of fixture temporary weld.

It is not allowed to turn over and carry over heavy assemblies in tacking condition in order to control the geometric dimensions to the requirements of the drawings. The work shall be positioned for flat welding wherever practicable and overhead weld shall be avoided as far as possible.

In the joints of the parts with dissimilar thickness smooth transition of one part to the other must be provided by way of the gradual decreasing of the thickness of the thicker part with the slope of the surface not exceeding 15 degree.

Welding shall not be done when the surface of the members are wet or exposed to rain, or high wind velocities unless the welding operator and the work are properly protected.

In joints connected only by fillet welds, the minimum size of fillet weld to be used shall be as per IS: 9595 - 1996.

Welds shall be defect free and surfaces shall be thoroughly cleaned to remove all visible weld defects and extra material.

For all built up sections such as Columns, Crane Girders, etc welding between web and flange plates shall be carried out by SAW process. Especially for Crane girders full penetration of weld between top of web plate and top flange shall be ensured. Welding shall be continuous and shall be on both sides of the connecting member. One side fillet weld is not acceptable.

In general all welding shall be performed as per the recommendation specified in IS: 9595 - 1996.

Pre-heating and Post weld Heat treatment shall be carried out as per the acceptable standards and procedure. The pre-heat and inter pass temperature shall be checked just prior to initiating the arc for each pass. The weld joint details and procedure for Pre- heating and Post heating shall be submitted by the Contractor if require.

ix. Welding Consumables

Electrodes, filler wires and flux used for welding shall be from approved manufacturers/ suppliers. Contractor shall submit the list of Electrode manufacturers proposed to be procured to the Authority (if require) for approval. The Contractor shall furnish certification that electrode or electrode flux combination will meet the requirements of classification. The classification and size of electrode, arc length, voltage and amperage shall be suited to type and thickness of material, type of groove, welding positions and other circumstances attending work.

Only low hydrogen electrodes shall be used for welding. All electrodes having low hydrogen covering shall conform to relevant acceptable standards. These electrodes shall be purchased in hermetically sealed containers or baked by the user as recommended by electrode manufacturer. Electrode flux coating shall be sound and unbroken. Broken or damaged coating shall cause the electrodes to be discarded. Before welding, the electrodes shall be dried in a holding oven at 120⁰ C at least for one (1) hour or as per manufacturer's recommendations. Only limited quantity shall be issued to the welders. The electrodes shall be kept in "carry ovens" and shall not be exposed to the atmosphere.

Welding plants and accessories shall have capacity adequate for welding

procedure laid down and shall satisfy appropriate standards and be of approved make and quality. Contractor shall furnish the details of equipment he proposes to deploy for the works. All the electrical plant in connection with the welding operation shall be properly and adequately earthed and adequate means of measuring the current shall be provided. Proper safety rules shall be strictly followed.

5.7 TESTING, INSPECTION AND REPORTS

i. General

Contractor shall give due notice to Authority (if require) in advance of the materials or workmanship getting ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material. The fact that certain material has been accepted at Contractor's shop shall not invalidate final rejection at site by Authority if it fails to conform to the requirements of these specifications, be in proper condition or has fabrication inaccuracies which prevent proper assembly.

No material shall be painted or dispatched to site without the inspection and approval by Contractor unless such inspection is waived in writing by the PMC/Authority (if require).

Shop inspection or submission of test certificates shall not relieve Contractor from the responsibility of furnishing material conforming to the requirements of these specifications, nor shall it invalidate any claim because of defective or unsatisfactory material or workmanship.

Contractor shall provide all the testing and inspection services and facilities for shop work except where otherwise specified. Contractor's inspection work shall be under the control of competent Chief Inspector whose primary responsibility is inspection (reporting to Management) and not to production department.

For fabrication work carried out in the field, the same standard of supervision and quality control shall be maintained as in shop fabricated work. The inspection and testing shall be conducted in a manner satisfactory to Authority (if require). The inspection and testing on structural steel members shall be as set forth below.

ii. Material Testing

All materials conforming to a particular Indian or any other standard as called for shall be tested as required by such standard. Proof in the form of certified test reports or mill certificates indicating the required tests have been carried

out as per specification at the source is acceptable.

If mill test reports are not available for any steel materials, the same shall be got tested by Contractor to demonstrate conformity with the relevant specification at his own cost.

Raw material with cracks, seams, laps, lamination and heavy pitting are not acceptable. Ultrasonic testing of plates above 50 mm thick shall be carried out for the soundness of material.

Authority has option to specify additional inspection or testing as he deems necessary and the additional cost of such testing shall be borne by the Contractor.

The Contractor shall maintain records of all inspection and tests, which shall be made freely available to the Authority and shall be submitted to the Authority on completion of each stage of work.

iii. Tests On Welds

All welds shall be tested for flaws by any of the methods described under. The choice of the method adopted shall be determined by the Authority. Following methods are generally recommended for the quality control of welded joints:

a. Magnetic Particle Test (MPT)

All fillet welds in general structural steel work shall have their final passes fully tested by MPT. However, for fillet welds of size 10 mm and above and/or critical areas, the root and final passes shall be tested using MPT. The Contractor shall however decide the requirements of this additional testing. For Complete penetration butt welds, the root and final passes shall be tested using MPT. All MPT shall be as per relevant acceptable standards. Defects if found, shall be repaired and retested. MPT shall be carried out using alternating current only. Direct current may be used with the permission of the Authority (if require). The cost of demagnetising after testing is deemed to be included in the quoted rates of the Contractor.

b. Liquid Penetrant Test (LPT)

MPT may be substituted by Liquid Penetrant Inspection where the former is not feasible due to configuration. The testing should be in accordance with relevant acceptable standards.

c. Radiographic Inspection (RT)

All completed full penetration butt welds shall be fully or selectively (say 10%) shall be radio-graphed in accordance with the relevant acceptable standards.

d. Ultrasonic Testing

Wherever built up sections for crane runways girders are fabricated, the T-joints of the sections shall be subjected to ultrasonic testing.

e. Acceptance Standard

The acceptable standards for various weld tests shall be as per ASME Sec VIII- Div I or relevant acceptable standards.

iv. Inspection Of Welds

Welding shall be carried out as per approved WPS and QWS by qualified welders.

All welds shall be inspected for flaws by any of the methods described under clause 7.3 the choice of the method adopted shall be determined by the Authority/ PMC (if require). The correction of defective welds shall be carried out without damaging the parent metal. When a crack in the weld is removed, magnetic particle inspection or any other equally positive means shall be used to ensure that the whole of the crack and material up to 25 mm beyond each end of the crack has been removed. Cost of all such tests and operations incidental to correction shall be to the Contractor's account.

Contractor shall perform the following minimum tests on welds with no cost implication to the Authority. Contractor's quoted rate is deemed to have included the cost of such tests.

Sr. No.	Location and Type of Weld	Type of Test	Extent of Test	Remarks
1.	All fillet welds in general other than those covered under Sr. No. 2, 3, 5, 7 and 8.	LPT	1% of fillet weld with minimum of one test on each member joint.	
2.	Fillet welds for plate thickness greater than 25 mm and fillet size more than 10 mm.	MPT/ DPT	10%	
3.	Flame cut edges of plates more than	MPT/ LPT	100%	

Sr. No.	Location and Type of Weld	Type of Test	Extent of Test	Remarks
	38 mm for fillet weld.			
4.	Flame cut edges of plates more than 25 mm for butt weld.	MPT/ LPT	100%	
5.	Fillet welds between tension flanges and webs.	MPT/ LPT	100%	
6.	Full penetration butt weld	DPT	100%	DPT shall be carried out after back gouging before second side welding.
7.	Fillet weld greater than 12 mm on flame cut edges of low alloy steel.	MPT	100%	
8.	Fillet welds for built up columns and other heavy structures for penetration.	Macro Etch test	One test per structure for penetration	
9.	Butt welds of thickness greater than 25 mm and less than 32 mm.	MPT/ DPT	100%	
10.	Butt welds of thickness greater than 32 mm.	RT	100%	
11.	Butt welds of rolled	RT	100%	

Sr. No.	Location and Type of Weld	Type of Test	Extent of Test	Remarks
	sections having depth greater than 600 mm.			

In addition to the minimum tests to be conducted by the Contractor, Authority reserves his right to direct the Contractor to conduct additional tests. The extent, type and location of test shall be decided by the Authority. These additional tests shall be conducted by the Contractor or through an approved agency in presence of the Authority (if require). If the test fails, the cost of that test shall not be payable to the Contractor. The tests which when successful will be paid for at the rates specified in the schedule.

v. Weld Defects and Acceptability Criteria

Type of Defect	Acceptance Criteria	Remarks
Cracks	Not acceptable	
Incomplete or lack of Fusion	Not acceptable	
Misalignment of Butt welds	0.25 x T (maximum of 3 mm)	T – Thickness of thinner plate.
Reinforcement	Maximum reinforcement of 2 mm for t < 10 mm 3 mm for t > 10 mm and < 15 mm 4 mm for 15 mm and greater	
Undercut	0.25 mm deep max.	
Sharp Edges	Minimum radius of 2 mm.	

vi. Weld Repairs

Whenever weld repair is required, Contractor shall give prior intimation to the Authority and obtain permission before the repair is taken up. When a defect is detected in a weld, it shall be removed by cutting/ grinding and smooth blending of the area with parent metal without sharp edges, corners. If welding is required, the same shall be done using the qualified procedure/ welder and stage inspection as per the original weld. Correction of defect in the same portion of the weld shall not be allowed more than two (2) times.

Portion of the welding seams which have been subjected to repair, must be indicated in the weld inspection reports.

5.8 INSPECTION AND TESTS ON STRUCTURAL STEEL FABRICATED MEMBERS

Inspection and tests on Structural Steel Fabricated Members shall be as set forth below:

- (a) All the fabricated parts of Structural Steel members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment and surface finish are in accordance with the requirements shown on the approved Contractor's shop drawings.
- (b) Fit ups shall be examined by the quality surveyor as per the approved QA plan prior to welding the joint. All welds shall be inspected for flaws by the method described under the **Clause 7.2** (Inspection Of welds).
- (c) The dimensions of the fit ups shall be maintained as specified in the fabrication drawings.
- (d) Dimensions of all the assemblies and sub-assemblies shall be as per fabrication drawings within the tolerances specified in IS: 7215.

Tolerances

The dimensional and weight tolerance for rolled shapes shall be in accordance with IS:1852 for indigenous steel and equivalent applicable codes for imported steel. The tolerances for fabrication of structural steel shall be as per IS:7215.

5.9 TEST FAILURE

In the event of any failure of welding, structural steel members to meet inspection or test requirements, the Contractor shall notify the Authority or his authorised representative. A design concession request has to be made and got approved from the Authority or his representative before repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair.

Contractor shall maintain records of all inspection and testing which shall be made available to the Authority or his authorized representative, for three years from the date of completion of the contract.

The Authority has the right to specify additional testing as he deems necessary, and the additional cost of such testing shall be borne by the Authority only in case of successful testing.

5.10 SHOP MATCHING

For structures like bunkers, tanks, etc. shop assembly is essential. For other steel work, such as columns along with the tie beams/ bracings may have to be shop assembled to ensure satisfactory fabrication, obtaining of adequate bearing areas etc. All these shop assemblies shall be carried out by **Contractor at no extra cost to the Authority.**

5.11 DRILLING HOLES FOR OTHER WORKS

As a part of this Contract, holes in members required for installing equipment or steel furnished by other manufacturers or other Contractors shall be drilled by the Contractor at no extra cost to the Authority. The information for such extra holes will be supplied by the Contractor.

5.12 MARKING OF MEMBERS

After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20 mm high and to such optimum depth as to be clearly visible.

All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt holes. The marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location.

Erection marks on like pieces shall be in identical locations. Members having lengths of 7.0 m or more shall have the erection mark at both ends.

5.13 ERRORS

Any error in shop fabrication, which prevents proper assembling and fitting up of parts in the field by moderate use of drift pins or moderate amount of reaming will be classified as defective workmanship. In case such material or defective workmanship, the same shall be replaced by the materials and workmanship requirements by Contractor free of cost at site.

5.14 SHOP PAINTING

Surface preparation and painting of steel surfaces shall be in accordance with Specification Part 7- Painting of Structural Steel.

5.15 QUALITY SURVEILLANCE

i. General

The Authority or his Authorized team (PMC) shall subject all works and

materials covered by this specification to Inspection if require.

The Contractor shall provide free access in his shop during working hours for the inspection staff, designated by the Authority, at all phases of the work and assist them where necessary in conducting the inspection. The Contractor shall expeditiously furnish all gauges, instruments and other necessary measuring equipment required for inspection of the work in the shop. The shop inspection by the inspector is intended to ensure that the material and workmanship are in accordance with this specification, but it will be not relieve the Contractor of any of his responsibilities for the product. The inspector's inspection will include, but not be limited to, the following:

ii. Material

The PMC (or Authorised person of Authority) will ascertain that only materials conforming to the requirements of this specification are used.

iii. Dimension And Tolerances

The PMC will ensure and check that the structural members conform to the dimensions and tolerances as set out on the drawings and as required by the specification.

iv. Welding Procedure

The PMC will witness the welding and testing of any procedure qualification tests that are required by this specification. The PMC will also check that welding procedure (including the electrode, flux, current, arc voltage, speed of travel) used are in accordance with the approved welding procedures.

v. Welding Equipment

The PMC will check the welding equipment to be used for the work to ensure that it is in such condition as to enable qualified welders to follow the procedures.

vi. Welder And Welding Operator Qualifications

The PMC will permit welding to be performed only by welders and welding operators who are qualified by tests in accordance with relevant standards.

When the quality of a welder or welding operators' work, appears to be below the requirements, the PMC may require testing of his qualifications by necessary tests.

vii. Welds

The PMC will ascertain that the sizes, length and the location of all welds conform to the requirements of this specification and the approved fabrication

drawings. Temporary welds used for the works shall be removed and ground flush with the original surface.

The PMC will identify with a distinguishing mark of all parts of the joints that he has inspected and accepted.

The Contractor shall comply with all the demands of the PMC to correct improper workmanship and to remove and replace, or correct as instructed, all welds found defective or deficient.

In the event of faulty welding or its removal for rewelding results in damage to the base metal in the judgment of the PMC, or its retention is not in accordance with the intent of the plans and specification, the Contractor shall remove and replace the damaged materials at his own cost.

6.0 ERECTION OF STRUCTURAL STEEL

6.1 SCOPE

This specification covers the general requirements for erection of structural steel. In addition to provision of erection and transport equipment, the scope of work includes supply of tools and tackles, consumables, materials, labour and supervision and shall cover the following:

Storing and staking of all fabricated structural components/ units/ assemblies at site storage yards till the time of erection.

Transportation of structures from storage yard to site of erection, including multiple handling, if required.

All minor rectifications/ modifications such as:

- (a) Removal of bends, kinks, twists, etc for parts damaged during transportation and handling.
- (b) Reaming of holes which do not fit properly or which are damaged, for use of next higher size bolt.
- (c) Plug-welding and re-drilling of holes which do not register and which cannot be reamed for use of next higher size bolt.
- (d) Drilling of holes which are either not drilled at all or are drilled in incorrect position during fabrication.

Fabrication of minor missing items as directed by the Authority if require.

Verification of the position of embedded anchor bolts and inserts with respect to lines and levels, installed by others based on Geodetic Scheme/ Bench Mark/ Reference co-ordinates to be furnished by Authority if require.

Verification of actual dimensions of structures (erected by others), which would have bearing on the cutting lengths, end connections, etc of those members which are to be erected under this scope of work.

Assembly at site of steel structural components wherever required, including temporary supports and staging.

Making arrangements for providing all facilities for

- (a) Conducting Ultrasonic Testing (UT) by reputed testing laboratories.
- (b) Making available test films/ graphs, with reports/ interpretation.

Rectifying at site damaged portions of shop primer by cleaning and application touch-up paint.

Erection of structures including making connections by bolts/ High strength Friction Grip bolts/ welding as per drawing.

Alignment of all structures true to line, plumb and dimensions within specified limits of tolerance.

Application at site after erection, required number of coats of primer and finishing paint as per specification.

Rectification of structures as per preliminary acceptance report and final acceptance report.

All necessary items of work required for satisfactory completion of job on schedule.

6.2 APPLICABLE CODES, STANDARDS AND SPECIFICATIONS

The pertinent clauses of the following Indian Codes, Standards and Specification (latest editions including all applicable official amendments, reaffirmations and revisions) shall apply to the material and workmanship covered by this specification. In the event of the conflict of certain requirements between this specification and the codes referred herein, this specification shall govern.

It is not the intent to specify herein all the codes and standards required for the satisfactory completion of work. The list of codes and standards indicates certain primary codes and standards and not all the codes required for the work under the contract. It is understood that all the pertinent codes and standards shall form the part of this specification whether explicitly indicated or not.

Reference codes and standards:

IS: 800	General Construction in Steel - Code of Practice.
IS 806	Code of Practice For Use of Steel Tubes In General Building Construction.
IS 822	Code of Procedure for Inspection of Welds.
IS 4000	High strength bolts in Steel Structures – Code of Practice.
IS 7205	Safety Code for erection of structural steelwork.
IS 7969	Safety Code for handling and storage of building materials.
IS 12843	Tolerances for erection of steel structures.
SP:6(1)	Structural Steel Sections.
AWS D1.1	Structural Welding Code: Steel.

6.3 REGULATORY REQUIREMENTS

The work covered in this specification, shall comply with all relevant government and local laws, regulations and standards. For subjects not covered by regulations, codes, standards or specifications, the materials and construction shall be based on good PMcing practice.

6.4 ERECTION SCHEME

Contractor after the award of work shall submit a detailed erection scheme covering the period of completion of all the works covered under this specification. The erection scheme shall include but not limited to the following:

- (a) Methods proposed to be employed for transporting his equipments, tools, tackles, gas cylinders, electrodes and all that is necessary to site.
- (b) Type, capacity and quantity of equipment that the Contractor proposes to bring to site for unloading, transporting within the site, handling, assembling, hoisting and erecting of the structural steel components for all these operations.
- (c) Strength and trade wise composition of the work force and supervisory personnel that will be deployed by the Contractor for the various operations.
- (d) Any special specific scheme being adopted for erection of special/ complicated structural elements.

A brief write-up covering the above activities shall be submitted along with the bid document by the Bidder during submission of his bid.

Authority reserves the right to direct the Contractor either at the start or during the contract period, to mobilise additional resources in terms of labour, material, equipment, tools and plant, etc. at no cost to the Authority if in his opinion the resources employed by the Contractor does not meet the schedule of completion.

6.5 ERECTION PROGRAMME

Within two (2) weeks of acceptance of bid, the Contractor shall submit a detailed erection programme with dates and estimated completion time for various parts of the work. This programme shall broadly comprise the following:

- (d) Layout plan identifying the areas proposed for unloading, main storage, subsidiary storage and assembly.
- (e) Transportation of fabricated material between the storage and work areas.
- (f) Layout to indicate the points at which proposed erection begins, direction in which it is proposed to progress, the deployment of equipment, access route for cranes to reach work areas, etc.
- (g) The locations and extent of site offices and stores, labour quarters, if any.
- (h) Layout of electrical cables and water pipes from the tap-off points.
- (i) Details of the method of handling, transport, hoisting and erection including false work/ staging, temporary bracing, guying, etc. along with complete details of the quantity and capacity of the various items of erection equipment that will be used.
- (j) Site organisation chart showing the number of supervisory personnel and the number and composition of the various gangs.

Any modifications to the erection programme for the reasons of inadequacy of

- (a) The quantity and/ or capacity of the erection equipment.
- (b) Erection personnel and supervisors, temporary bracing, guying, etc.
- (c) Safety of the erection methods or stability of the erected portions of structures or unsuitability of the erection sequence due to interference with the work of other agencies.
- (d) Any other unforeseen events, which may delay the schedule.

Shall be incorporated by Contractor and the work shall be carried out in accordance with the revised programme. Approval by Authority shall not relieve the Contractor from the responsibility for the safe, sound, accurate and timely erection of structural steel work. Contractor shall also make no extra claims for bringing additional equipment to site for erection.. Contractor shall be deemed to have visualised all erection problems while bidding for the work and no additional compensation shall be claimed on this account.

6.6 SITE OPERATIONS

Contractor shall employ an experienced and qualified PMC who shall be in full time charge of the job (at no cost to Authority) and responsible for all site activities. Contractor shall complete all preliminary works at site well before the arrival of structural steel, such as establishment of a well equipped and adequately staffed site office, stores, unloading gantry, unloading and pre-assembly yard, labour quarters if any, electrical and water connections, electrical winches, derricks, cranes, compressors, all tools and tackles, rivet guns, welding sets, torque wrenches, spud wrenches, staging, etc. as well as experienced erection and supervisory personnel as part of this contract and any other work that may be necessary so as to start erection immediately after the arrival of the first batch of steel at site.

Contractor shall furnish at his own expense, the necessary non-inflammable staging and hoisting materials or equipment required for the erection work and shall remove and take them away after completion of the job. Contractor shall also provide necessary passageways, fences, safety belts, helmets, lights and other fittings to the respective persons/labours and to meet the rules of local authorities and for protection to his men and materials. A licensed electrician shall be kept on the job for the entire duration of the work to maintain Contractor's electrical equipment and connections.

Contractor shall protect all existing plant, structures, piping, conduits, equipment and facilities against damage during erection. Any damage caused by Contractor shall be rectified entirely at Contractor's cost. If work has to be carried out adjacent to existing switch yards or electrical installations which are live, Contractor must ensure suitable safety precautions at site.

If a portion of the work of the project area cannot be made available to Contractor for his activities due to operations being carried out by other agencies, he shall suitably modify his sequence of operations so as to continue work without interruption. Contractor shall work in coordination with

other agencies working on the project site and plan his work suitably so as not to hinder the progress of construction at site.

6.7 ACCEPTANCE OF STEEL, ITS HANDLING AND STORAGE

The fabricated material received at erection site shall be verified with respect of marking on the key plan/ marking plan or shipping list.

Any material found damaged or defective shall be stacked separately and the damaged or defective material shall be painted in distinct colour for identification and the same shall be brought to the notice of Authority.

No dragging of steel shall be permitted. All fabricated items shall be stored 300 mm above ground on suitable packing to avoid damage. It shall be stored in the order required for erection, with erection marks visible. All storage areas shall be prepared and maintained by Contractor. Steel shall not be stored in the vicinity of areas where excavation or grading will be done and, if so stored temporarily, this shall be removed by Contractor well before such excavation and/ or grading commences to a safe distance to avoid burial under debris.

Scratched or abraded steel shall be given a coat of primer in accordance with specification Clause 7 – Painting of structural steel after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust/ corrosion by suitable coating and also from getting damaged.

6.8 ANCHOR BOLTS, EMBEDDED PARTS AND FOUNDATIONS

Contractor shall carefully check the location and layout of anchor bolts embedded in foundations constructed by others, to ensure that the structures can be properly erected as shown on the drawings. Any discrepancy in the anchor bolts/ foundation shall be reported to Authority (if require).

Contractor shall carefully check the actual dimensions of structures and also the location, level and sizes of embedded parts in the RC beam/ column, and/ or cleats/ plates provided in steel beam/ column constructed by others to receive structures covered under this scope of work.

Contractor shall take note of discrepancies, if any, report the same to Authority and fabricate the structures covered under this contract suitably before the commencement of erection.

Levelling of column bases to the required elevation may be done either by providing shims or three nuts on the upper threaded portion of the anchor bolt. All shim stock required for keeping the specified thickness of grout and in

connection with erection of structures on foundations, crane brackets or at any other locations shall be of good MS plates and shall be supplied by Contractor at his cost.

A certain amount of cleaning of foundations and preparing the area is considered normal and shall be carried out by Contractor at no extra cost.

Where beams bear in pockets or on walls, bearing plates shall be set and levelled as part of the work. All grouting under column base plates or beam bearing plates will be carried out by Contractor, unless the grouting is specifically excluded from the Contractor's scope.

6.9 ASSEMBLY AND CONNECTIONS

Field connections may be effected either by bolting, welding or by use of high strength friction grip bolts as shown in the design and erection drawings.

All bolts, nuts, washers, rivets, electrodes required for field connections shall be supplied by Contractor free of cost. The materials shall have necessary test certificates. Materials shall be procured from the reputed manufacturers. All assembling shall be carried out on a level platform.

Drifts shall be used only for drawing the work to proper position and must not be used to such an extent as to damage the holes. Size of drifts larger than the nominal diameter of hole shall not be used. Any damaged holes or burrs must be rectified.

Corrections of minor misfits and reasonable amount of reaming shall be considered as a part of erection. Any error in the shop, which prevents proper fit on a moderate amount of reaming and slight chipping or cutting, shall be immediately reported to Authority (if require).

6.10 ERECTION

Erection work shall be taken up after receipt of clearance. All structural steel shall be erected as per approved design/ fabrication drawings.

For safety requirements during erection, provisions of IS: 7205, IS: 7969 and other relevant codes shall be strictly followed.

Erection shall be carried out with the help of maximum mechanisation possible.

Prior to commencement of erection, all the erection equipment, tools, tackles, ropes, etc shall be tested for their load carrying capacity. Such tests may be repeated at intermediate stages also if considered necessary. Frequent visual

inspection shall be done of all vulnerable areas and components to detect damages or distress in the erection equipments, if any.

Temporary bracing, whenever required, shall be provided to sustain forces due to erection loads and equipment, etc. Erected parts of the structure shall remain stable during all stages of erection when subjected to action of wind, dead weight and erection forces, etc. Such bracings shall be left in place as long as may be required for safety and stability. Specified sequence of erection of vertical and horizontal structural members shall be followed.

Erected members shall be held securely in place by bolts to take care of dead load, wind/ seismic load and erection load.

All structural members shall be erected with erection marks in the same relative position as shown in the appropriate erection and shop drawings.

All connections shall achieve free expansion and contraction of structures wherever provided.

No final bolting or welding of joints shall be done until the structure has been properly aligned.

For positioning beams, columns and other steel members, the use of steel sledges is not permitted.

Instrumental checking of correctness of initial setting out of structures and adjustment of alignment shall be carried out in sequence and at different stages as required. The final levelling and alignment shall be carried out immediately after completion of each section of a building.

The Contractor shall design, manufacture, erect and provide false work, staging temporary support, etc. required for safe and accurate erection of structural steelwork and fully responsible for the adequacy of the same.

The Contractor shall also provide facilities such as adequate temporary access ladders, gangways, tools and tackles, instruments, etc. to Authority for his inspection at any stage during erection.

Proper size steel cable slings, etc., shall be used for hoisting. Guys shall not be anchored to existing structures, foundations, etc. Care shall be taken to see that ropes in use are always in good condition.

Steel columns in the basement, if any, are to be lowered and erected carefully with the help of a crane and/ or derrick without damaging the basement walls steel or floor.

Structural steel frames shall be erected plumb and true. Frames shall be lifted at such points that they are not liable to buckle and deform. Trusses shall be lifted only at node points. All steel columns and beams shall be checked for plumb and level individually before and after connections are made.

Chequered plates shall be fixed to supporting members by welding or by countersunk bolts as shown/ specified in relevant drawings. The edges shall be made smooth and no burrs or jagged ends shall be left. While splicing, care should be taken so that there is continuity in pattern between the two portions. Care should also be taken to avoid distortion of the plate while welding. The erection of chequered plates shall include:

- (a) Welding of stiffening angles/ vertical stiffening ribs as per drawings.
- (b) Cutting to size and making holes to required shape wherever necessary to allow service lines such as piping, cables, etc to pass through.
- (c) Splicing as shown in relevant drawings.
- (d) Smoothing of edges.
- (e) Fixing of chequered plates by welding and/ or countersunk bolts.
- (f) Providing lifting hooks for ease of lifting.

Cutting, heating or enlarging holes may be carried out only with prior written approval from the Authority (if require).

6.11 FIELD CONNECTIONS

i. Assembly by Permanent Bolts:

The number of washers on permanent bolts shall not be more than two (2) and not less than one (1) for the nuts and one (1) for the bolt head.

Only wooden rams or mallet shall be used in forcing members into position in order to protect the metal from injury or shock.

Where bolting is specified on the drawing, the bolts shall be tightened to the maximum limit. The threaded portion of each bolt shall project through the nut by at least one thread. Tapered washers shall be provided for all heads and nuts to achieve uniform bearing on sloping surface.

To prevent loosening of nuts, spring washers or lock-nuts shall be provided as specified in the design/ shop drawings.

All machine fitted bolts shall be perfectly tight and the ends shall be checked to prevent nuts from becoming loose. No unfilled holes shall be left in any part of the structure.

ii. Assembly By Welding:

All field assembly by welding shall be executed in accordance with the requirements for shop fabrication. Where the steel has been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints to be welded.

All other requirements of welding and its acceptance standards shall be in accordance with clauses specified in Clause 5 - Supply and fabrication of structural steel.

iii. Assembly By High Strength Friction Grip Bolts (HSFG Bolts)

Assembly of structures with HSFG bolts shall conform to IS: 4000.

The mating surface shall be prepared in accordance with the requirements of design in order to achieve required properties to develop adequate friction between the surfaces.

The mating surfaces shall be absolutely free from grease. Lubricant, dust, rust etc and shall be thoroughly cleaned before assembly.

The nuts shall be tightened up to the specific torque with the help of torque-wrench or by half-turn method with the help of pneumatic wrench lever.

The direction of tightening of the nuts shall be from the middle towards the periphery of assembly.

After desired tightening the bolt heads, nuts and edges of the mating surfaces shall be sealed with a coat of paint to obviate entry of moisture.

6.12 INSPECTION

Authority or their authorised representatives shall have free access to all parts of the job during erection and all erection shall be subjected to their approval. In case of faulty erection, all dismantling and re-erection required will be at Contractor's cost. No paint shall be applied to rivet heads or field welds or bolts until these have been approved by Authority if require.

6.13 TOLERANCES

Tolerances mentioned below shall be achieved after the entire structure or part thereof is in line, level and plumb. The tolerances specified below do not apply to steel structures where the deviations from true position are intimately linked with and directly influence technological process. In such cases, the tolerances on erected steel structures shall be as per recommendations of process technologists/suppliers which will be indicated in the drawings.

i. Columns

Deviation of column axes at foundation top level with respect to true axes

(a) In longitudinal direction : ± 5 mm

(b) In lateral direction : ± 5 mm

Deviation in the level of bearing surface of columns at foundation top with respect to true level. ± 5 mm

Out of plumb (verticality) of column axis from true vertical axis, as measured at column top:

(a) For columns up to and including 15 metres in height. $\pm 1/1000$ of column height in mm or ± 15 mm whichever is less.

(b) For columns exceeding 15 metres in height. $\pm 1/1000$ of column height in mm or ± 20 mm whichever is less.

Deviation in straightness in longitudinal and transverse planes of column at any point along the height. $\pm 1/1000$ of column height in mm or ± 10 mm whichever is less.

Difference in erected position of adjacent pairs of columns along length or across width of building prior to connecting width of building prior to connecting trusses/ beams with respect to true distance. ± 10 mm

Deviation in any bearing or seating level with respect to true level. ± 5 mm

Deviation in differences in bearing levels of a member on adjacent pair of columns both across and along the building. ± 10 mm

ii. Trusses and Beams

Shift at the centre of span of top chord member with respect to the vertical plane passing through the centre of bottom chord. $\pm 1/250$ of height of truss in mm or ± 15 mm whichever is less.

Lateral shift of top chord of truss at the centre of span from the vertical plane whichever passing through the centre of supports of the truss.	$\pm 1/1500$ of span of truss in mm or ± 15 mm is less.
Lateral shift in location of truss from its true vertical position.	± 10 mm
Lateral shift in location of purlin true position.	± 5 mm
Deviation in difference of bearing levels of trusses or beams from the true difference.	i. ± 20 mm for trusses ii. For beams: Depth < 1800 mm: ± 6 mm Depth > 1800 mm: ± 10 mm
Deviation in sag in chords and diagonals of truss between node points.	$1/1500$ of length in mm or 10mm whichever is smaller.
Deviation in sweep of trusses, beams etc in the horizontal plane.	$1/1000$ of span in mm subject to a maximum of 10 mm.
iii. <u>Crane Girders and Rails</u>	
Shift in the centre line of crane rail with respect to centre line of web of crane girder.	± 5 mm
Shift in plan of alignment of crane rail with respect to true axis of crane rail at any point.	± 5 mm
Difference in alignment of crane rail in plan measured between any two points 2 metres apart along rail.	± 1 mm
Deviation in crane track with respect to true gauge.	
(a) For track gauges up to and including 15 metres.	± 5 mm
(b) For track gauges more than 15 metres.	$\pm [5 + 0.25 (S-15)]$ where S in metres is true gauge.
Deviation in the crane rail level at any distance point from true level.	$1/1200$ of the gauge or ± 10 mm whichever is less.

Difference in the crane rail actual levels between any two points 2 metres apart along the rail length.	± 2 mm
Difference in levels between crane track rails at	
(a) Supports of crane girders	± 15 mm
(b) Mid span of crane girders	± 20 mm
Relative shift of crane rail surfaces at a joint in plan and elevation.	2 mm subject to grinding of surfaces for smooth transition.
Relative shift in the location of crane stops (end buffers) along the crane tracks with track gauge S in mm.	1/1000 of track gauge S in mm subject to maximum of 20 mm.

6.14 CLEAN UP OF WORK SITE

During erection, the Contractor shall without any additional payment, at all times keep the working and storage areas used by him, free from accumulation of waste materials or rubbish. Before completion of erection, he shall remove or dispose of in a satisfactory manner all temporary structures, waste and debris and leave the premises in a condition satisfactory to Authority.

7.0 PAINING OF STRUCTURAL STEEL

7.1 SCOPE

This specification covers the general requirements for shop and field painting for Structural Steel works using hot/ cold rolled steel sections joined by using bolting and/ or welding.

Briefly the scope of works covered under this specification is as follows:

- (a) Supply of all primers, paints and all other materials required for painting other than Authority's Supply;
- (b) Furnishing of all labour, materials, tools and equipment and the performance of all operations and incidentals necessary for surface preparation, painting, handling, storing, transporting, scaffolding, etc.;
- (c) Testing of paints as per the relevant codes in the Standard Laboratory identified by the Authority (if require) and furnishing of required test certificates for Authority's approval (if require);

- (d) Repair work of damaged shop primer.
- (e) Inspection of painting system after its application to conform to the specification requirement;
- (f) Any other requirement, as required, for satisfactory completion of specified work.

7.2 EXCLUSIONS

This specification excludes painting of the following structures/ equipment, Mechanical and Electrical equipment and parts:

- (a) Buried and Overhead piping works.
- (b) Storage tanks.
- (c) Insulated parts.
- (d) Any other items of work specifically excluded in the scope of works.

7.3 APPLICABLE CODES AND STANDARDS

The pertinent clauses of the following Indian/ International Codes, Standards and Specification (latest editions including all applicable official amendments, reaffirmations and revisions) shall apply to the material and workmanship covered by this specification. In the event of the conflict of certain requirements between this specification and the codes referred herein, this specification shall govern.

It is not the intent to specify herein all the codes and standards required for the satisfactory completion of work. The list of codes and standards indicates certain primary codes and standards and not all the codes required for the work under the contract. It is understood that all the pertinent codes and standards shall form the part of this specification whether explicitly indicated or not.

i. IS Codes

- a) IS: 5 Colours for ready mixed paints and Enamels.
- b) IS: 101 Methods of sampling and test for paints, varnishes and related products (all parts and all sections).
- c) IS: 104 Ready mixed paint, brushing, zinc chrome, priming.
- d) IS: 158 Ready Mixed paint, Brushing, Bituminous, Black, Lead free, Acid, Alkali and heat resisting.
- e) IS: 1303 Glossary of Terms relating to paints

- f) IS: 1477 Code of practice for painting of ferrous metals in Buildings; Part I: Pre treatment; Part II: Painting.
- g) IS: 2932 Enamel, synthetic, exterior: (a) undercoating (b) finishing – Specification.
- h) IS: 9954 Pictorial Surface Preparation Standards for Painting of Steel Surfaces.
- i) IS: 13183 Aluminium paint, Heat resistant-specification.

ii. International Standard Codes

- a) SSPC Society for Protective Coatings (USA) Vols. I and II.
- b) NACE National Association of Corrosion Engineers, USA (NACE).
- c) ISO 8501 Preparation of Steel Substrates before application of paints and related products. Visual assessment of surface cleanliness (Parts 1-4).
- d) ISO 8502 Preparation of Steel Substrates before application of paints and related products - Tests for assessment of surface cleanliness (Parts 1-4).
- e) ISO 8503 Preparation of Steel Substrates before application of paints and related products - Surface roughness characteristics of blast-cleaned steel substrates. (Parts 1 and 2).
- f) ISO 8504 Preparation of Steel Substrates before application of paints and related products - Surface preparation methods (Parts 1-3).
- g) ISO 12944 Paints and Varnishes - Corrosion Protection of Steel Structures by Protective Paint System (Parts 1-8).

7.4 HEALTH, SAFETY AND REGULATORY REQUIREMENTS

The work covered in this specification shall comply with all relevant government and local laws, regulations and standards. For subjects not covered by regulations, codes, standards or specifications, the materials and construction shall be based on good engineering practice.

Contractor shall ensure that all health and safety regulations are observed for the erection of scaffolding and use of the selected paint material.

All necessary precautions shall be taken to ensure the safety of personnel and property. Extreme caution shall be used when working with oil or oil-based paints, cleaning fluids, etc., especially in close proximity to oxygen piping or oxygen equipment. Heavy concentrations of volatile or toxic fumes must be avoided and in confined areas, blowers or exhaust fans shall be used.

Rags and other waste material soiled with paints, thinners or solvents shall be kept in tightly closed metal containers while on the job site and not in use. Legal disposal of waste materials outside plant site premises is Contractor's responsibility.

7.5 SURFACE PREPARATION OF STEEL

One or more of the following methods of surface preparation shall be followed, depending on condition of steel surface and as specified data sheet. Authority reserves the right to instruct the type of surface preparation depending upon the condition of material. Recommended methods of surface preparation of steel briefly are as under.

- (a) Solvent cleaning.
- (b) Manual or hand tool cleaning.
- (c) Mechanical or power tool cleaning.
- (d) Abrasive Blast cleaning.

It is necessary that the Contractor may have to resort to any one or combination of the above method of surface preparation to achieve the required acceptable standard. Hence the rate quoted shall take into account for such preparation.

i. Solvent Cleaning:

The removal of all contaminants like oil, grease, etc. shall be carried out either by special solvents or by degreasing agents. Application and cleaning of solvents shall be as per manufacturer's instructions and shall be in accordance with SSPC-SP1.

ii. Manual Or Hand Tool Cleaning:

This method of cleaning shall be used to remove all loose mill scale, loose rust, loose paint and other loose detrimental foreign matter by use of non-

powered hand tools. The minimum acceptable standards in case of manual or hand tool cleaning shall be in accordance with ISO 8501- St2/ SSPC-SP2.

iii. Mechanical Or Power Tool Cleaning

This method of cleaning shall be used to remove all mill scale, rust, paint and other detrimental foreign matter by use of power assisted hand tools. The minimum acceptable standards in case of power tool cleaning shall be in accordance with ISO 8501- St3/ SSPC-SP3.

iv. Abrasive Blast Cleaning (Shot Blasting/ Grit Blasting)

Shot/ Grit blasting shall be resorted to only after removal of grease, oil and other contaminants as per SSPC-SP-1. Special care shall be taken on weld areas to remove flux and spatter. Precautions shall be taken when grit or shot blasting of light gauge steel surfaces, to ensure that buckling does not occur due to continuous impingement of grit or steel shots under high velocity. Surface anchor profiles shall be measured by Testex tape - press-o-film and the finished surfaces shall conform to the requirements of ISO 8501- Sa 2½/ SSPC-SP10.

Blast cleaning shall not be performed where dust can contaminate the surfaces undergoing such cleaning or during humid weather conditions having humidity exceeding 85%.

v. Tests On Surface Preparations

The following inspection and tests shall be performed on the steel surfaces subjected to surface preparation. Test / inspection reports shall be submitted to Authority for his approval and acceptance (if require).

- (a) Visual examination of surface preparation with comparators.
- (b) Profile check of the prepared surface with suitable "profilometer" e.g. TESTEX method.

7.6 PAINT MATERIAL

i. Procurement:

All types of paint required for the work shall be procured from the reputed manufacturers. List of some of the manufacturers are as under. However Contractor shall obtain the detailed list of approved paint manufacturers before initiating the procurement action.

- (a) Asian Paints (I) Ltd.
- (b) Berger Paints Ltd.
- (c) Cipy Polyurethane Pvt Ltd.

ii. Storage:

The Paint material shall be stored strictly in accordance with the instructions of the paint manufacturer. In general painting materials should be stored in dry, cool, well ventilated and frost free area.

iii. Packing

All paints delivered to the fabrication shop/ site shall be in original sealed container, as packed by the manufacturer. Paint containers shall clearly mark with paint manufacturer's name, batch number, date of manufacture, shelf life and a clear indication of the type and colour of the product.

iv. Mixing

Paint shall be thoroughly mixed prior to application. Mixing shall be done in a well-ventilated, clean and dust free area. Paint shall be mixed by rotating power mixers or rolling rigs, until a uniform consistency is achieved.

Multiple pack paint materials shall be mixed in accordance and under the conditions as specified by the paint manufacturer. Pot life as specified by the paint manufacturer shall be strictly followed.

v. Thinner And Solvents

Only additives, thinners, solvents, etc as recommended by the paint manufacturer shall be used. A possible extension of the "pot life" by additions of thinners is prohibited.

vi. Tests On Paint

In order to ensure that the supplied paint meets the stipulations, samples of paint shall be tested in laboratories to establish quality of paint with respect to

- (a) Viscosity.
- (b) Adhesion/ bond of paint on steel surfaces.
- (c) Adhesion/ simulated salt spray test.
- (d) Chemical analysis (percentage of solids by weight).
- (e) Normal wear resistance as encountered during handling and erection.
- (f) Resistance against exposure to acid fumes, etc.

Alternatively manufacturer's test certificates shall be furnished by the Painting Contractor in respect of above tests. Authority reserves the right to test the paint material either before the commencement of work or during the progress of work, if in his opinion the paints supplied are of inferior quality and does not meet the codal requirements.

vii. Paint Sample

Before buying the paint in bulk, it is recommended to obtain sample of paint and establish "Control Area of Painting". On control area surface preparation, painting shall be carried out in the presence of Authority (if require) and the Manufacturer of paint.

viii. Finishing Paint

Colour/ shade of the finishing paint shall be as per the choice of the Authority and Contractor shall obtain prior approval before procurement action is initiated by him.

7.7 PAINT APPLICATION

Painting shall be carried out by any one or the combination of the following method of application to suit the site condition and the type of paint being used. Manufacturer's recommended method of application shall be strictly followed.

- (a) Brush Application.
- (b) Roller Application.
- (c) Spray Application.

i. Brush Application

Brush application of paint shall be in accordance with the following:

- (a) Brushes shall be of a style and quality that will enable proper application of paint.
- (b) Round, oval or wide flat brushes shall be used depending upon the surface irregularity, rough or pitted steel, large flat painting areas, etc.
- (c) There shall be a minimum of brush marks left in the applied paint.
- (d) Surfaces not accessible to brushes shall be painted by spray.

ii. Roller Application

Suitable rollers of different nap length to suit varying surface roughness shall be used. Rollers are not generally recommended for application of primers. Roller application shall only be used if the first or priming coat of paint has been applied by brush or other means. Manufacturer's recommendation shall be strictly followed for roller applied paints.

iii. Spray Application

Airless or pneumatic spray application shall be in accordance with the following:

- (a) Airless spray application shall be as per steel structure paint Manual Vol 1 and Vol 2 SSPC, USA.

- (b) Spraying shall be carried out keeping the spray gun at the minimum suitable distance from the work piece and consistently at 90⁰ to the surface being painted.
- (c) Correct spray tips, air pressures, etc. as recommended by the equipment supplier shall be used.

Air spray application shall be in accordance with the following:

- (a) The equipment used shall be suitable for the intended purpose, shall be capable of properly atomising the paint to be applied, and shall be equipped with suitable pressure regulators and gauges.
- (b) Appropriate pressure and nozzles shall be those recommended by the manufacturer of the equipment for the material being sprayed. The equipment shall be kept in satisfactory condition to permit proper paint application.
- (c) Correct combination of air volume, air pressure and fluid flow to give good atomisation shall be ensured to get a defect free painted surface.
- (d) Traps or separators shall be provided to remove oil and condensed water from the air. These traps or separators must be of adequate size and must be drained periodically during operations. The air from the spray gun impinging against the surface shall show no condensed water or oil.
- (e) Ingredients shall be kept properly mixed in the spray pots or containers during application by continuous mechanical agitation.
- (f) Spray equipment shall be kept sufficiently clean so that dirt, dried paint and other foreign materials are not deposited in the paint film. Any solvents left in the equipment shall be completely removed before applying paint to the surface being painted.

Selection of type of spray application shall depend upon the type of paint coating being used. At all time paint manufacturer's recommendation shall be strictly followed.

7.8 COATING PROCEDURE

i. Compatibility

General compatibility between primer, intermediate and top coats, as applicable for individual painting system, shall be established through the paint manufacturer supplying the paints. Primer and finishing paint for the

entire project shall preferably be procured from the same manufacturer. Mixing of material from different manufacturers is strictly prohibited.

Surface shall not be coated in rain, wind, when steel surface temperature is less than 5° C or when the relative humidity is greater than 85%.

Applied paint system shall be allowed to cure at ambient and surface temperatures between 10° C and 60° C with relative humidity below 85%. All paint shall be air cured.

A suitable test area (approx 0.5 m²) shall be painted with agreed paint system. The test area shall be fully coated with all coats of the agreed coating system using the tools and equipment to be used for the actual coating work. The painted test area shall be maintained for the duration of the project. Painting on test piece shall be carried out such that all the coats shall be made visible for reference at all time.

Structural steel shall be preferably prime coated at shop and subsequent finish coats shall be carried out at site after the alignment and erection is complete. Portions of structural steel members to be embedded in the concrete shall not be painted.

Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly.

Surfaces inaccessible after erection, including top surfaces of floor beams supporting grating/ chequered plate shall receive one additional coat of finish paint over and above the number of coats specified prior to erection.

Each coat of paint material shall be applied as a continuous film of uniform thickness and free of pores. Any spot or areas missed in application shall be recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.

Each coat shall be in proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for recoating when an additional coat can be applied without development of any detrimental film irregularities, such as lifting or loss of adhesion of the under coat. Manufacturer's instruction shall be strictly followed for intercoat intervals.

No paint shall be force dried under conditions, which will cause checking, wrinkling, blistering, formation of pores or detrimentally affect the condition of the paint.

No drier shall be added to paint on the job, unless specifically called for in the manufacturer's specification for the paint.

Paint shall be protected from rain, condensation, contamination, snow and freezing until dry to the fullest extent practicable.

Blast cleaned surface shall be coated with one coat of primer before surface degradation occurs, but in no case later than 3 hours. Irrespective of the method of surface preparation, the first coat of primer shall be applied not later than 2-3 hours after preparation and on dry surface.

When the successive coat of the same colour is specified, alternate coat shall be tinted as far as practicable; sufficiently to produce enough contrast to indicate complete coverage of the surface. The tinting material shall be compatible with the material and not detrimental to its service life.

All field-welded areas on shop-painted item shall be mechanically cleaned (including the weld area proper, adjacent areas contaminated by weld spatter or fumes and areas where existing primer, intermediate/ finishing paint is burnt). Subsequently, new primer and finishing coats of paint shall be applied as per painting specification.

Care shall be taken to protect adjacent equipment, piping, structures, etc., from spillage and spatter during field painting by use of adequate temporary covers. If surfaces are accidentally spattered or sprayed, the paint shall be immediately and thoroughly removed. For cleaning of spillages, an inert absorbent material shall be used.

All structures shall receive appropriate number of primer, intermediate and finishing coats in order to achieve overall DFT as per the drawings/ specifications/ data sheets.

7.9 PAINTING SYSTEM

The recommended painting system for all structural steel works, unless otherwise noted, covering surface preparation, application of primer coats, intermediate coats (if specified) and final coats to develop required minimum DFT shall be as specified below:

Paint System	Surface Preparation	Primer Coat (µm)	Top Coat (µm)	Total DFT (µm)
PS-2	Sa 2½	Inorganic Zinc Sulphate	HB Epoxy Polyamide	150

		(1x75 = 75)	(Pigmented) (1x75 = 75)	
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The painting system for application of fire intumescent paint and top coat shall be as specified in the Schedule of Quantities.

7.10 REPAIR OF COATED SURFACE

Wherever shop primer painting is scratched, abraded or damaged, the surfaces shall be thoroughly cleaned using emery paper and power driven wire brush wherever warranted, and touched up with corresponding primer. Touching up paint shall be matched and blended to eliminate conspicuous marks.

If more than 30% area of the painted surface of an item requires repair, the entire surface shall be repainted. In such an event no extra payment will be permitted.

7.11 TEST ON PAINTING SYSTEM

Following inspection and tests shall be performed during and after the application of paint system:

- (a) Wet Film Thickness (WFT) spot checks shall be carried out during the course of painting operation to ensure that film thickness is being maintained.
- (b) Dry Film Thickness (DFT) check of intermediate and final coating layers in accordance with the specification and/ or paint manufacturer's recommendation.
- (c) Quality of adhesion between the coating system and the steel substrate and of the adhesion between the coatings layers shall not be less than those specified in the Codes/ Standards.
- (d) Porosity Check: Holiday detection test shall be carried out and all indications shall be repaired as per approved repair procedures.

7.12 FINAL INSPECTION

As part of the Quality Assurance, a final inspection in the presence of the representatives of Authority and Contractor shall be conducted prior to the final acceptance of the paintwork. Part of this final inspection checks shall include:

- (a) Visual check of the appearance.
- (b) Checks on DFTs of the total applied coating system.

- (c) Shade verification.
- (d) Holiday Testing.
- (e) Scratch Test.
- (f) Adhesion test.

As part of acceptance procedure, a report shall be prepared that shall include:

- i. General:
 - (a) Name of the Painting Contractor and the responsible personnel.
 - (b) Scope of work.
 - (c) Dates when the work was carried out.
 - (d) Copy of the work and Quality Plan
 - (e) Deviations from this Specification and/ or the Quality Plan.
- ii. Inspection equipment
 - (a) Type and calibration of instruments used.
- iii. Surface Preparation
 - (a) Condition of surface before preparation.
 - (b) Checks on the requirements as specified for cleaned surface.
- iv. Coating application
 - (a) Information on coating systems being applied (i.e. product names, DFTs).
 - (b) Checks on requirements as specified for coating application.
 - (c) Check on dry film thicknesses of the total coating system applied.
- v. Conditions
 - (a) Checks on humidity, dew point and substrate temperature.
- vi. Inspection reports
 - (a) Copy of the inspection reports of the Contractor.
 - (b) Inspection from an independent third party.

7.13 DOCUMENTATION

Contractor shall keep records and furnish the following documents to the Authority:

- (a) A written Quality Plan with procedure for qualification trials and for the actual work,
- (b) Daily progress report with details of weather conditions, particular of applications, number of coats and type of material applied, anomalies, progress of work versus program,

- (c) Results of measurement of temperatures, relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority,
- (d) Particulars of surface preparation and paint application during trials and during the work,
- (e) Details of non-compliance, rejects and repairs,
- (f) Type of testing equipments and calibration,
- (g) Code and batch numbers of paint materials used including shelf life,
- (h) Visual examination of surface preparation compared with the standards,
- (i) Profile check of the prepared surface with suitable “profilometer”,
- (j) Dry film thickness check of intermediate and final coating layers, in accordance with the specification and/ or paint manufacturer’s recommendation, and
- (k) Checks/ tests carried out as per clauses above.

7.14 GUARANTEE

The paint system shall provide sufficient protection of the underlying steel surface against the attack of the environment, other than mechanical damage, chemical spillage as result of operational activities or other unusual occurrences from the outside caused by others.

The Contractor is fully responsible for the quality of the work and for all related QA/ QC activities as indicated in the specification.

The Contractor shall guarantee quality of their coating works for the period specified in for the coating condition as specified below.

The guarantee period starts from the date of acceptance of Contractor’s paint work.

Initial acceptance of any new coating work by Authority will not release the Contractor of his obligation under this section until final inspection has been carried out and acceptance of the completed work has been agreed in writing.

These guarantee clauses regarding coating specifications are prevailing and supersede the warrantee requirements in General Conditions of Contract.

8.0 DISMANTLING

SCOPE

Contractor has to dismantle railing, kerbs, Guard Rail RC Post, Brick work in steps, Tiles, Rubble masonry Retaining wall, existing Building as per scope of work and specified in proposal document, as shown in drawings or as directed by the Engineer -In-Charge. The work shall be executed in accordance with Indian standards and Specifications. Dismantled material shall be stacked or shall be neatly piled at points designated by the Engineer - In-Charge.

APPLICABLE CODES

List of Codes & Standards

	IS Code No.		Subject
❖	IS 1200	-	(Pt – XVIII) Method of Measurements of Building and Civil Engineering Works (Part –XVIII) Demolition and Dismantling
❖	IS 4130	-	Demolition of Buildings–Code of Safety

GENERAL

Precautions - All materials obtained from dismantling or demolition shall be the property of the CLIENT unless otherwise specified and shall be kept in safe custody until they are handed over to the Engineer-in-Charge/ authorized representative. The demolition shall always be well planned before hand and shall generally be done in reverse order of the one in which the structure was constructed. The operations shall be got approved from the Engineer-in-Charge before starting the work.

Due care shall be taken to maintain the safety measures prescribed in IS 4130. Necessary propping, shoring and or under pinning shall be provided to ensure the safety of the adjoining work or property before dismantling and demolishing is taken up and the work shall be carried out in such a way that no damage is caused to the adjoining work or property.

Wherever specified, temporary enclosures or partitions and necessary scaffolding with suitable double scaffolding and proper cloth covering shall also be provided, as directed by the Engineer-in-Charge.

Necessary precautions shall be taken to keep noise and dust nuisance to the minimum. All work needs to be done under the direction of Engineer-in-

Charge. Helmets, goggles, safety belts etc. should be used whenever required and as directed by the Engineer-in-Charge. The demolition work shall be proceeded with in such a way that it causes the least damage and nuisance to the adjoining building and the public. Dismantling shall be done in a systematic manner. All materials which are likely to be damaged by dropping from a height or by demolishing roofs, masonry etc. shall be carefully removed first. Chisels and cutters may be used carefully as directed. The dismantled articles shall be removed manually or otherwise, lowered to the ground (and not thrown) and then properly stacked as directed by the Engineer-in-Charge. Where existing fixing is done by nails, screws, bolts, rivets, etc., dismantling shall be done by taking out the fixing with proper tools and not by tearing or ripping off. Any serviceable material, obtained during dismantling or demolition, shall be separated out and stacked properly as directed by the Engineer-in-Charge within. All unserviceable materials, rubbish etc. shall be disposed off as directed by the Engineer-in-Charge. The contractor shall maintain/disconnect existing services, whether temporary or permanent, where required by the Engineer-in-Charge. No demolition work should be carried out at night. Screens shall be placed where necessary to prevent injuries due to falling pieces. Water may be used to reduce dust while tearing down plaster from brick work. Safety belts shall be used by labours while working at higher level to prevent falling from the structure. First-aid equipment shall be got available at all demolition works of any magnitude.

9.0 SPECIFICATIONS FOR DEWATERING

SCOPE

This specification covers the general requirements of dewatering excavations in general.

GENERAL REQUIREMENTS

All excavations shall be kept free of water. Grading in the vicinity of excavation shall be properly closed to prevent surface water running into excavated areas. Contractor shall remove by pumping or other means approved by Engineer-In-Charge any water inclusive of rain water and subsoil water accumulated in excavation and keep all excavations dewatered until the foundation work is completed and backfilled. Sumps made for dewatering must be kept clear of the excavations / trenches required for further work. Method of pumping shall be approved by Engineer-In-Charge; 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. Pumping arrangements shall be adequate to ensure no delays in construction.

When there is a continuous inflow of water and quantum of water to be handled is considered in the opinion of Engineer-In-Charge, as large, well point system - Single stage or multi stage, shall be adopted. Contractor shall submit to Engineer-In-Charge his scheme of well point system including the stages, the spacing, number and diameter of well points, headers etc., and the numbers, capacity and location of pumps of approvals. Unless separately provided for in the Schedule of prices, the cost of dewatering shall be included in the item rate for excavation.

10.0 MASONARY WORKS

SCOPE

This specification covers the general requirements for brick and stone masonry work, flooring, doors, water- proofing, plastering, painting and such other related works forming a part of this job, which may be required to be carried out though not specifically mentioned above. The works under this specification shall consist of furnishing of all tools, plants, labour, materials, and everything necessary for carrying out the works.

APPLICABLE CODES AND SPECIFICATIONS

The following codes, standards and specifications are made a part of this specification. All standards, specifications, codes of practice referred to herein shall be the latest version on the date of offer made by the Bidder.

In case of discrepancy between this specification and those referred to herein, this specification shall govern.

List of Codes & Standards

IS Code No.	Subject
Materials	
□ IS: 110	- Ready mixed paint, brushing, grey filler, for enamels for use over primers.
□ IS: 426	- Paste filler for Colour coats.
□ IS: 428	- Distemper, oil emulsion, Colour as required.
□ IS: 1077	- Specification for common burnt clay building bricks.
□ IS: 1081	- Code of practice for fixing and glazing of metal (steel & aluminium) doors, windows and ventilators.
□ IS: 1124	- Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.
□ IS: 1200	- Method of measurement of building and civil engineering works.
□ IS: 1237	- Specification for cement concrete flooring tiles.
□ IS: 1346	- Code of practice for water-proofing of roofs with bitumen felts.
□ IS: 1443	- Code of practice for laying and finishing of cement concrete flooring tiles.
□ IS: 1542	- Specification for sand for plaster.
□ IS: 1597	- Code of practice for construction of stone masonry: Part 1 Rubble stone masonry.
□ IS: 1661	- Code of practice for application of cement and cement-lime plaster finishes.
□ IS: 1838	- Specification for preformed fillers for expansion joint in concrete pavements and structures (non-extruding and resilient type): Part 1 Bitumen impregnated fibre.
□ IS: 2116	- Specification for sand for masonry mortars.
□ IS: 2185	- Specification for concrete masonry units (Parts 1, 2 & 3).
□ IS: 2212	- Code of practice for brickwork.
□ IS: 2250	- Code of practice for preparation and use of masonry mortars.
□ IS: 2339	- Aluminium paint for general purposes, in dual container.
□ IS: 2395	- Code of practice for painting Concrete, masonry and plaster surfaces (Part 1 & Part 2).
□ IS: 2571	- Code of practice for laying in-situ cement concrete flooring.
□ IS: 2690	- Specification for burnt clay flat terracing tiles: Part 1 Machine

	IS Code No.	Subject
		made.
□	IS: 2691	- Specification for burnt clay facing bricks.
□	IS: 2750	- Specification for steel scaffoldings.
□	IS: 3036	- Code of practice for laying lime concrete for a water-proofed roof finish.
□	IS: 3067	- Code of practice of general design details and preparatory work for damp-proofing and water-proofing of buildings.
□	IS: 3068	- Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete.
□	IS: 3384	- Specification for bitumen primer for use in water-proofing and damp-proofing.
□	IS: 3495	- Method of test for burnt clay building bricks : Part 1 to 4.
□	IS: 5410	- Cement paint, colour as required.
□	IS: 8042	- Specification for white Portland cement.
□	IS: 8112	- Specification for 43 grade ordinary Portland cement.
□	IS: 8543	- Methods of Testing Plastics (Part 4 / Section 1)
□	IS: 15058	- PVC water stops at transverse contraction joints – specification.

BRICKWORK

1. Materials

(a) Bricks used in the works shall conform to the requirements laid down in IS: 1077. The class of the bricks shall be as specifically indicated in the respective items of work.

(b) Standard modular size of common bricks shall be 190mm x 90mm x 90mm as per IS: 1077. The nominal thickness of one brick and half brick walls using modular bricks shall be considered as 200 mm and 100 mm respectively. In the event of use of non-modular bricks, standard size shall be 230mm x 110mm x 70mm. The nominal thickness of one brick and half brick walls using non-modular bricks shall be considered as 230 mm and 115 mm respectively. The dimensional tolerances of modular and non-modular sized bricks over the standard sizes shall be as per IS 1077.

(c) Bricks shall be sound, hard, homogenous in texture, well burnt in kiln without being vitrified, hand/machine moulded, deep red, cherry or copper coloured, of regular shape and size & shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaws and nodules of free lime. Hand moulded bricks shall be moulded with a frog and those made by extrusion process may not be provided with a

frog. Bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 5N/sq.mm unless otherwise specified in the item.

(d) The average water absorption shall not be more than 20 percent by weight upto class 12.5 and 15 percent by weight for higher classes. Bricks which do not conform to this requirement shall be rejected. Over or under burnt bricks are not acceptable for use in the works.

(e) Sample bricks shall be submitted to the ENGINEER for approval and bricks supplied shall conform to approved samples. If demanded by ENGINEER, brick samples shall be got tested as per IS: 3495 by CONTRACTOR at no extra cost to OWNER. Bricks rejected by ENGINEER shall be removed from the site of works within 24 hours.

(f) Mortar for brick masonry shall consist of cement and sand and shall be prepared as per IS: 2250. Mix shall be in the proportion of 1:5 for all brickworks, unless otherwise specified in the respective items of work. Sand for masonry mortar shall conform to IS: 2116. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by ENGINEER. If so directed by the ENGINEER, sand shall be screened and washed till it satisfies the limits of deleterious materials.

(g) For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Mixing shall be done thoroughly in a mechanical mixer, unless hand mixing is specifically permitted by ENGINEER. The mortar thus mixed shall be used as soon as possible, preferably within 30 minutes from the time water is added to cement. In case, the mortar has stiffened due to evaporation of water, this may be re-tempered by adding water as required to restore consistency, but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and shall be removed forthwith from the site. Droppings of mortar shall not be re-used under any circumstances.

(h) The CONTRACTOR shall arrange for test on mortar samples if so directed by ENGINEER.

2.

Workmanship

(a) Workmanship of brick work shall conform to IS: 2212. All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid.

(b) The cement mortar for brick masonry work shall be as specified in the respective item of work. Brick work 200mm/230mm thick and over shall be laid in English Bond unless otherwise specified. 100mm/115mm thick brickwork shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be slightly pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Only full-size bricks shall be used for the works and cut bricks utilized only to make up required wall length or for bonding. Bricks shall be laid with frogs uppermost.

(c) All brickwork shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. In case of one brick thick or half brick thick wall, at least one face should be kept smooth and plane, even if the other is slightly rough due to variation in size of bricks. For walls of thickness greater than one brick both faces shall be kept smooth and plane. All interconnected brickwork shall be carried out at nearly one level so that there is uniform distribution of pressure on the supporting structure and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45°. But in no case the level difference between adjoining walls shall exceed one meter. Brick-work shall not be raised more than one meter per day.

(d) Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 10mm/15mm by raking tools during the progress of work when the mortar is still green, so as to provide a proper key for the plastering/pointing respectively to be done later. When plastering or pointing is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top.

(e) During inclement weather conditions, newly built brick masonry works shall be protected by tarpaulin or other suitable covering to prevent mortar being washed away by rain.

(f) Brickwork shall be kept constantly moist on all the faces for at least seven days. The arrangement for curing shall be got approved from the ENGINEER.

(g) Double scaffolding having two sets of vertical supports shall be provided to facilitate execution of the masonry works. The scaffolding shall be designed adequately considering all the dead, live and possible impact loads to ensure safety of the workmen, in accordance with the requirements stipulated in IS: 2750 and IS: 3696 (Part 1). Scaffolding shall be properly maintained during the entire period of construction. Single scaffolding shall not be used on important works and will be permitted only in certain cases as decided by the ENGINEER. Where single scaffolding is adopted, only minimum number of holes, by omitting a header shall be left in the masonry for supporting horizontal scaffolding poles. All holes in the masonry shall be carefully made good before plastering/painting.

(h) In the event of usage of traditional bricks of size 230 mm x 115 mm x 75 mm, the courses at the top of the plinth and sills as well as at the top of the wall just below the roof/floor or slabs and at the top of the parapet shall be laid with bricks on edge.

- (i) All brickwork shall be built tightly against columns, floor slabs or other structural members.
- (j) To overcome the possibility of development of cracks in the brick masonry following measures shall be adopted.
- i. For resting RCC slabs, the bearing surface of masonry wall shall be finished on top with 12 mm thick cement mortar 1:3 and provided with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50 micron thick polyethylene sheets.
 - ii. RCC/steel beams resting on masonry wall shall be provided with plain or reinforced concrete bed blocks of dimensions as indicated in the drawings duly finished on top with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50 micron thick polyethylene sheets.
 - iii. Steel wire fabric shall be provided at the junction of brick masonry and concrete as specified elsewhere before taking up plastering work.
- (k) The above items shall be measured and paid for separately under the respective items of work.
- (l) Bricks for partition walls shall be stacked adjacent to the structural member to pre-deflect the structural member before the wall is taken up for execution. Further, the top most course of half or full brick walls abutting against either a de-shuttered slab or beam shall be built only after any proposed masonry wall above the structural member is executed to cater for the deflection of the structural element.
- (m) Reinforced cement concrete transoms and mullions of dimensions as indicated in the construction drawings are generally required to be provided in half brick partition walls. Reinforced concrete for transoms and mullions shall be measured and paid for separately under the respective items of work.
- (n) Where drawings indicate that structural steel sections are to be encased in brickwork, the brick masonry shall be built closely against the steel section, ensuring a minimum of 20mm thick cement-sand 1:4 over all the steel surfaces. Steel sections partly embedded in brickwork shall be provided with bituminous protective coating to the surfaces at the point of entry into the brick masonry.
- (o) CONTRACTOR shall note that the unit rates quoted for the masonry work shall be deemed to include for the installation of miscellaneous inserts such as pipe sleeves, bolts, steel sections with anchors etc. and providing pockets, leaving openings, cutting chases etc. in accordance with the construction drawings. Miscellaneous inserts shall be either supplied FREE by the OWNER or to be furnished by the CONTRACTOR. Any of the miscellaneous inserts which are required to be fabricated and supplied by the CONTRACTOR and cement concrete to be provided in the pockets for the hold fasts of door/window frames etc. shall however, be measured and paid separately under the respective items of work.

(p) Facing bricks of the type specified conforming to IS: 2691 shall be laid in the positions indicated on the drawings and all facing brickwork shall be well bonded to the backing bricks/RCC surfaces. The level of execution of the facing brickwork shall at any time be lower by at least 600 mm below the level of the backing brickwork.

(q) Facing bricks shall be laid over 10 mm thick backing of cement mortar. The mortar mix, thickness of joint and the type of painting to be carried out shall be as specified in the item of work. The pattern of laying the bricks shall be as specifically indicated in the drawings.

(r) For facing brickwork, double scaffolding shall be used.

(s) Faced works shall be kept clean and free from damage, discoloration etc., at all times.

(t) Cutting of chases in 230 thick wall and above for routing GI pipes, CI pipes or for any other services shall preferably be in the vertical direction. Horizontal chases shall be avoided, as far as possible. The depth of vertical chases and horizontal chases, if any, shall not exceed one third and one sixth of the thickness of masonry respectively. Vertical chases shall not be closer than 2m in any stretch. Not more than 2 horizontal chases shall be permitted in a stretch of wall and these should be located in upper or lower one-third of height of wall. No continuous horizontal chase should exceed 1m length. No horizontal chases will be permitted in half brick wall.

No lintel need be provided for circular openings upto 400mm diameter in 230 mm thick wall and above. Similarly, no lintel need be provided for rectangular holes of 300 mm wide and below. No openings shall be provided in 115 mm thick brick wall.

CONCRETE BLOCK MASONRY

3. Materials

Masonry units of hollow and solid concrete blocks shall conform to the requirements of IS: 2185 (Part 1).

Masonry units of hollow and solid light-weight concrete blocks shall conform to the requirements of IS: 2185 (Part 2).

Masonry units of autoclaved cellular concrete blocks shall conform to the requirements of IS: 2185 (Part 3).

The height of the concrete masonry units shall not exceed either its length or six times its width.

The nominal dimensions of concrete block shall be as under.

- (a) Length 400,500 or 600 mm.
- (b) Height 100 or 200 mm.
- (c) Width 100 to 300 mm in 50 mm increments
- (d) Half blocks shall be in lengths of 200, 250 or 300 mm to correspond to the full-length blocks. Actual dimensions shall be 10 mm short of the nominal dimensions.

The maximum variation in the length of the units shall not be more than ± 5 mm and maximum variation in height or width of the units shall not be more than ± 3 mm.

Concrete blocks shall be either hollow blocks with open or closed cavities or solid blocks.

Concrete blocks shall be sound, free of cracks, chipping or other defects which impair the strength or performance of the construction. Surface texture shall be as specified. The faces of the units shall be flat and rectangular, opposite faces shall be parallel and all arises shall be square. The bedding surfaces shall be at right angles to the faces of the block.

The concrete mix for the hollow and solid concrete blocks/light weight concrete blocks shall not be richer than one part of cement to six parts of combined aggregates by volume i.e. (1:6).

Concrete blocks shall be of approved manufacture, which satisfy the limitations in the values of water absorption, drying shrinkage and moisture movement, as specified for the type of block as per relevant IS code. CONTRACTOR shall furnish the test certificates and also supply the samples, for the approval of ENGINEER.

4. Workmanship

The type of the concrete block, thickness and grade based on the compressive strength for use in load bearing and/or non-load bearing walls shall be as specified in the respective items of work. The minimum nominal thickness of non-load bearing internal walls shall be 100 mm. The minimum nominal thickness of external panel walls in framed construction shall be 200 mm.

The workmanship shall generally conform to the requirements of IS: 2572 for concrete block masonry, IS: 6042 for light weight concrete block masonry and IS: 6041 for autoclaved cellular concrete block masonry works.

From considerations of durability, generally concrete block masonry shall be used in superstructure works above the damp-proof course level.

Concrete blocks shall be embedded with a mortar which is relatively weaker than the mix of the blocks in order to avoid the formation of cracks. Cement mortar of proportion 1:6 shall be used for the works unless otherwise specified in the respective items of work. Preparation of mortar shall be as specified in 7.0 of CPWD Specification-Vol-1.

The thickness of both horizontal and vertical joints shall be 10 mm. The first course shall be laid with greater care, ensuring that it is properly aligned, levelled and plumb since this will facilitate in laying succeeding courses to obtain a straight and truly vertical wall. For the horizontal (bedding) joint, mortar shall be spread over the entire top surface of the block including front and rear shells as well as the webs to a uniform layer of 10 mm. For vertical joints, the mortar shall be applied on the vertical edges of the front and rear shells of the blocks. The mortar may be applied either to the unit already placed on the wall or on the edges of the succeeding unit when it is standing

vertically and then placing it horizontally, well pressed against the previously laid unit to produce a compacted vertical joint. In case of two cell blocks with slight depression on the vertical sides these shall also be filled up with mortar to secure greater lateral rigidity. To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of the block as the mortar will stiffen and lose its plasticity. Mortar while hardening shrinks slightly and thus pulls away from the edges of the block. The mortar shall be pressed against the units with a jointing tool after it has stiffened to effect intimate contact between the mortar and the unit to obtain a weather tight joint. The mortar shall be raked to a depth of 10 mm as each course is laid to ensure good bond for the plaster.

Dimensional stability of hollow concrete blocks greatly affected by variations of moisture content in the units. Only well dried blocks should be used for the construction. Blocks with moisture content more than 25% of maximum water absorption permissible shall not be used. The blocks should not be wetted before or during laying in the walls. Blocks should be laid dry except slightly moistening their surface on which mortar is to be applied to obviate absorption of water from the mortar.

As per the design requirements and to effectively control cracks in the masonry, RCC bond beam/studs, joint reinforcement shall be provided at locations as per details indicated in the construction drawings. Joint reinforcement shall be fabricated either from mild steel wires conforming to IS: 280 or welded wire fabric/high strength deformed bass as per the drawings. For jambs of doors, windows and openings, solid concrete blocks shall be provided. If hollow units are used, the hollows shall be filled with concrete of mix 1:3:6. Hold fasts of doors/windows should be arranged so that they occur at block course level.

At intersection of walls, the courses shall be laid up at the same time with a true masonry bond between at least 50% of the concrete blocks. The sequence for construction of partition walls and treatment at the top of load bearing walls for the RCC slab shall be as detailed under clause for the brick work.

Curing of the mortar joints shall be carried out for at least 7 days. The walls should only be lightly moistened and shall not be allowed to become excessively wet.

Double scaffolding as per 7.0 of CPWD Specification-Vol-1. shall be adopted for execution of block masonry work.

Cutting of the units shall be restricted to a minimum. All horizontal and vertical dimensions shall be in multiples of half-length and full height of units respectively, adapting modular co-ordination for walls, opening locations for doors, windows etc.

Concrete blocks shall be stored at site suitably to avoid any contact with moisture from the ground and covered to protect against wetting.

5. Measurement

Measurement shall be in cu. m. correct upto two places of decimal for walls of thickness 200 mm and above. Measurement shall be in sq. m correct upto two places of decimal for walls of 100mm/150mm in thickness. Measurement shall be for the quantities as actually executed duly deducting for openings, and concrete works. Concrete and reinforcement will be measured and paid separately. The rate quoted shall be for the type of masonry blocks specified in the respective items of work which shall include for the specific sequential operations as stipulated in the construction drawings.

DAMP - PROOF COURSE

6. Materials and Workmanship

Where specified, all the walls in a building shall be provided with damp-proof course to prevent water from rising up the wall. The damp-proof course shall run without a break throughout the length of the wall, even under the door or other openings. Damp-proof course shall consist of 50 mm thick cement concrete of 1:2:4 nominal mix with approved water-proofing compound admixture conforming to IS: 2645 in proportion as directed by the manufacturer. Concrete shall be with 10 mm downgraded coarse aggregates.

The surface of brick/stone masonry work shall be levelled and prepared before laying the cement concrete. Side shuttering shall be properly fixed to ensure that slurry does not leak through and is also not disturbed during compaction. The upper and side surface shall be made rough to afford key to the masonry above and to the plaster.

Damp-proof course shall be cured properly for at least seven days after which it shall be allowed to dry for taking up further work.

7. Measurement

Measurement of damp-proof course shall be in Sq.m correct to two places of decimal as actually executed. No separate payment will be made for formwork.

RUBBLE SUB-BASE

8. Materials

Stones used for rubble packing under floors on grade, foundations etc., shall be clean, hard, durable rock free from veins, flaws, laminations, weathering and other defects. Stones shall generally conform to the requirements stipulated in IS: 1597 (Part-I).

Stones shall be as regular as can be obtained from quarries. Stones shall be of height equal to the thickness of the packing proposed with a tolerance of ± 10 mm. Stones shall not have a base area less than 250 sq.cm nor more than 500 sq.cm, and the smallest dimension of any stone shall not be less than half the largest dimension. The quality and size of stones shall be subject to the approval of ENGINEER.

9. Workmanship

Stones shall be hand packed carefully and laid with their largest base downwards resting flat on the prepared sub-grade and with their height equal to the thickness of the packing. Stones shall be laid breaking joints and in close contact with each other. All interstices between the stones shall be wedged-in by small stones of suitable size, well driven in by crow bars and hammers to ensure tight packing and complete filling-in of the interstices. The wedging shall be carried out simultaneously with the placing in position of rubble packing and shall not lag behind. After this, any interstices between the smaller wedged stones shall be in-filled with clean hard sand by brooming so as to fill the joints completely.

The laid rubble packing shall be sprinkled with water and compacted by using suitable rammers.

10. Measurement

Measurement shall be in sq. m correct to two places of decimal for the specified compacted thickness of rubble sub-base.

11.0 CEMENT PLASTERING & POINTING WORK

PLASTERING WORK

11. Materials

The proportions of the cement mortar for plastering shall be 1:4 (one part of cement to four parts of sand) unless otherwise specified under the respective item of work. Cement and sand shall be mixed thoroughly in dry condition and then water added to obtain a workable consistency. The quality of water and cement shall be as per relevant IS. The quality and grading of sand for plastering shall conform to IS: 1542. The mixing shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by ENGINEER. If so desired by the ENGINEER sand shall be screened and washed to meet the specification requirements. The mortar thus mixed shall be used as soon as possible preferably within 30 minutes from the time water is added to cement. In case the mortar has stiffened due to evaporation of water this may be re-tempered by adding water as required to restore consistency but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and removed forthwith from the site. Droppings of plaster shall not be re-used under any circumstances

12. Workmanship

Preparation of surfaces and application of plaster finishes shall generally conform to the requirements specified in IS: 1661 and IS: 2402.

Plastering operations shall not be commenced until installation of all fittings and fixtures such as door/ window panels, pipes, conduits etc. are completed.

All joints in masonry shall be raked as the work proceeds to a depth of 10mm/20mm for brick/ stone masonry respectively with a tool made for the purpose when the mortar is still green. The masonry surface to be rendered

shall be washed with clean-water to remove all dirt, loose materials, etc., Concrete surfaces to be rendered shall be roughened suitably by hacking or bush hammering for proper adhesion of plaster and the surface shall be evenly wetted to provide the correct suction. The masonry surfaces should not be too wet but only damp at the time of plastering. The dampness shall be uniform to get uniform bond between the plaster and the masonry surface.

Interior Plain Faced Plaster - This plaster shall be laid in a single coat of 13mm thickness. The mortar shall be dashed against the prepared surface with a trowel. The dashing of the coat shall be done using a strong whipping motion at right angles to the face of the wall or it may be applied with a plaster machine. The coat shall be trowelled hard and tight forcing it to surface depressions to obtain a permanent bond and finished to smooth surface. Interior plaster shall be carried out on jambs, lintel and sill faces, etc. as shown in the drawing and as directed by ENGINEER. Rate quoted for plaster work shall be deemed to include for plastering of all these surfaces.

Plain Faced Ceiling plaster - This plaster shall be applied in a single coat of 6mm thickness. Application of mortar shall be as stipulated in 3.0 of CPWD Specification-Vol-1.

Exterior plain faced plaster - This plaster shall be applied in 2 coats. The first coat or the rendering coat shall be approximately 14mm thick. The rendering coat shall be applied as stipulated in relevant clause of CPWD specifications, except finishing it to a true and even surface and then lightly roughened by cross scratch lines to provide bond for the finishing coat. The rendering coat shall be cured for at least two days and then allowed to dry. The second coat or finishing coat shall be 6 mm thick. Before application of the second coat, the rendering coat shall be evenly damped. The second coat shall be applied from top to bottom in one operation without joints and shall be finished leaving an even and uniform surface. The mortar proportions for the coats shall be as specified in the respective item of work. The finished plastering work shall be cured for at least 7 days.

Interior plain faced plaster 20mm thick if specified for uneven faces of brick walls or for random/coursed rubble masonry walls shall be executed in 2 coats.

Exterior Sand Faced Plaster - This plaster shall be applied in 2 coats. The first coat shall be 14mm thick and the second coat shall be 6mm thick. These coats shall be applied as stipulated in clause 11.1.2 of this document. However, only approved quality white sand shall be used for the second coat and for the finishing work. Sand for the finishing work shall be coarse and of even size and shall be dashed against the surface and sponged. The mortar proportions for the first and second coats shall be as specified in the respective items of work.

Wherever more than 20mm thick plaster has been specified, which is intended for purposes of providing beading, bands, etc. this work shall be carried out in two or three coats as directed by ENGINEER duly satisfying the requirements of curing each coat (rendering/floating) for a minimum period of 2 days and curing the finished work for at least 7 days.

In the case of pebble faced finish plaster, pebbles of approved size and quality shall be dashed against the final coat while it is still green to obtain as far as possible a uniform pattern all as directed by ENGINEER.

Where specified in the drawings, rectangular grooves of the dimensions indicated shall be provided in external plaster by means of timber battens when the plaster is still in green condition. Battens shall be carefully removed after the initial set of plaster and the broken edges and corners made good. All grooves shall be uniform in width and depth and shall be true to the lines and levels as per the drawings.

Curing of plaster shall be started as soon as the applied plaster has hardened sufficiently so as not to be damaged when watered. Curing shall be done by continuously applying water in a fine spray and shall be carried out for at least 7 days.

When the specification items of work calls for waterproofing plaster the CONTRACTOR shall provide the waterproofing compound as specified while preparing the cement mortar. Payment for water-proofing compound will be made separately if it is not included as a combined item of work.

Where lath plastering is specified, it shall be paid for at the same rate as for plaster work except that separate payment for metal lath will be made.

For external plaster, the plastering operations shall be commenced from the top floor and carried downwards. For internal plaster, the plastering operations for the walls shall commence at the top and carried downwards. Plastering shall be carried out to the full length of the wall or to natural breaking points like doors/ windows etc. Ceiling plaster shall be completed first before commencing wall plastering.

Double scaffolding to be used shall be as specified in 7.0 of CPWD Specification-Vol-1.

The finished plaster surface shall not show any deviation more than 4mm when checked with a straight edge of 2m length placed against the surface.

To overcome the possibility of development of cracks in the plastering work following measures shall be adapted.

(a) Plastering work shall be deferred as much as possible so that fairly complete drying shrinkage in concrete and masonry works takes place.

(b) Steel wire fabric shall be provided at the junction of brick masonry and concrete to overcome reasonably the differential drying shrinkage/thermal movement. This steel item shall be measured and paid for separately.

(c) Ceiling plaster shall be done, with a trowel cut at its junction with wall plaster. Similarly trowel cut shall be adopted between adjacent surfaces where discontinuity of the background exists.

13.

Measurement

Measurement for plastering work shall be in sq.m correct to two places of decimal. Unless a separate item is provided for grooves, mouldings, etc., these works are deemed to be included in the unit rates quoted for plastering work.

The quantity of work to be paid for under these items shall be calculated by taking the projected surface of the areas plastered after making necessary deductions for openings for doors, windows, fan openings etc. The actual plaster work carried out on jambs/sills of windows, openings, etc. shall be measured for payment.

CEMENT POINTING

14. Materials

The cement mortar for pointing shall be in the proportion of 1:3 (one part of cement to three parts of fine sand) unless otherwise specified in the respective items of work. Sand shall conform to IS: 1542 and shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by ENGINEER and if so directed it shall be washed/screened to meet specification requirements.

15. Workmanship

Where pointing of joints in masonry work is specified on drawings/respective items of work, the joints shall be raked at least 15mm/ 20mm deep in brick/stone masonry respectively as the work proceeds when the mortar is still green.

Any dust/dirt in the raked joints shall be brushed out clean and the joints shall be washed with water. The joints shall be damp at the time of pointing. Mortar shall be filled into joints and well pressed with special steel trowels. The joints shall not be disturbed after it has once begun to set. The joints of the pointed work shall be neat. The lines shall be regular and uniform in breadth and the joints shall be raised, flat, sunk or 'V' as may be specified in the respective items of work. No false joints shall be allowed.

The work shall be kept moist for at least 7 days after the pointing is completed. Whenever coloured pointing is to be done, the colouring pigment of the colour required shall be added to cement in such proportions as recommended by the manufacturer and as approved by ENGINEER.

16. Measurement

The quantity of work to be paid for under this Item shall be measured in sq.m correct to two places of decimal by taking the projected surface of the area pointed after making necessary deductions for openings, etc.

WATER-PROOFING ADMIXTURE

Water-proofing admixture shall conform to the requirements of IS: 2645 and shall be of approved manufacture. The admixture shall not contain calcium chloride. The quantity of the admixture to be used for the works and method of mixing etc., shall be as per manufacturer's instructions and as directed by ENGINEER. Payment shall be made for the actual quantity of such admixture used unless it is already covered in the rate for the relevant item of work.

12.0 RAIN WATER DRAINAGE

SCOPE

This specification covers the drainage of rain water in excavated areas.

Grading in the vicinity of excavation shall be such as to exclude rain/ surface water draining into excavated areas. Excavation shall be kept clean of rain and such water as the Contractor may be using for his work by suitably pumping out the same at no extra cost to the Authority. The scheme for pumping and discharge of such water shall be prepared by Contractor at no extra cost to the Authority. Contractor shall ensure that the surface runoff outside the excavated pit/ working area shall be collected through a catch water drain excavated around the working area and led away to a natural stream, at no extra cost to the Authority. Contractor shall maintain the catch water drains in proper condition during the construction period at no extra cost to the Authority.

13.0 WATER SEALING MATERIALS

9.1 SCOPE

Providing and fixing hydrophilic water sealing materials at construction joints at different locations during the construction of Reinforced Concrete Basement Raft and peripheral Reinforced Concrete Retaining Wall and also construction joints at other water retaining structures including creating necessary nominal trapezoidal key shape in the formwork finish or by mason's finish, including applying suitable adhesives and sealants as recommended and supplied by the approved manufacturer for proper and highly secure bonding with substrate, rough/ smooth and wet/ dry, proper splicing and jointing at corners, T, L and X junctions using suitable glue, at all such locations.

9.2 MATERIALS

It shall be hydro-swelling water bar, ready for installation in construction joint to render the joints leak proof. It is based on the specially designed polymer composite that acts as undergoing reversible swelling on exposure to water to form an effective seal.

Hydro swelling water bar has water molecules held by molecular attraction not by vacuum. It should not generate gas or foam with water and prevents water ingress even when joint width varies. It should have elastomeric properties which keeps swelling and reverting to original volume on drying throughout the life of structure.

The material properties such as tensile strength, elongation, hardness and water pressure resistance of the hydrophilic water bar shall conform to ASTM/ DIN standards.

Construction joints at the retaining wall shall be installed with hydro-swelling water bar based on advance vinyl acrylate polymers. The water bar shall be formulated to exhibit low pre-mature swelling (less than 50% within 12 hours) and shall not be based on super absorbents. The water bar shall have low swelling pressure; not exceeding 0.25 mpa at full swelling capacity. The water bar shall be installed with special adhesive as per approved manufacturer's instructions.

9.3 WORKMANSHIP

The concrete substrate to which the water bar is to be fixed must be even, sound, clean and free from all contaminants. All concrete spatter and nibs shall be removed.

The water bar shall be cut to the required length.

The water bar shall be fixed to the concrete substrate using approved adhesive. Light tension shall be applied to the water bar as it is being fixed. The adhesive on the verticals shall be allowed to dry at least over night before concreting.

The fixed water bar shall be protected from mould release oil and dirt. It shall be ensured that the water bar is not saturated before concreting as this may cause it to swell.

14.0 ANTITERMITE PRECONSTRUCTION ,CHEMICAL TREATMENT IN BUILDINGS

10.1 SCOPE

This specification covers the general requirements for Anti-termite Constructional Measures, chemical treatment of soils for the protection of buildings from attack by subterranean termites, chemicals to be used with their minimum rates of application and procedure to be followed while the building is under construction.

10.2 APPLICABLE CODES AND SPECIFICATIONS

The following codes, standards and specifications are made a part of this specification. All specifications, standards, codes of practices referred to herein shall be the latest edition including all applicable official amendments

and revisions. In case of discrepancy between this specification and those referred to herein, this specification shall govern:

- 1 IS: 6313, Part I : Code of Practice for Anti-termite Measures in Buildings Constructional Measures
- 2 IS: 6313, Part II : Pre-constructional Chemical Treatment Measures
- 3 IS: 8944 : Specification for Chloropyrifos Emusifiable Concentrates
- 4 IS: 4015, Part I : Guide for Handling cases of Pesticide Poisoning First Aid Measures
- 5 IS: 4015, Part II : Symptoms, Diagnosis and Treatment

10.3 GENERAL

Contractor shall furnish all tools, plants, instruments, qualified supervisory personnel, labour, materials, any temporary works, consumables, any and everything necessary whether or no such items are specifically stated herein for completion of the job in accordance with specification requirements.

All work shall be done in the order of progress required as per construction programme.

Contractor shall take all necessary precautions to prevent any accident in connection with the performance of the work.

On final completion of all work, Contractor shall leave the entire premises within the site of his operation clean and free from all rubbish resulting from his operation.

Authority reserves the right to inspect, check and direct any or all operations at any stage of the work and to require unsatisfactory work to be remedied at Contractor's expense.

No work shall be carried out under unsuitable weather conditions viz. when raining or when the soil is wet due to rain or sub-soil water.

Chemicals shall be brought to site of work in sealed original containers. The materials shall be brought in, at a time, in adequate quantity to suffice for the work. The material shall be kept in cool and locked stores. The empties shall not be removed from the work site till the relevant item of work has been completed and permission granted by Authority//PMC (if require).

Chemicals available in concentration forms with concentration indicated on the sealed containers only shall be used. Chemicals shall be diluted with water in required quantity before use, using graduated containers to achieve the desired percentage of concentration:

Example: Chloropyrifos 20: 1 litre is diluted to 20 litres to give 1.0% emulsion.

10.4 PRE-CONSTRUCTIONAL CHEMICAL TREATMENT

i. Essential Requirements

Hand operated pressure pump with graduated containers shall be used to ensure uniform spraying of the chemical. Continuous check shall be kept to ensure that the specified quantity of chemical is used for the required area during the operation.

ii. Condition of Formation

The treated soil barrier shall be complete and continuous under the whole of the structure to be protected. All foundations shall be fully surrounded by and in close contact with the barrier of treated soil. Each part of the area treated shall receive the specified dosage of chemical.

iii. Time of Application

Soil treatment shall start when the foundation trenches and pits are ready to receive mass concrete in foundations. Laying of mass concrete shall start when the chemical emulsion has been absorbed by the soil and the surface is quite dry. Treatment shall not be carried out when it is raining or soil is wet with rain or sub-soil water. The foregoing also applies in the case of treatment to the filled earth surface within the plinth before laying the subgrade for the floor.

iv. Disturbance

The treated soil barriers shall not be disturbed after they are formed. If by chance, treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and completeness of the barrier system.

10.5 CHEMICALS, METHOD AND RATE OF APPLICATION

i. Mound Treatment

Termite mounds within the plinth and contingent apron area shall be destroyed by means of insecticides in the form of water suspension or emulsion which shall be poured into the mounds at several places after breaking open the earthen structure and making holes with crow bars. For a

mound volume of about one (1) cum., four (4) litres of an emulsion in water of one of the following shall be used:

- (a) 0.50 percent Chloropyrifos
- (b) Soil Treatment

Any one of the following chemicals (conforming to Indian Standards) in water emulsion shall be applied uniformly over the area to be treated.

<u>Chemical</u>	<u>Concentration by weight</u> <u>(percent)</u>
Chloripyrifos	1.0

ii. Treatment of Column Pits, Wall Trenches and Basement Excavations

The bottom surface and the sides (up to a height of about 300 mm) of the excavations made for column pits, wall trenches and basements shall be treated with the chemical at the rate of 5 litres per sq. m of the surface area.

After the column foundations and the retaining walls of the basement come up, the backfill in immediate contact with the foundation structure shall be treated at the rate of 15 litres per sq. m of the vertical surface of the sub-structure for each side. If water is used for ramming the earth- fill, the chemical treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and spraying the chemical with the above dose. The earth shall be returned in layers and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the concrete or masonry surfaces of the columns and walls so that the earth in contact with these surfaces is well treated with the chemical.

In the case of R.C.C. framed structures with columns and plinth beams and R.C.C. basements, with concrete mix 1:2:4 or richer, the treatment shall start at the depth of 500 mm below ground level for columns and plinth beams. From this depth the back-fill around the columns, beams and R.C.C basement walls shall be treated at the rate of 15 litres/sqm of vertical surface. The other details of treatment shall be as laid down in clause (b) above.

iii. Treatment of Top Surface of Plinth Filling

The top surface of the filled earth within plinth beams/ walls shall be treated with chemical emulsion at the rate of 5 litres per sqm of the surface before the sand bed/ subgrade is laid. Holes upto 50 to 70 mm deep at 150 mm centres

both ways shall be made with 12 mm dia. crow-bar on the surface to facilitate saturation of the soil with chemical emulsion.

iv. Treatment of Junction of Wall and Floor

To achieve continuity of vertical chemical barrier to inner wall surfaces from the ground level, small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor (before laying the subgrade) and rod holes made in the channel upto ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 15 litres/sq.m of the vertical wall or column surface so as to soak the soil right to the bottom. The soil shall be tamped back into place after this operation.

v. Treatment of Soil Under Apron Along External Perimeter of Building

The top surface of the consolidated earth over which the apron is to be laid shall be treated with chemical emulsion at the rate of 5 litres/sq.m of the surface before the apron is laid, by making rod holes 75 mm deep at 150 mm centres both ways.

vi. Treatment of Soil Along External Perimeter of Building

After the building is complete, holes shall be made in the soil with iron rods along the external perimeter of the building at interval of about 150 mm and depth 300 mm and these holes filled with chemical emulsion at the rate of 7.5 litres/metre of perimeter of the external wall. If the earth outside the building is graded on completion of building, this treatment shall be carried out on completion of such grading. If the filling is more than 300 mm the external perimeter treatment shall extend to the full depth of filling upto the original ground level so as to ensure continuity of chemical barrier.

vii. Treatment for Expansion Joints

Anti-termite treatment shall be supplemented by treating through the expansion joint after the sub-grade has been laid at the rate of 2 litres per linear meter of expansion joint.

viii. Treatment of Soil Surrounding Pipes and Conduits

When pipes and conduits enter the soil inside the area of the foundations, the soil surrounding the points of entry shall be loosened around each such pipe or conduit for a distance of 150 mm and to a depth of 75 mm before treatment is commenced. When they enter the soil external to the foundations, they shall be similarly treated for a distance of over 300 mm unless they stand clear of the walls of the building by about 75 mm.

10.6 SAFETY PRECAUTIONS

All chemicals used for anti-termite treatment are poisonous and hazardous to health. These chemicals can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mists or swallowed. Person using or handling these chemicals should be warned of these dangers and advised that absorption through the skin is most likely source of accident poisoning. They should be cautioned to observe carefully the safety precautions given below.

These chemicals are usually brought to site in the form of emulsifiable concentrates. The containers should be clearly labelled and should be stored carefully so that children and pet cannot get at them. They shall be kept securely closed.

Particular care shall be taken to prevent skin contact with concentrates. Prolonged exposure to dilute emulsions shall also be avoided. Workers shall wear clean clothing and wash thoroughly with soap and water, especially before eating and smoking. In the event of severe contamination, clothing shall be removed at once and the skin washed with soap and water. If chemicals splash into eyes they shall be flushed with plenty of soap and water and immediate medical attention shall be sought.

The concentrates are oil solutions and present a fire hazard owing to the use of petroleum solvents. Flames shall not be allowed during mixing.

Care shall be taken in the application of chemicals to see that they are not allowed to contaminate wells or springs which serve as source of drinking water.

ELECTRICAL WORKS- TECHNICAL SPECIFICATION

TECHNICAL SPECIFICATION

1 COMPACT SUBSTATION

1.1 SCOPE

- a. All scope for Design, Supply, Installation, Testing and Commissioning of the equipment and systems as specified in this specification shall be strictly as per specification, rules and regulations; and, not limited to this specifications and guidelines.
- b. The specific scope of this specification for Compact Substation (CSS) covers the following:
- c. Design, engineering and manufacturing; testing at manufacturer's works, packing, forwarding and delivery to site; unloading and handling (shifting from unloading point to the storage area, storage and shifting from the place of storage to the place of installation) at site, assembly, erection, cleaning & touch up painting, testing, commissioning and performance demonstration at site of Compact Substations of various ratings as specified in this document. Each CSS shall typically consist of the following major parts: -
 - Metallic Enclosure with ventilation and rain/ dust protection as appropriate
 - 33 kV VCB.
 - 33 / 0.433 kV Dry type transformer of adequate rating along with required accessories
 - LT switchgear.
- d. All the above components of each CSS shall conform to latest relevant standards, codes and requirements.
- e. Civil works for the preparation of equipment foundation, cable trench and earth pits electrodes, earth grid around CSS and chain link fencing with gate for each CSS is included in the scope of this specification.

1.2 SYSTEM DESCRIPTION

- a. The CSS shall be located in the open space and fenced around for safety and to avoid unauthorized access.

1.3 APPLICABLE CODES AND STANDARDS

- a. The design, manufacture and performance of equipment shall comply with latest applicable Codes of Standards IEC 694, IEC 298, IEC 129, IEC 265, IEC 420, IEC 60, IEC 1330, IEC 529, IEC 76, and IEC 439-1.
- b. All components as well as the CSS as a whole shall be type tested in accordance with the above standards.
- c. Contractor shall submit the type test certificates of similar equipment within past five year along with the Bid/ after award of contract.
- d. All equipment and material shall be designed, manufactured and tested in accordance with the latest applicable Indian Standard / IEC standard.
- e. Equipment and material conforming to any other standard which ensures equal or better quality may be accepted. In such case copies of English version of the standard adopted shall be submitted.
- f. The electrical installation shall meet the requirement of Indian Electricity Rules as amended upto date; relevant IS code of practice and Indian electricity act.

1.4 SPECIFIC REQUIREMENT

- a. Compact Sub-station (CSS) should be a factory-designed, prefabricated substation, tested, ready-to-install and consist of:
 - Vacuum Circuit Breaker
 - Distribution Transformer
 - L.T. Switchgear
- b. The complete unit shall be installed on a substation plinth (base) as Outdoor substation.
- c. The Vacuum Circuit Breaker shall be used to control and isolate the Distribution transformer.
- d. The pre-fabricated unitized substation shall be designed for:
 - Compactness
 - Fast installation
 - Maintenance free operation
 - Safety for worker/operator & public
- e. The Switchgear and component thereof shall be capable of withstanding the mechanical and thermal stresses of short circuit listed in ratings and requirements without any damage or deterioration of the materials.
- f. For continuous operation at specified ratings temperature rise of the various switchgear components shall be limited to permissible values stipulated in the relevant standard.

1.5 SERVICE CONDITIONS

- a. The equipment offered shall be suitable for continuous satisfactory operation in the area of Installation.
- b. The Enclosure of the Unitized substation shall be designed for normal outdoor service condition and the enclosure construction shall be such that it fully protects ingress of rain water, dust & rusting.
- c. The enclosure should take minimum space for the installation including the space required for approaching various doors & equipment inside.

1.6 EQUIPMENT SPECIFICATION

- a. All the components of Compact Substation shall be enclosed, by either common enclosure or by an assembly of enclosure. All the components shall comply with their relevant IS/ IEC standards.

1.7 ENCLOSURE

- a. The enclosure shall be made of 2.0 mm thickness Galvanized Sheet Steel tropicalised to meet weather conditions including all the partition sheets & doors.
- b. The base of the enclosure shall be of 4.0 mm thickness Hot Dip Galvanized Sheet Steel to ensure rigidity for easy transport & installation. The entire Compact Substation shall be Factory Assembled & Factory Fitted.
- c. The structure of the substation shall be capable of supporting the gross weight of all the equipment & the roof of the substation compartment shall be designed to support adequate loads. In case of relocation of the Compact Substation, the entire substation should be capable of getting lifted and placed as a Single Unit without dismantling of any of the major equipment inside. The lifting arrangement should be from the bottom of the enclosure & not from the top.
- d. The protection degree of the enclosure shall not be less than IP55 for LT & HT switchgear compartment & IP23 for Transformer compartment. Protection against mechanical impact shall be IK10.
- e. There shall be proper / adequate ventilation inside the enclosure so that hot air inside enclosure is directed out by help of duct. Louvers and / or apertures shall be provided so that there is circulation of natural air inside the enclosure. The Compact Substation should be designed to have natural cooling & ventilation instead of forced cooling / ventilation as the same would de-rate the transformer further and shall be an additional load on the Transformer.
- f. The complete design shall be compartmentalized.

- g. The connection between Transformer and LT switchgear shall be by means of suitable size of Cables / Aluminium bus bars. The connection cables to consumer shall be taken out from the L.T. switchgear.
- h. Failure within the unitized substation due either to a defect, an exceptional service condition or mal-operation may initiate an internal arc. Such an event may lead to the risk of injury, if persons are present. It is desirable that the unit shall be tested for Internal Arc fault test to the tune of 25kA for 1 second adhering to the latest IS/ IEC standard.
- i. There shall be arrangement for internal lighting activated by associated switch on doors for HV & LV compartments separately.
- j. Covers & doors shall be a part of the enclosure. When they are closed, they shall provide the degree of protection specified for the enclosure. All covers, doors or roof shall be provided with locking facility or it shall not be possible to open or remove them before doors used for normal operation have been opened. The doors shall open outward at an angle of at least 90 degrees & be equipped with a device able to maintain them in an open position. Proper padlocking facility shall be provided for doors of each compartment. Transformer compartment doors must be open from both the sides & should not have access from outside.
- k. All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequate terminal intended for connection to the earth system of the installation, by way of flexible jumpers/strips & Lug arrangement. The continuity of the earth system shall be ensured taking into account the thermal & mechanical stresses caused by the current it may have to carry.
- l. The components to be connected to the earth system shall include:
 - The enclosure of Unitized / prefabricated substation
 - The enclosure of High voltage switchgear & control gear from the terminal provided for the purpose
 - The metal screen & the high voltage cable earth conductor
 - The transformer tank or metal frame of transformer
 - The base frame
 - Enclosure of low voltage switchgear
- m. Labels for warning, manufacturer's operating instructions, local standards & regulations shall be pasted / provided inside and shall be durable & clearly legible.
- n. paints shall be carefully selected to withstand tropical heat & rain, unless otherwise specified. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling. For this purpose, powder coating shall be used. Special care shall be taken by the manufacturer to ensure against rusting of nuts,

bolts and fittings during operation. All bushings and current carrying parts shall be cleaned properly after final painting. The fabrication process shall ensure that there are no sharp edges on the GI sheets used.

2 HV SWITCHGEAR

- a. The switchgear should be fixed type, Vacuum circuit breakers with O/C & E/F relay and corresponding auxiliary equipment and accessories.
- b. The Vacuum circuit breaker, Bus bars should be mounted inside a sealed for life, cast resin / stainless steel tank. The operating mechanism of the switches and breakers shall be outside the SF6 tank and accessible from front.
- c. The tank should be filled with SF6 gas at an adequate pressure. The degree of protection for gas tank shall be IP67. There shall be provision for filling the SF6 gas at site. Moreover, the Cast Resin / Stainless Steel Gas Tank shall confirm to the sealed pressure system criteria (a system for which no handling of gas is required throughout service life of approximate 30 years) and ensure the gas leakage to 0.1 % per year as per IEC.
- d. It shall provide full insulation, making the switchgear insensitive to the environment. Thus assembled, the active parts of the switchgear unit shall be maintenance free.
- e. The tank shall be totally metal enclosed, vermin and dust proof suitable for tropical climate use as detailed in the specification. The switchgear & switchboard shall be designed so that the position of different devices is visible to the operator on the front of the switchboard & operations are visible as well. The switchboard shall be designed so as to prevent access to all live parts during operation without the use of tools. CSS should be tested for internal arc fault.

2.1 Circuit Breaker

- a. Circuit breaker shall be Vacuum Circuit Breaker (VCB). These shall be triple pole, single throw and suitable for local / remote operation.
- b. Circuit Breaker shall be provided with operating mechanism, self-powered Static relay (Over current & Earth Fault Protection) with associated CTs for control and protection of Distribution Transformer. Relay should have facility to display the maximum loaded phase current also. Relay should also have facility to trip the breaker from remote commands without shunt trip coil.
- c. An integral cable earthing switch with full making capacity shall also be provided with Circuit Breaker. Earthing switches shall be mechanically interlocked with the associated breakers to prevent accidental earthing of live circuit or busbars.

- d. Circuit Breaker shall be provided with the following accessories, unless otherwise specified:
- Mechanical ON/OFF/EARTH Indication
 - Mechanical charge/discharge indicator
 - Auxiliary contacts 2NO and 2NC
 - Tripped on fault indicator
 - “Live Cable” LED Indicators through Capacitor Voltage Dividers mounted on the bushings.
- e. Ratings of HV Circuit Breakers, Current Transformers & relay settings shall be selected considering the ambient conditions. The bus bars, Vacuum Circuit Breaker shall have adequate continuous rating as per the requirement and in accordance with relevant IS / IEC standard.
- f. The complete switchgear shall be suitable for breaking capacity as specified in the datasheet and/ or relevant standards.
- g. Busbars shall be of copper and complete with all connections to the switch or breaker. Continuous rating of Copper busbars shall be adequate considering all derating factors. The busbars should be fully encapsulated by SF6 gas inside the tank.
- h. The circuit breaker shall be fitted with static type self powered relay inside the front cover to avoid any tampering. The same shall be used in conjunction with suitable CT's and Tripping Coil for fault tripping of the Circuit Breakers. CT's shall be mounted on bushing of breaker. CT's mounted on cable inside cable compartment are also acceptable.
- i. Each Cable compartment shall be provided with three bushings of adequate sizes to terminate the incoming / outgoing, HT cables. Cable compartment shall be front access, Arc proof and interlocked with the respective earthing switches. From safety point of view, it should not be possible to open the cable box unless the earth switch is ON.
- j. There shall be enough height from the base of the mounted switchgear so that the cables can be bent and taken vertically up to the bushings. The Cable termination shall be done by Heat shrinkable Termination method so that adequate clearances shall be maintained between phases for Termination. Cable Termination boots shall be supplied by the switchgear manufacturer.
- k. The moving contacts of the earthing switch shall be visible in the closed position through transparent covers.
- l. Suitable padlocking arrangements shall be provided as stated below:
- Circuit Breaker manual operating handle in the “OFF” position.
 - Each feeder Panel operating handle in ‘Closed’ ‘Open” or ‘Earth’ position.

- □ Each isolator operating handle in 'Closed', 'Open', or 'Earth' position.

2.2 System Particulars

- Nominal System Voltage : 33kV
- Highest System Voltage : 36kV
- Frequency : 50Hz ±5%
- No. Of Phases: 3 Phase
- Neutral Grounding: Solidly Grounded
- Fault level: 25kA for 1 Sec.
- Internal Arc withstanding level: 25kA for 1 Sec.

Max Ambient Temperature for design shall be 45°C.

3 TRANSFORMER (DRY TYPE)

3.1 Distribution transformer shall be a part of the compact substation which will be housed in the enclosure. The transformer shall be suitable for installation in hot, humid tropical atmosphere. All equipment accessories and wiring shall be provided with tropical finish to prevent fungus growth.

3.2 Applicable Standards

Transformer shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards and codes of practice specified as under. In case of conflict between the applicable reference standards and this specification, this specification shall govern.

Transformer	: IS 1180-2014, IS 2026 1981 (Part I-V), BS171, IEC76, CBIP Pub No. 317 IEC 60076
Fittings & Accessories	: IS 3639, IS 3347
Climate proofing	: IS 3202 , BS-CP-1014, IEC 354
Dry Type Transformer	: IS 11171, IEEE C57.12.01-1988, IEC 60076-11
Degree of Protection	: IS 12063
Bushing for > 1000 V, AC	: IS 2099 ,BS-223,IEC 144
Bushing for < 1000 V, AC	: IS 7421 ,BS-223,IEC 144
Degree of protection	: IS 13947 ,IEC 76
Tests	: IS 2026 ,BS-171,IEC 76

Tolerance on guaranteed Particulars	: IS 2026
Buchhloz relay	: IS 3637
Electrical insulation classified by thermal Stability	: IS 1271 ,BS 2727,IEC 85
Auxiliary Transformer	: IS 1180
Code of practice for selection, Installation & maintenance of transformer	: IS 10028

3.3 General

The transformers shall be capable of continuous operation of rated output under the operating conditions of voltage and frequency variations as per statutory limits governed by relevant Indian Standard, Indian Electricity Rules and IEC with latest amendments in force.

- a. The distribution transformer shall be dry type suitable for compact substation housed in an enclosure.
- b. Insulating material shall be of proven design, complying with the requirements of applicable standards.
- c. The transformer shall have a continuous rating as specified at any of the specified tapping position and with the maximum temperature rise specified.
- d. The magnetic circuit shall be constructed from high grade cold-rolled non-ageing grain-oriented silicon steel laminations with non-hygroscopic insulation material on both sides. HV and LV windings shall be of copper.
- e. The maximum temperature rise at the specified maximum continuous output shall not be less than that specified in applicable standards. The transformer shall be suitable for carrying load within the temperature rise.

3.4 General Constructional Features

- a. The transformer shall be compact and suitable for easy installation at site. It shall be of modular design; i.e. windings can be individually mounted and replaced on site.
- b. The transformer shall be provided with 4 Nos. Bi-directional cast iron rollers fitted on cross channels to facilitate the movement of the transformer in both directions.

- c. These rollers shall be suitable for being turned through an angle of 90° and locked in that position when the transformer/enclosure is jacked up.
- d. Steel bolts and nuts shall be galvanized.
- e. Transformer shall be suitable for tropical climate & shall be anti-fungal treated. It shall be capable of withstanding thermal effect and stresses caused by short circuit or voltage surges.
- f. Rating and diagram plates of stainless steel shall be provided on LT box of the transformer and shall be easily accessible. Rating and diagram plate shall be riveted to the transformer enclosure at a proper height so that it is readable. The rating diagram plate shall bear details as specified in relevant standards.
- g. Lifting eyes or lugs shall be provided on all parts of the transformer, which require independent handling, during loading, unloading, assembly or dismantling.

3.5 Core

- a. The magnetic circuit shall be constructed from high grade cold-rolled non-ageing grain-oriented silicon steel laminations with non-hygroscopic insulation material on both sides. The magnetic circuit shall be of “core type” Construction. The core shall be built up with ‘step-lap’ configuration. The grade of laminations shall be low loss type to meet the loss. It shall be carefully interlaced step lap epoxy arranged yoke. It shall be mitered to have low noise and losses.
- b. An adequate painting of resin coat shall cover the complete core and the clamping structure and shall protect it against corrosion.
- c. The Final assembled core shall be free from distortion. It shall be rigidly clamped to ensure adequate mechanical strength & prevent vibration during operations.
- d. The core shall be provided with lugs suitable for lifting the complete core & coil assembly.
- e. The core clamping structure designed to minimise eddy current loss & bolts shall not pass through the laminations for any purpose.
- f. The bandages for the core shall be of polyester tape/fiber glass the spacers for clamping the windings shall be of high-quality rubber/fiber glass to withstand the temperature rise and the supports shall be of porcelain.
- g. The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand a voltage of 2500V for one minute.

3.6 Windings

- a. LV Winding:

- LV Winding shall be of Copper foil, coated with class F insulation, epoxy resin reinforced with fibre glass layers pre-impregnated and casted under vacuum, to be thermally bound to the winding.
 - The conductors shall be transposed at suitable intervals in order to minimize eddy current and to equalize the distribution of current and temperature along with windings.
 - Insulation of LV winding shall be adequate to withstand surge voltages appearing across them as result of transfer due to an impulse striking on HV terminals.
 - Adequate cooling ducts in epoxy cast shall be provided in the LV winding to obtain the required cooling in axial and radial directions.
 - The resin used for winding insulation shall be non-hygroscopic. It should be possible to energise the transformer without drying even after long period of service interruption.
 - In case of Dyn11 transformers, neutral shall be brought out in open for solid earthing on secondary side.
 - The winding shall be designed to reduce the out of balance forces in the transformer at all voltage ratios at all operating conditions.
 - The winding shall be so designed that all coil assembly of identical voltage rating shall be interchangeable and field repairs to the windings can be made without special equipment.
- b. HV Winding:
- HV Winding shall be of Copper wire, double layer winding, and cast under vacuum with epoxy resin. The resin shall be pure low viscosity epoxy resin, fiber glass reinforced. The resin cast winding shall be void free.
 - Insulation of HV winding shall be Class 'F' With avg. temperature rise of winding limited to Class B.
 - Resin on winding shall be casted under vacuum and then pressure impregnated. It shall be thermally bound to the winding after initial curing. Casting shall be cured thermally in controlled autoclave with complete cycle and temperature (typically 145°C for 4-6 hrs.) recommended by manufacturer / standards.
 - The winding shall be designed to reduce to a minimum the out of balance forces in the transformer at all voltage ratios at all operating conditions.
 - The winding shall be so designed that all coil assembly of identical voltage rating shall be interchangeable and field repairs to the windings can be made without special equipment.

- Adequate cooling ducts in epoxy cast shall be provided in the HV winding to obtain the required cooling in radial and axial directions.
- HV and LV winding shall be suitably braced and supported at top as well bottom to withstand short circuit stresses set up by surges and damage because of inertia.
- The resin casting process shall be carried out under the most strict and automated controlled conditions in order to ensure optimum insulating and mechanical properties.
- The coil finishing shall provide smooth surface eliminating dust accumulation and give effective cooling.

3.7 Earthing

- a. The framework and clamping arrangement of core and coil shall be suitably earthed internally to the body of enclosure. Separate 2 nos. earthing terminals shall be provided on enclosure for connection to Owner's earth grid.
- b. Core shall be earthed to the frame. Suitable arrangement shall be provided for disconnecting the core earthing for insulation measurement.
- c. 2 Nos. separate earthing pad / terminals shall be provided on the HV cable box for armour earthing from inside and for Owner's grid connection from outside.
- d. Apart from the neutral leads for power connection, a separate neutral terminal shall be provided to facilitate termination of 2 nos. earthing conductors, which in turn will be connected to two (2) distinct earthing pits by direct connection. The connection may be by insulated cable or by bare strip. In case of cable connection, suitable cable box to terminate the cables shall be provided.
- e. Flexible earthing braid shall be provided between all metal parts joined with gaskets.
- f. Arrangement for supporting 2 runs of GI, up to grade level, from neutral terminal connection installed outside shall be provided.

3.8 Bushings

- a. Bushings shall be designed and tested to comply with the applicable standards specified in the specifications.
- b. Bushing rated for 400A and above shall have non-ferrous flanges and hardware.
- c. Fittings made of steel or malleable iron shall be galvanized.
- d. Bushings shall be supplied with terminal connector clamp suitable for connecting the bushing terminal to the specified conductor/ cable.

- e. For 33KV, 36KV Class bushings shall be used and for 0.433KV, 1.1KV class bushings shall be used. Bushings of plain sheds as per IS-3347 shall be mounted on the side of the tank and not on top level.
- f. Dimensions of the bushings of the following voltage class shall conform to Indian Standards mentioned below.

Voltage class	Indian Standards or porcelain parts	For metal parts
1.1KV	IS-3347/part-I/Sec.I/1965/1979	IS-3347/Part-I/Sec.I/1979 (As per IS-1180/1989)
36KV	IS-3347/part-III/Sec.I/1972	IS-3347/part-III/Sec.I/1972

- g. A minimum phase to phase clearance of 75mm for LV (upto 1.1KV bushing) and 255mm for HV (3.3KV and above) bushings shall be obtained with the bushing mounted on the transformer.
- h. The bushings shall be fixed on sides with pockets in the same plane. Arcing horns shall not be provided and instead brass caps shall be provided.
- i. The LV bushing shall be so located that even under the hottest conditions the level of the transformer oil shall be below the opening meant for fixing the LV bushings. The LV jumpers and bushing material shall be selected and designed for this condition.
- j. The design of the internal bushing for LV shall be such as to provide adequate earth clearance as stipulated in the clause 10, 2.1 of IS1180 Part.I and creepage distance as per Clause 7.1 of IS 2099. All other tests as per relevant standards shall be applicable. The LV bushing and HV bushing stems shall be provided with suitable terminal connectors as per IS 5082 so as to connect the jumper without disturbing the bushing stem. High voltage phase windings shall be marked both in the terminal boards inside the tank and on the outside with capital letters 1U, 1V, 1W and low voltage windings for the same phase marked by corresponding small letters 2u, 2v, 2w. The neutral point terminal shall be indicated by the letter 2n. Terminal connectors shall be type tested as per IS 5561. The vector diagram plate shall clearly indicate the method adopted for marking the terminals both outside and interior.

3.9 Terminations

- a. Transformers shall be fitted either with bushing insulators or with air insulated cable boxes / air insulated cable box with disconnecting chamber, as per requirement based on transformer HV incomer.

- b. The neutral of the star-connected winding shall be brought out to a separate bushing terminal. The neutral bushing shall be provided in a suitable location to facilitate lead of the earth conductor down to the ground level.

3.10 Fittings and Accessories:

- a. Enclosure with Top cover
- b. Rating & diagram plate
- c. Terminal marking plate
- d. 2 Earthing terminals
- e. Cable box with HV plug-in connectors
- f. Bus duct termination arrangement/ cable box for LV side
- g. Neutral cable box for neutral earthing
- h. Lifting lugs
- i. Hauling lugs
- j. Base Channel
- k. Under carriage with 4 nos. of Rollers which can be turned 90° and bidirectional
- l. High-voltage danger notices against touching of coils
- m. Louvers
- n. Winding Temperature indicator with RTD sensor (minimum 2 per phase) - Pre-set PTC sensors shall be provided and attached to each of the LV winding as close as possible to the hottest spot. The PTC sensors shall be selected in order to protect both, HV and LV windings. Contacts for alarm and trip and shall be suitable for 220V/110V/24V D.C. The Indicators shall have a suitable RS 485 port for transfer of data to SCADA system).
- o. Marshalling Box
- p. Off Circuit Tap Changing Links - The tap-changing shall be performed by link mechanism. The links shall be accessible after opening the door/cover. Vendor to indicate the method of tapping from the main winding (braced joint or any other type)
- q. All necessary cable glands, cable lugs, armour earthing clamps, terminal connectors, cable sealing ends and accessories required for termination of the Owner's cables/ bus duct shall be included.

3.11 Tests

- a. The routine tests shall be carried out as per applicable standards and shall be deemed to be included in the Vendor's scope. The following additional points/tests shall also be considered as part of routine tests and included in the scope.

- Resistance must be measured at extreme taps also in addition to principal tap.
 - Impedance must be measured at extreme steps also in addition to principal tap.
 - No load loss and exciting current shall be measured at rated frequency at 90%, 100% and 110% rated voltage. These tests shall be done after impulse tests if the latter are specified.
 - No load loss and exciting current shall be measured and recorded with 415V, 3-phase, 50 Hz. Input on LV side.
 - Magnetic circuit (Isolation) test as per CBIP.
 - Measurement of zero sequence impedance.
- b. Type tests, if required, shall be carried out, as per applicable standards and the Vendor shall quote extra unit prices for carrying out each of the type test. However, Heat run test for the transformer is deemed to be considered in the vendor's scope.
- c. In addition, if required, special Tests as listed below shall be carried out as per applicable standards and the Vendor shall quote extra unit prices for carrying out the same.
- Partial Discharge test
 - Acoustic Sound Level measurement
 - Short Circuit Test
 - Thermal Shock Test
 - Environmental Test
 - Climate Test
 - Fire Behavior Test
- d. All the test shall be from NABL accredited lab only.

3.12 Test at Site

- a. The following tests on dry type transformer shall be performed by the Vendor at site at the time of erection and commissioning. Typical checks to be carried out at site are listed below:
- Preliminary checks.
 - Compare nameplate details with the specifications.
 - Check for any physical damage, in particular of support insulators.
 - Check tightness of all bolts, clamps and connecting terminals.
 - Check cleanliness of support insulators, core coil assembly, marshalling panels, enclosure, etc.

- Check for clearances.
- Check earthing of transformer supporting structure/enclosure and neutral terminals.
- Check that the transformer is correctly installed with reference to its phasing and properly aligned with respect to switchgear and interconnecting external bus duct.
- Check for proper termination support of HV and control cables, and provision of cable glands for the same.
- Check for proper alignment and connection of LV side bus bars with switchgearLV bus bars.
- Check welding/bolting to embedded parts/floor of the building.
- Commissioning checks
- Insulation resistance test of windings and polarisation index on winding
- Vector group test
- Phase sequence test
- Winding resistance test at all taps
- Insulation resistance of control wiring
- Core loss test at service tap
- Voltage/turns ratio at all the taps
- Magnetic current balance at full voltage
- Capacitance and tan delta measurement
- Tests on current transformers
- Continuity test
- Polarity test
- IR tests
- Magnetization characteristics
- Ratio test
- Secondary winding resistance measurement.
- Measurement of mV drop across HV and LV power connections and joints

3.13 Rejection

- a. Owner may reject any transformer if during tests or service any of the following conditions arise:
 - No load loss exceeds the guaranteed value.
 - Load loss exceeds the guaranteed value.
 - Impedance value differs from the guaranteed value by +10% or more.
 - Winding temperature rise exceeds the specified value.