

# **GUJARAT INTERNATIONAL FINANCE TEC-CITY COMPANY LIMITED (GIFTCL)**

## **BID DOCUMENT**



### **DEVELOPMENT OF SEZ NORTH GATE AT GIFT CITY ON EPC BASIS**

***JUNE 2026***

**VOLUME-2**

**SECTION-6****SCOPE OF WORK (CIVIL)**

The scope of work for the development of a SEZ entry vehicular gate includes the complete design, fabrication, supply, installation, testing, and commissioning of an aesthetically appealing and structurally robust entrance gate system for vehicle access. The concept drawing for the gate structure shall be provided by GIFTCL. The work shall cover preparation of detailed shop drawings, civil foundation works, structural steel framework, cladding and decorative architectural elements, gate automation systems (if applicable), access control integration, electrical wiring, lighting provisions, painting and protective coatings, safety features, and all associated hardware and fittings. The contractor shall ensure proper alignment, smooth operation, durability against environmental conditions, and compliance with relevant engineering standards, project specifications, and local authority requirements, including coordination with landscaping, security systems, and roadway interfaces to achieve a functional and iconic grand entrance feature.

**1) Project Overview**

This Scope of Work covers the complete design, engineering, supply, construction, installation, testing, and commissioning of a landmark vehicular entry gate complex at SEZ North Gate of GIFT City, including:

- Main vehicular entry and exit gates
- Security cabins/guard houses
- Grand architectural gateway structure
- Traffic management infrastructure
- Electrical and lighting systems

- Façade enhancement works

The project aims to create a secure, aesthetically iconic, and operationally efficient entrance facility for the premises.

## **2) Project Objectives**

The project objectives include:

- Establishing a premium architectural identity
- Providing secure vehicular access management
- Creating functional security and visitor management facilities
- Ensuring smooth traffic circulation
- Integrating smart access control systems
- Enhancing visual appeal through architectural and landscape elements

## **3) Scope of Work**

### **3.1 Site Survey & Investigation**

The contractor shall:

- Conduct topographical survey
- Verify existing utilities and underground services
- Assess soil conditions and foundation requirements
- Study traffic movement patterns
- Assess drainage conditions
- Prepare detailed site survey report

### **3.2 Master Planning & Architectural Design**

**(NOTE: Concept drawing for the Project shall be provided by GIFTCL.)**

The contractor shall develop detail Architectural drawings incorporating every aspect of the Project viz. Civil, Structure, MEPF, Finishing etc.

### **3.3 Detail Engineering**

- Detail structural designing

- Designing considering all the relevant IS codes and provisions.
- Designing all the structural members like, but not limited to, Security cabins, Structural support for top canopy, top horizontal canopy
- Detail engineering for all the aspects of the Project viz. Architectural and Civil Structure, MEPF detailing etc.
- Incorporating all the Designing aspects, as per the Concept Detailing, in the detail engineering.
- Drainage detailing up to GIFTCL city level storm network.
- Detail designing for provision of ELV works in synchronization with GIFTCL ICT team.

### **3.4 Security Cabin / Guard House Works**

#### **Design & Construction**

The contractor shall design and construct security cabins including:

#### **Functional Areas**

- Security operator room
- Visitor management desk
- Resting area
- Pantry provision
- Storage cabinets
- Equipment racks

#### **Civil & Architectural Works**

- RCC/steel structural framework
- Composite Structure (Steel + Concrete)
- Masonry and wall systems
- Waterproofing
- Flooring
- Doors and windows
- Architectural façade treatment (ACP Cladding)



- Interior finishing

#### **Cabin Services**

- Electrical wiring
- Lighting fixtures
- HVAC/air conditioning
- LAN/data connectivity
- UPS provision
- Fire extinguisher provision

### **3.5 Vehicular Gate Systems**

The contractor shall supply and install:

#### **Gate Type**

- Boom barriers

#### **Mechanical Scope**

- Structural steel fabrication
- Heavy-duty hinges
- Corrosion protection
- Galvanizing and paint finish

### **3.6 Architectural Feature Works**

The contractor shall execute:

#### **Façade Development**

- Texture coatings
- Architectural paint systems

#### **Decorative Elements**

- Sculptural elements
- Monument signage
- Feature walls

- LED-lit branding

#### **Feature Lighting**

- Uplighting
- Linear façade lighting
- Landscape lighting
- Bollard lighting
- Dynamic RGB lighting (optional)

### **3.7 Civil & Structural Works**

The contractor shall carry out:

#### **Foundations**

- Excavation
- PCC and RCC works
- Composite Structure
- Anchor bolt installation
- Reinforcement works

#### **Road & Pavement Works**

- Entry/exit lanes
- Kerbstones
- Interlocking pavers
- concrete paving

#### **Drainage Works**

- Stormwater drainage
- Trench drains
- Catch pits
- Gratings

### **3.8 Electrical Works**

The contractor shall execute:

#### **Power Distribution**

- LT panel connection
- Distribution boards
- Cabling and conduits
- Earthing and lightning protection

#### **Lighting System**

- Street lighting
- Architectural lighting
- Security lighting
- Emergency lighting

### **4) Testing & Commissioning**

The contractor shall perform:

#### **Mechanical Testing**

- Gate cycle testing
- Motor performance verification
- Structural alignment checks

#### **Electrical Testing**

- Insulation resistance test
- Earthing resistance test
- Load testing

#### **Architectural Inspection**

- Finish quality checks
- Lighting effects verification
- Water leakage inspection

### **5) Deliverables**

The contractor shall submit (based on the Concept drawings provided by GIFTCL) following details:

- All the relevant GFC drawings
- Architectural drawings
- Structural drawings with all the Calculations
- MEP drawings
- Material samples
- Structural calculations
- Lighting simulations
- As-built drawings
- O&M manuals
- Warranty documents

#### **SCOPE OF WORK (MEPF)**

1. This Scope defines the minimum MEPF work to be executed by the Contractor on a lump-sum EPC basis. Contractor shall carry out detailed engineering, obtain approvals, and deliver a fully functional system.
2. The scope of work covers the complete design, supply, installation, testing, commissioning and maintenance during DLP of MEPF works for the North Entrance Gate at GIFT City.
3. Design & Engineering: Detailed engineering for all MEPF disciplines based on site condition, load calculation, lux level design, hydraulic calculation, LPS risk assessment as per IS/IEC 62305. Submit GA drawings, SLDs, load schedules, pipe routing, lighting design for Client approval before procurement.
4. Statutory Approvals: Obtain approval from Local Electrical Inspectorate, Fire Department, and any other authority. All the approvals, permission, NOC's, certificates, etc. as require.
5. Coordination: Interface with Civil, Structural, Landscape, Access Control, IT team and vendors. Ensure no clashes and timely handover.
6. Supply & Installation: All materials, labor, tools, testing equipment, consumables.



Only new, BIS/ISI marked materials of approved make and model.

7. Testing & Commissioning: Carry out all site tests, trial run, training to Client and end user staff. Submit O&M manuals, as-built drawings in AutoCAD, PDF and 5 set of hard copies.
8. Preventive and Corrective Maintenance, repair or replacement of all MEPF equipment and system during defect liability period. The contractor shall provide all required services, maintenance, and replacement in the DLP period and beyond the Defect Liability Period, as applicable, in accordance with the guarantee/warranty period specified in the technical specifications and approved TDS of MEPF works.
9. ELECTRICAL WORKS:
  - North Entrance Offices/Security Cabin: Complete internal electrical wiring, lighting, power, fans, Split type AC, fire extinguisher, etc. as required.
  - Complete design of SLD and layout for electrical power distribution for internal offices and security cabin area, external area and Gate structure.
  - External lighting: Street light with poles, Bollards, Post Top Light with poles, Spike lights, Uplighters, LED strip – Aluminum profile light on Gate, Downlights, Façade lighting etc. with complete wiring/cabling, protection switchgears, IP rated junction box, fixing arrangements, foundation if require and accessories as required. As mentioned above are indicative lighting fixtures for external lighting, actual lighting fixtures shall be as per the approved drawings.
  - Power Distribution: The scope includes SITC work of main incoming power panel/DB to receive supply from GIFT PCL near by source with all the required cabling work from GIFT PCL power source, necessary termination, etc. Complete Panel/DB including all the necessary switchgears (MCCB / MCB / ELCB / RCCB / RCB / RCBO), SPD, relays, contactors, connectors, DinRails, terminal block, wiring/cabling, termination with lugs and glands, earthing, etc.
  - Raw Power DB for Offices and Security cabin: Required Nos. of TPN and SPN DB as per approved SLD and drawing including switchgears like MCCB,

MCB, RCCB, RCB, RCBO, DinRails, connector, terminal block, necessary wiring/cabling, termination with lugs and glands, earthing and SPD Class-II.

- UPS Power DB: Required TPN/SPN DB as per approved SLD and drawing including switchgears like MCCB, MCB, RCCB, RCB, RCBO, DinRails, connector, terminal block, necessary wiring/cabling, termination with lugs and glands, earthing and SPD Class-II.
- External Lighting DB: If required separate DB for external lighting as per approved SLD and drawings including switchgears like MCCB, MCB, RCCB, RCB, RCBO, timer, contactor, DinRails, connector, terminal block, necessary wiring/cabling, termination with lugs and glands, earthing and SPD Class-II.
- Centralized single UPS System for North Entrance Gate work: Single required kVA Online UPS with minimum 1 hour backup at full load and dedicated UPS DB to feed computer plug points in offices and security cabin, printer/xerox machine in offices and security cabin, Boom Barrier, Flap Gate, Biometric device, routers, servers and Data Network Rack. UPS load calculation and battery sizing shall be provided by bidder for approval.
- UPS Power supply arrangement for Access Control: Boom Barrier, Flap Gate, Biometric of Access control system.
- Complete wiring/cabling with modular type switchboard, switch-socket & accessories, PVC conduit/Metal conduit/DWC for offices and security cabin power plugs, lighting fixture, switchboards, Computer/Printer/Xerox machine power plug, Ceiling Fans, Exhaust Fans, Water cooler & RO power plug, Geyser power plug, HVAC system power plug, Freeze and induction stove plug point, Plumbing motor & pumps, etc.
- SITC of Modular type required module switchboard with necessary switches(1 way/2 way/bell switch), socket (5/16/20 Amp), MCB, cover plate, metal box of same make for light points, Fan points, Bell points, AC points, Geyser points, Freeze/Stove points, Computer/printer/Xerox machine points, power plug-points, etc. as required.

- For each office minimum 4 nos. UPS power plug-points shall be in scope for computers and printers, For Security cabin minimum 6 nos. UPS power plug-points shall be in scope for computers and printers, minimum 1 no. UPS power plug-points for xerox machine shall be in scope in each office and security cabin. For each office minimum 2 nos. and for security cabin minimum 4 nos. raw power plug points shall be provided for routine requirements like laptop or mobile charging. Each switchboard for fan and light operation shall be with 6Amp plug point with switch in offices and security cabin.
- Power Points & Equipment Supply: Provide wiring and power outlet for:
  - UPS power 6A/16A sockets – min. 3 Nos. 6A + 1 No. 16A for each office
  - UPS power 6A/16A sockets – min. 4 Nos. 6A + 2 No. 16A for security cabin
  - UPS power 16A sockets – min. 1 No. 16A for each office and security cabin
  - Raw power 6A sockets – min. 2 Nos. 6A for each office
  - Raw power 6A sockets – min. 4 Nos. 6A for security cabin
  - Raw power 16A sockets – min. 1 No. 16A for each office
  - AC Point: min. 20/25A socket for AC in each Office/Cabin as require and suggested by EIC
  - Geyser Point: 16A socket with indicator in toilet as required
  - Water Cooler, RO Unit - 1 No. 6A + 1 No. 16A
  - Data Network Rack – circuit from UPS DB
  - Access Control: Boom Barrier, RFID Reader, Flap Gate – min. 20A circuit from UPS DB for each controller/point.
  - Attendance Punching/Biometric Device – 5A socket if require
- SITC of Ceiling Fan 1200mm sweep, BIS, energy efficient, <50W, with electronic 2M regulator as per requirement for offices and security cabin. Minimum 1 no. ceiling fan shall be provided for each room of office and security cabin.
- SITC of Exhaust Fan in each toilet area shall be in scope of work. Supply and installation of mirrors with wooden frames for toilet area shall be in scope of work.
- SITC for Geyser with require accessories and water pipes, valve and tap in toilet-washroom as per standard practice & technical specifications.
- SITC of bell point including electronic bell and necessary wiring for offices.

- External Lighting: Design to achieve Lux level as mentioned in technical specification. Submit lighting design using Dialux/Relux for approval. Design, supply, installation, testing & commissioning Includes but not limited to following indicative external lighting fixture:
  - LED Street Light with Pole, RCC foundation, JB, protection switchgears cabling, accessories, etc.
  - LED circular Post Top fixture on Pole with RCC foundation, JB, protection switchgears cabling, accessories, etc.
  - LED Bollard Light with RCC foundation, JB, cabling, accessories, etc.
  - Spike light, Uplighter, Wall washer for landscape and façade with JB, cabling, accessories, etc.
  - LED Strip Light IP65 on Gate structure in Al profile with driver, cabling, accessories, etc.
  - Downlight under structure and outside Cabin with necessary accessories and cabling as required
  - Civil foundation design and execution for Poles, Bollards, Post Top Lanterns, etc.
- Internal Lighting: Design to achieve Lux level as mentioned in technical specification. Design, supply, installation, testing & commissioning Includes but not limited to following indicative internal lighting fixture:
  - Office/Cabin: Minimum 18W LED Downlight recessed/surface mounted with necessary wiring and accessories as required
  - LED Tube/Batten: Minimum 20W with necessary wiring and accessories as required.
- Earthing & LPS work, DBs, cabling in DWC pipe, wiring in conduit, testing & commissioning, documentation, as-built drawings.
- For earthing system, whole design for earthing shall be done by the contractor based on IS codes & standards. As per the approved design, SITC of whole earthing system with necessary Cu. Bonded electrode, chemical compound, GI/Cu. Earthing strip, Cu. Wire/cable, earth pit, etc. Necessary excavation and boring shall be in scope of contractor. Separate earthing shall be provided for UPS system.
- LPS – Lightning Protection System: As per IS/IEC 62305. Contractor to do risk assessment and design. Supply, installation and commissioning of LPS Includes Air Terminal, Down Conductor, GI Strip, Test Joint, Separate Earth Pit with 3m cu. Bonded rod Electrode, etc.

- Scope covers all the necessary cabling/wiring for complete work. The cables/wires shall be 1.1 kv, copper, FRLSZH for power, UPS and lighting requirements. Cabling/wiring shall be in manner as per following:
  - Indoor concealed: Heavy Duty PVC conduit in wall/slab
  - Outdoor/Exposed: GI conduit
  - Underground: DWC Pipe, min. 750mm deep, with sand, brick
  - Inside Office/Cabin: Raceway/Trunking for desk wiring as suggested by EIC
  - Cable Tray if required and as suggested by EIC
- Testing of Insulation Resistance, Earth Resistance test, Polarity, Continuity, Lux level test, UPS backup test, RCCB trip test, etc. shall be in scope of work.

#### 10. HVAC WORKS:

- The scope covers work for the split-type air conditioning for North Entrance Gate offices & security cabin of GIFT City.
- Scope includes design, supply, installation, testing and commissioning of split inverter type Hi Wall AC (3-star rating). This also includes installation of fabricated stand for outdoor unit, core-cut, and supply & installation of refrigerant pipe, drainpipe, control cable to outdoor unit, supply and laying of electrical power cable and other accessories as per site requirement and as directed by Engineer-in-charge.
- Documentation reports & drawings: Preparation and submission of Material datasheets & technical submittals, project schedule, procurement plan, Material Supply, Installation, testing & commissioning reports, etc.
- Handover of the system: After successful completion of testing & commissioning of HVAC work, the contractor shall handover the entire works under the scope of this contract to DCS operation and maintenance contractor for operation and maintenance.

#### 11. FIRE FIGHTING WORKS:

- The scope covers the design, supply, installation, testing and commissioning of portable fire extinguisher as per IS 2190 & NBC 2016. The scope includes following:

- 6kg ABC Dry Powder Extinguisher – 1 No. near entrance of each Office/Cabin
- 6kg ABC Dry Powder Extinguisher – 1 No. near electrical panel
- 3kg CO2 Extinguisher – 1 No. near electrical panel
- 2. Mounting & Signage: Mounting height 1.2m to handle. Wall signboard + floor marking.
- 3. Maintenance: Service and refilling as require during DLP.

12. Modular type RJ45 and RJ11 socket with necessary concealed conduiting shall be in scope of the work for data and telephone for offices and security cabin. Qty. shall be as per actual requirement.
13. The scope covers any core-cutting required for the MEPF work including fixing-closing of core in proper manner up to the satisfaction of EIC after passing the utility from core.
14. The scope covers the submittal for Approval like Lighting design, SLDs, Load calculation, Battery sizing, Pipe sizing, LPS risk assessment, Layout drawings, TDS of all materials, etc.
15. The scope covers the submittal at Completion like As-built drawings, Test reports, O&M Manuals, Warranty certificates, Training record, etc.
16. This Scope is to be read in conjunction with technical specifications, approved Drawings, and General Conditions of Contract.

**SECTION: 7 TECHNICAL SPECIFICATIONS**

**CIVIL WORKS**

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| <b>S. No.</b> | <b>Description</b>                        |
|---------------|---|
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| B             | Applicable codes and specifications       |
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| 2             | Pre-Constructional ANTI-TERMITE Treatment |
| 3             | Masonry Works                             |
| 4             | Plastering                                |
| 5             | Concrete and allied Works                 |
| 6             | Structural Steel                          |
| 7             | Flooring                                  |
| 8             | Partition Works                           |
| 9             | Painting Work                             |
| 10            | Miscellaneous                             |

#### A. LIST OF APPROVED MAKES

| SR. | DETAILS OF MATERIALS / EQUIPMENTS     | TENDER MAKES   |
|-----|---------------------------------------|--|
| 1.  | Ordinary Portland Cement / PPC        | Ultra-Tech / ACC / JK laxmi / Ambuja   |
| 2.  | White cement                          | Birla White / JK/ Ultratech White/ Coromandal White/ Zuari White   |
| 3.  | Reinforcement Steel                   | TATA Tiscon / SAIL / JSW / Jindal / Essar  |
| 4.  | Structural Steel                      | TATA / SAIL / JINDAL/ JSW steel  |
| 5.  | Mechanical Anchors / Chemical Anchors | Hilti / Wurth / Fischer  |
| 6.  | Ready Mix Concrete                    | ACC / ULTRATECH or Equivalent  |
| 7.  | Anti-Termite Treatment                | Pidilite / Biflex / Madhura / Bifenthrin / Biflex TC   |
| 8.  | CONCRETE ADMIXTURES                   | Fosroc/ Cico/Sika/BASF   |
| 9.  | Surface Treatments                    | Fosroc/ Pidilite /BASF / CERA /Dr.Fixit  |
| 10. | Bonding agents                        | Fosroc/ Pidilite /BASF / CERA /Dr.Fixit  |
| 11. | Grouts                                | BASF/ FOSROC/ SIKA/ Pidilite   |
| 12. | Construction joint product            | Euclid / FOSROC / MYK /BASF  |
| 13. | Micro concrete.                       | Parex Group / Pidilite / MAPEI<br>Construction Products India Pvt. Ltd / FOSROC  |
| 14. | Testing Agencies                      | Civil aid technologies / Structwell / SGS<br>Construction / Elite Engineering<br>Consultancy/ Capital Consultancy/<br>Metalab Consultancy/ |



|     |                                      |  |
|-----|--------------------------------------|--|
| 15. | Waterproofing Chemical Manufacturers | Fosroc / Sika / Pidilite / BASF / Tikidan / MYK/ GRACE/PENETRON  |
| 16. | Epoxy Grouts & Adhesives             | Laticrete / Ardex Endura/ Kerakoll/ Sika/ BASF/ Pidilite/ Fosroc/ Mapei  |
| 17. | Nuts bolts, washers' rivets.         | Kundan/ Arrow/ Atul  |
| 18. | Lightweight Concrete                 | Hermalite / Vermiculate/Cinder   |
| 19. | Aluminium Sections                   | Jindal Aluminium / Hindalco / Indal / Bhoruka/ Century / SSAIL (Satya Surya) / Nalco (National Aluminum Company Limited) |
| 20. | Foundation Bolts                     | Aquarius industries, SK Industries/ MK metals / SK Fasteners   |
| 21. | AAC / fly ash blocks                 | Charbuja, Aerocon, Siporex, Ecolite, CEEFpro, BLIT   |
| 22. | Cement                               | Ultratech, Ambuja, ACC, JK Lakshmi   |
| 23. | Door seals [ dust / fire ]           | Lorient, Enviroseals, Pemko, Assorted  |
| 24. | Structural, Weather Sealant          | Dow Corning, GE, Dupont  |
| 25. | Glazed, Ceramic & Vitrified Tiles    | Euro, Naveen, Kajaria, Nitco, Jhonson, RAK   |
| 26. | Pigmented Joint fillers              | Laticrete, Pidilite  |
| 27. | Cement Putty                         | Birla Wall Care, JK White, Berger, Ferros Crete,   |
| 28. | Paint                                | Asian Paints   |
| 29. | Glass                                | Saint Gobain, AIS, Pilkington, Emirates  |
| 30. | Fire rated glass                     | Schott, Saint Gobain, Pyrex  |
| 31. | Doors, Window Fittings and Fixtures  | Dorma, Giesse, Dline, Union, Yale, Assa Abloy brands   |

|     |  |  |
|-----|--|--|
| 32. | Toughened Glass  | Saint Gobain, Gujrat Guardian Glass or equivalent.                       |
| 33. | Zinc chromate primer for metal surfaces  | Asian Paints, Berger Paints  |
| 34. | Patch fittings / friction fittings, Floor spring, Hinges, Door closer, door locks and handles, Automated Sliding Door sensor | Godrej, Geze, Dorma , Enox, Hettich, Hafele, Ebco or approved equivalent |

#### **B. APPLICABLE CODES AND SPECIFICATIONS**

The more important Codes, Standards and Publications applicable to this section are listed hereinafter:

| <b>Code Reference</b> | <b>Description</b>   |
|-----------------------|--|
| IS: 110               | Ready mixed paint, brushing, grey filler, for enamels for use over primers     |
| IS: 269               | Specification for 33 grade Ordinary Portland Cement                            |
| IS: 280               | Specification for mild steel wire for general engineering purposes             |
| IS: 383               | Specification for coarse and fine aggregates from natural sources for concrete |
| IS: 456               | Code of practice for plain and reinforced concrete                             |
| IS: 712               | Specification for building limes   |
| IS: 1077              | Specification for common burnt clay building bricks                            |
| IS: 1200              | Methods of measurement of building and Civil engineering works                 |
| IS: 1489 (Part 1)     | Portland Pozzolana Cement: Fly ash based                                       |
| IS: 1489 (Part 2)     | Portland Pozzolana Cement: Calcined clay based                                 |
| IS: 1542              | Specification for sand for plaster   |

| Code Reference | Description  |
|----------------|--|
| 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: 1834       | Specification for hot applied sealing compound for joint in concrete             |
| IS: 2074       | Ready mixed paint, air drying, red oxide-zinc chrome, priming                    |
| IS: 2116       | Specification for sand for masonry mortars                                       |
| IS: 2185       | Specification for concrete masonry units (Parts 1 & 2)                           |
| IS: 2212       | Code of practice for brickwork   |
| IS: 2250       | Code of practice for preparation and use of masonry mortars                      |
| IS: 2395       | Code of practice for painting concrete, masonry and plaster surface (Part 1 & 2) |
| IS: 2402       | Code of practice for external rendered finishes                                  |
| IS: 2572       | Code of practice for construction of hollow concrete block masonry               |
| IS: 2645       | Specification of integral cement waterproofing compounds                         |
| IS: 2691       | Specification for burnt clay facing bricks                                       |
| IS: 2750       | Steel Scaffoldings   |
| IS: 3620       | Specification for laterite stone block for masonry                               |
| IS: 3696       | Safety code of scaffolds and ladders (Parts 1 & 2)                               |
| IS: 4082       | Recommendation of Stacking and Storage of construction materials                 |
| IS: 5410       | Cement paint, colour, as required  |

| Code Reference | Description   |
|----------------|---|
| IS: 6041       | Code of practice construction of autoclaved cellular concrete block masonry |
| IS: 6042       | Code of practice for construction of light weight concrete block masonry    |
| IS: 8042       | Specification for white Portland cement                                     |
| IS: 8112       | Specification for 43 grade Ordinary Portland Cement                         |
| IS: 12269      | Specification for 53 grade Ordinary Portland Cement                         |
| <b>Legend</b>  |   |
| IS             | Indian Standards  |

### **QUALITY ASSURANCE AND QUALITY CONTROL**

1. The work shall conform to high standards of design and workmanship, shall be structurally sound and aesthetically pleasing. Quality standards prescribed shall form the backbone for the Quality Assurance and Quality Control system.
2. At the site level the Contractor shall arrange the materials, their stacking/ storage in appropriate manner to ensure the quality. Contractor shall provide equipment and manpower to test continuously the quality of materials, assemblies, etc., as directed by the Engineer. The tests shall be conducted continuously, and the results of tests maintained. In addition, the Contractor shall keep appropriate tools and equipment for checking alignments, levels, slopes, and evenness of the surface.
3. The Engineer shall be free to carry out such tests as may be decided by him at his sole discretion, from time to time, in addition to those specified in this document. The Contractor shall provide the samples and labour for collecting the samples. Nothing extra shall be payable to the Contractor for samples or for the collection of the

samples. The test shall be conducted at the Site laboratory that may be established by the Contractor or at any other Standard Laboratory selected by the Engineer.

4. The Contractor shall transport the samples to the laboratory for which nothing extra shall be payable. In the event of Contractor failing to arrange transportation of the samples in proper time Engineer shall have them transported and recover two times the actual cost from the Contractor's bills.
5. The testing charges shall be borne by the Contractor.
6. Testing may be witnessed by the Contractor or his authorized representative. Whether witnessed by the Contractor or not, the test results shall be binding on the Contractor.

## **GENERAL REQUIREMENTS**

### **PREAMBLE**

- These specifications cover the items of works in structural and nonstructural parts of the works coming under purview of this document on Design build contract basis. All work shall be carried out in conformation with this specification. In general, provisions of Indian Standards, and other National Standards shall be followed. These specifications are not intended to cover the minute details. The work shall be executed in accordance with the best modern industry practices. All Codes and Standards referred to in these specifications shall be the latest published ones.
- The work to be performed under this specification consists of design, engineering, preparation of detailed specifications, general arrangement, construction, fabrication and erection drawings including supply of all Labour, materials, consumables, equipment, temporary works, temporary Labour and staff colony, constructional plant, fuel supply, transportation and all incidental works not shown or specified but reasonably implied or necessary for the completion and proper functioning of the campus, all in strict accordance with the specifications, including revisions and amendments thereto as may be required during the execution of the work.

- The Contractor to submit all the loading calculation & design files of all structural elements. Also, the other data and files as demanded by the approving Engineer/ Engineer's Representative for all buildings and structures, etc.
- The work shall be carried out according to the detailed design, drawings, and specifications to be developed by the Contractor and approved by the Engineer/ Engineer's Representative. For all buildings, structures, etc., necessary details are to be developed by the Contractor keeping in view the statutory & functional requirements of the campus and facilities and providing enough space and access for operation, use and maintenance. Certain minimum requirements are indicated in this specification for guidance purposes only. However, the bidder's offer shall cover the complete requirements as per the best prevailing practices and to the complete satisfaction of the Engineer.
- The scope shall also include setting up a complete testing laboratory in the field by the Contractor to carry out all relevant tests required for the works.

#### DETAILED DESIGN BY CONTRACTOR

- The Contractor's detailed design shall comply with the Engineer's requirements as outlined in the Master Plan, Design Specifications and Drawings, which are made part of this specification. All other materials and components shall be accommodated within the locations, space and dimensions indicated on the layout drawings.
- The detailed design of buildings and structures shall be evolved considering the strength and serviceability requirements as per the relevant standards and specifications, functional, technological, operation & maintenance of MEP services and other requirements for efficient operation, ensuring comfortable working environment for personnel, satisfying the aesthetic requirements. Special care shall be taken to provide elegance and aesthetics, with effective use of appropriate treatment, materials, fittings, and finishes.
- The Contractor shall design and construct all buildings and structures to meet the stipulated performance and quality requirements of the Contract and to the approval of the Engineer.

- Approval by the Engineer shall not relieve the Contractor of any of his responsibilities under the Contract.
- The bid purpose drawings are provided to enable Contractor to carry out design for the project in line with the specification requirements. These drawings are indicative only and represent the minimum construction, quality, scope, dimensional and space requirements. The drawings are issued subject to increase in quantity, quality and space requirement as recommended by the Contractor or as may be instructed by the Engineer to accommodate the actual operational requirements of the Project.
- The Contractor shall himself make all necessary independent investigations and studies to ensure that the design of all buildings/ structures including all foundations and site development meets with the requirements of the Contract and is suitable and adequate for the purpose.
- Contractor shall inspect the site, examine, and obtain all information required and satisfy himself for site conditions such as access to site, communications, transport, right of way, the type and number of equipment and facilities required for the work, availability of local Labour, materials and their rates, local working conditions, weather, tidal / flood levels, subsoil conditions, natural drainage, etc. Ignorance of the site's conditions shall not be accepted by the Owner as basis for any claim for compensation or extension of time. The submission of a bid by the Contractor will be construed as evidence that such an examination was made and any later claims / disputes regarding price quoted shall not be entertained or considered by the Owner on account of ignorance of prevailing site conditions.

**DOCUMENTS TO BE SUBMITTED BY BIDDER ALONG WITH DESIGN AND BUILD BID****PERTAINING TO CIVIL WORKS**

- Suggested plot plan locating all buildings, structures, facilities, roads, temporary site office, etc. with their plan dimensions.

- A study notes on proposed site grading with levels along with certified data collected from various agencies to arrive at the same. Also, the source of earth to be used as fill having quality as per specification should be indicated.
- Concept Note or Detailed write up on the following satisfying the statutory requirements,
- Proposed shoring system for excavation during construction where water table is higher.
- Proposed dewatering system during construction where water table is higher.
- Waterproofing system and detailed methodology proposed for each area.
- A report on foundation proposed for various structures, buildings and facilities based on the data furnished by the Engineer and further data collected by the Contractor. Allowable safe bearing capacity for open foundation, depth of foundation, need for pile foundations, type, length, and capacity of piles, if piles are proposed, soil improvement if any required, special precaution against aggressive soil etc. shall also be covered in the report.
- Detailed design criteria proposed to be adopted for each building, structures etc.
- List of software proposed to be used in various areas for analysis, design, drafting as well as project monitoring along with their sources and validation report for software.
- Details of quality control laboratory with a list of testing equipment.
- All deviations from bid document shall be furnished by Contractor in the format given in the specification document. Deviation furnished elsewhere in the bid other than at the place titled “Deviations” will not be considered as deviations.
- Any exclusions from the scope mentioned and implied in these specifications, shall be clearly mentioned by the Contractor separately in a section titled “EXCLUSIONS”. Only the details mentioned in this section shall be considered as exclusions. All works, other than these, shall be deemed to be in the scope of this contract and shall be executed by the Contractor at no extra cost to the Engineer.

**DOCUMENTS TO BE SUBMITTED BY CONTRACTOR AFTER THE AWARD OF CONTRACT**



**PERTAINING TO CIVIL WORKS**

The following documents are to be submitted for the approval of the Engineer, prior to commencement of construction/ fabrication & erection.

The list is not exhaustive but indicative only:

- Topographical survey drawings along with location and details of benchmark, grid and boundary pillars based on detailed survey conducted after the award of work.
- Geotechnical investigation report based on additional geotechnical investigation carried out by Contractor along with foundation recommendation for various buildings / structures / facilities.
- Site Grading and Storm Water Drainage Concept Note furnishing levels of various terraces, arrangement and details of drains, culverts etc. for storm water drainage system within plot. The study shall also cover harvesting of rainwater to the maximum extent.
- General plot layout drawing with co-ordinates of roads, boundary wall, buildings and facilities, piping / cable corridors, provision of landscaping and green belt development, diversion drains etc.
- Drawing showing underground facilities with co-ordinates of these facilities like buried pipes, buried cables, trenches, ducts, sewer, drains, sumps, pits, culverts, foundations etc.
- Detailed Architectural floor plans, elevations, cross sections, and perspective view (in colour) of all buildings/ structures. Detailed drawings of all architectural works shall include finish schedule, colour scheme (both internal and external), doors and windows, flooring, and false ceilings, etc.
- Detailed Design Reports for all buildings, structures, and facilities along with design calculations and drawings for foundations/ substructure and superstructure and other structures within the premises. Design calculations to include dynamic analysis for all foundations subjected to dynamic loads. Design and drawing of vibration isolation system shall also be furnished in case the same will be supplied along with the equipment.

- All other designs, details / drawings or any other submissions as indicated elsewhere in this specification and as required by the Engineer.
- The loading calculation & design files including but not limited to Calculation of loads, Codal compliances in spread sheets, software files used for Calculation, modelling, analysis, design and drawing of all structural elements and other data and files as demanded by the approving Design Reviewer/Engineer/ Engineer's Representative for all buildings and structures, etc.
- Details of corrosion protection measures for all structures.
- Copies of all reports on investigation and studies carried out by the Contractor as per the scope.
- Total quantity of concrete (grade wise), reinforcement steel (diameter wise) and structural steel (section wise) in all construction drawings.
- Fabrication drawings for important structures or any other structure specifically called for by the Owner or his authorized representatives.
- Contractor shall submit 6 copies of each drawing for each revision for approval before commencing any work. While scheduling the contractor should consider an approval period of 10-15 days for each drawing and calculation. The responsibility of scheduled approval from Engineer or Engineer's representative before commencing any work lies with contractor.

### **C. DESIGN BASIS FOR CIVIL WORKS**

- **INTRODUCTION**

Gujarat International Finance Tec-City Company Limited ("GIFTCL") is developing a Global Financial Services Hub, being a Central Finance and Business District, known as GIFT City, on around 886 Acres of land situated and lying at Taluka and District Gandhinagar, Gujarat. GIFT City is planned to be implemented over a period of 10 to 12 years. In GIFT city, district cooling system is planned to cater the city wide air conditioning needs from centralized plant. The planned infrastructure is being implemented in phases, preceding the built-up area

development in respective stage. In each stage the development would comprise of buildings to be constructed in the Multi- Services Special Economic Zone (SEZ), and Domestic Tariff Area (DTA) spread in the GIFT City Area. The DTA area of GIFT City is being developed by GIFTCL and SEZ area of GIFT City is being developed by GIFT SEZ Limited (a wholly owned subsidiary of GIFTCL Limited).

- **OBJECTIVE OF THE REPORT**

This Concept Note describes the methodology to be adopted for structural analysis and design of proposed North SEZ Gate to be constructed under Gujarat International Finance Tec-City Company Limited “GIFTCL”, to satisfy functional requirements and ensure structural integrity of the structure as envisaged in the applicable safety standards.

- **SCOPE**

This Concept Note is intended to highlight project site description, selection of materials, types of loads, load combinations and general guidelines for structural analysis and design. This report will form the design criteria and basis for methods of analysis and design to be adopted in this project, with the aim of achieving a design that satisfies all strength and serviceability requirements under all types of loadings. This document also records all inputs that shall be followed in structural design and will form the basis for all future detailed structural design.

The Concept Note for other disciplines shall be referred in respective discipline’s Concept Notes.

- **LOCATION OF STRUCTURE**

The North SEZ Entrance of GIFT City

- **SOIL INVESTIGATION AND FOUNDATION RECOMMENDATION**

The geotechnical investigation shall be provided by GIFTCL.

- **CODES STANDARDS AND SPECIFICATION**

The design shall comply with the latest editions and revisions of the codes, specifications, and standards listed below as noted, supplemented, or modified herein:

|   |         |                    |
|---|---------|--------------------|
| • National Building Code of India   | SP 7:   | 2016               |
| • Code of practice for design loads (Part 1, 2, 3, 4 & 5)   | IS875:  | Part 1:1987(R2018) |
|   | IS875:  | Part 2: 987(R2018) |
|   | IS875:  | Part 3: 2020       |
|   | IS875:  | Part 4: 2021       |
|   | IS875:  | Part 5:1987(R2018) |
| • Criteria for Earthquake Resistant Design of Structures - Part 1: General Provisions and Buildings                               | IS1893: | 2021               |
| • Criteria for Earthquake Resistant Design of Structures Part 2 Liquid Retaining Tanks  | IS1893: | 2014               |
| • Criteria for Earthquake Resistant Design of Structures Part 3 Bridges and Retaining Walls                                       | IS1893: | 2014               |
| • Criteria for Earthquake Resistant Design of Structures Part 4 Industrial Structures and Stack-Like Structures (Second Revision) | IS1893: | 2024               |
| • Guidelines for Criteria for Earthquake Resistant Design of Structures Part 6: Base Isolated Buildings                           | IS1893: | 2022               |

|   |          |      |
|---|----------|------|
|   |          |      |
| <ul style="list-style-type: none"> <li>Earthquake Resistant Design And Detailing Of Steel Buildings - Code Of Practice</li> </ul> | IS18168: | 2023 |

## DESIGN LOADS

Buildings and structures for this project shall be design for the following loads.

### Dead Loads (DL)

The dead loads to be calculated based on 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 data provided by the project architect and other service consultants will be used for the specific materials/ equipment's.

Dead load for a building shall be calculated in accordance to IS 875 PART-1

Dead load for common burnt clay bricks: 18.85 KN/m<sup>3</sup>

AAC Blocks : 8 KN/m<sup>3</sup>

Density for reinforced concrete : 25.00 KN/m<sup>3</sup>

Density of plain cement concrete : 23.50 KN/m<sup>3</sup>

Cement Plaster : 20.40 KN/m<sup>3</sup>

Glass : 25.00 KN/m<sup>3</sup>

Structural steel : 78.50 KN/m<sup>3</sup>

Water : 9.81 KN/m<sup>3</sup>

Soil dry : 18.00 KN/m<sup>3</sup>

Soil Bulk Density : 20.60 KN/m<sup>3</sup>

Coefficient of active earth pressure: 0.33

Equipment load : As per OEM specifications.

Operation and Maintenance Load : As per OEM/MEP specifications.

Note:

Total dead load contribution is calculated in two parts,  $DL = SW + SIDL$ .

Terrace water proofing, Cooling Tower Basin water proofing and terrace are to be considered as per Architectural or MEP drawings.

Epoxy flooring to be considered as per Architectural or MEP drawings.

Equipment foundation, Pedestal load, Inertial Block etc if any to be accounted in Equipment load as per OEM and MEP specifications and should be approved from Engineer In-Charge.

Live Loads (LL)

All the live loads shall be as per IS 875 (part 2) and as per any specific requirement by MEP, if any.

Wind Loads (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 (Part 3).

|  |                                     |       |            |
|--|-------------------------------------|-------|------------|
| Basic Wind speed   | $V_b = 39$                          | m/sec |            |
| Design Wind Speed at any height:                                       | $V_z = V_b * K_1 * K_2 * K_3 * K_4$ | m/sec | Clause 6.3 |
| Where, $K_1$ = Probability factor = 1 (50 year life, general building) |                                     |       |            |
| $K_2$ = Terrain roughness & height factor                              |                                     |       |            |
| For Category 2, Values of Table 2 of IS: 875-Part 3 to be referred.    |                                     |       |            |

|   |                          |                  |            |
|---|--------------------------|------------------|------------|
| K3 = Topography factor = 1.0 (For terrain slope less than 3°)                 |                          |                  |            |
| K4 = 1 (non-costal area) Importance factor for cyclonic region (Clause 6.3.4) |                          |                  |            |
| Design Wind Pressure at any height:   | $P_z = 0.6 \times V_z^2$ | N/m <sup>2</sup> | Clause 7.2 |

Based on the above wind pressure and exposure of the building, further load calculations will be carried out with respect to profile of building as per IS: 875 (Part 3).

For steel building the height is more than 10m hence  $p_z$  shall not be reduced by 20%.

Steel structure, pipe support, pipe rack on terrace to be designed for wind load as per IS code provisions as per actual site condition and should be approved by Engineer In-Charge.

#### Seismic Loads

All buildings, structures, foundations shall be designed to resist the effects of earthquakes in accordance with IS 1893 (Part 1):2016, IS 1893 (Part 2): 2014 and IS 1893 (Part 4):2024 for Seismic Zone III. All the buildings and structures shall be designed for Design Basis Earthquake (DBE).

#### Seismic Parameters

Seismic design forces shall be determined 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 –IV | Fig.1 - Map Showing Seismic Zones of India.<br><br>(IS 1893 – Part 1) |

|   |  |  |
|---|--|--|
| Zone Factor (z):  | 0.24   | Table 3 (IS 1893-Part 1)   |
| Importance Factor (I):  | 1.5 (As per table 8 of IS code)  | Table 8 (IS 1893-Part 1)   |
| Response Reduction Factor (R):  | 5.0 For RCC Structure with special moment resisting frame (SMRF)   | Table 9 (IS 1893-Part 1)<br>CL.No.7.2.6                                  |
| Fundamental Natural Period (Ta)   | $0.09 h / (\sqrt{d})$ for RCC Structure  | Clause No: 7.6.2 –b<br>IS: 1893 (Part 1).                                |
| Average Response Acceleration Coefficient (Sa/g) :<br>For medium soil sites | $1+15T$ $0.10 < T$<br>$2.5$ $0.1 \text{ s} \leq T \leq 0.55$<br>$1.36/T$ $0.55 < T < 4.0$<br>$0.25$ $T > 4.00$ | Fig. 2 Design Acceleration Coefficient corresponds to 5 percent damping. |
| Design Spectrum<br>The design horizontal seismic coefficient (Ah)           | $(Z/2) * (Sa/g) * (I/R)$   | Clause No: 6.4.2 –<br>IS: 1893 (Part 1).                                 |
| Design Seismic Base Shear   | $VB = Ah W$  | Clause No: 7.6.1 –<br>IS: 1893 (Part 1).                                 |
| Damping Coefficient   | 0.05 for Structures  | Clause No: 7.2.4 –<br>IS: 1893 (Part 1).                                 |



**IMPORTANT NOTE**

- **Material, any kind, to be procured only after approval from GIFTCL, after providing relevant samples for assessment.**
- **For Cement only Ultratech, Ambuja, ACC, JK Lakshmi makes are allowed.**
- **For Reinforcement steel only Tata, Essar, SAIL, JSW, Jindal, Welspun makes are allowed.**
- **For any kind of RCC work, SCADA batch mix report printout is must for every Transit Mixer output.**
- **Manual excavation may also be carried out to safeguard existing live utilities, as per the actual site conditions and instructions of GIFTCL, including excavating multiple trial pits to ascertain locations of the existing live utilities. No separate payment shall be done for this purpose.**

## **1. EARTHWORK IN EXCAVATION AND BACK FILLING**

### **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 directed by the Engineer and all operations covered within the intent and purpose of this specification.

The work includes excavation with ground leveling in all types of soils such as murrum, sand, sandy silt, clay, black cotton soil, soil mixed with boulder, bajri, kankar etc., including back filling and compaction, using mechanical roller of 8-10T capacity, including watering, with selected available excavated material, dewatering if any, barricading, including disposal of surplus excavated material with all lead and lift inside or outside GIFT boundary, including all machinery, transportation, royalty, fees, taxes as applicable, etc. complete as per drawing, specification and as directed by the Engineer - in -Charge.

### **1.2. 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, 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 Engineer based on ground profile. These shall be checked by the Engineer and thereafter properly recorded.

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.

Rock/ soil excavated shall be stacked properly as directed by the Engineer. As a rule, all softer material shall be laid along the center of heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Rock shall be stacked separately.

### **1.3. 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 as directed by the Engineer. Where earth fill is intended, the area shall be stripped of all loose/ soft patches, topsoil containing objectionable matter/ materials before fill commences.

### **1.4. EXCAVATION**

All excavation work shall be carried out by mechanical equipment unless, in the opinion of the Engineer, 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 as may be specified by the Engineer. 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 as directed by the Engineer. The final excavation if so instructed by the Engineer 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 Engineer, at his own cost outside the lines shown on the drawings or directed by the Engineer. 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, up to the required elevation. No extra shall be claimed by the Contractor on this account.

**Before the start of any excavation, be wary of the location of existing underground utilities and inform respective utilities representative/GIFT representative before any**

**start of excavation. All efforts shall be made to locate underground utilities that may reasonably be expected to be encountered during excavation work. To ensure existing utilities permission/NOC from respective utility owners shall be taken prior to commence excavation. The contractor shall be responsible for exposing all existing utilities without any damage. This work shall be carried out manually only, unless permitted otherwise. Any material lying in the work front area shall be removed/shift by the contractor as instructed by the Engineer.**

All excavation shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Contractor in each individual case, for the method he proposes to adopt for the 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 if the slips are due to the negligence of the Contractor.

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 Engineer.

The Engineer may also direct that in some extreme case; the rock may be excavated by heating and sudden quenching for splitting the rock. Fire-wood shall be used for burning and payment shall be made for such work as called for in the schedule of quantities.

#### **1.5. ACCESS ROAD**

Roads, whether of temporary or other nature, required to be constructed for access and for movement of men, materials, equipment, transport vehicles, vehicles carrying fill material etc. to or over borrow areas and/or to or over areas on which fill has to be deposited shall be constructed by the Contractor at his cost. Such costs shall be deemed to have been included in the unit rates quoted by the Contractor. Such access in roads shall be maintained in good condition during all seasons to ensure completion of work according to time schedule.

## **1.6. DEWATERING**

All areas of work shall be kept free of water. Contractor shall remove by pumping or other means approved by Engineer any water inclusive of rainwater and subsoil water accumulated and keep all area dewatered until the work is completed. Sumps made for dewatering must be kept clear of the earth fill area required for further work. Method of pumping shall be approved by Engineer; but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping arrangement shall be adequate to ensure no delays in construction.

When there is continuous inflow of water and quantum of water to be handled is considered in the opinion of Engineer, as large, well point system - single stage or multistage, shall be adopted. Contractor shall submit to Engineer his scheme of well point system including the stages, the spacing, the 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 earthwork / earth fill.

## **1.7. RAINWATER DRAINAGE**

This section covers the drainage of rainwater 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. The scheme for pumping and discharge of such water shall be approved by the Engineer.

Contractor shall ensure that the surface runoff outside the excavated pit/ working area shall be collected through a catch drain excavated around the working area and led away to a natural stream. Contractor shall maintain the catch drains in proper condition during the construction period.

Unless separately provided for in the schedule of prices, the cost of rainwater drainage shall be included in the item rate for earthwork / earth fill.

## **1.8. FILL MATERIAL**

### **1.8.1. General**

All fill material will be subject to the Engineer's approval. If any material is rejected by the Engineer, the Contractor shall remove the same forthwith from the site at no extra cost to the Owner. Surplus fill material shall be deposited/ disposed off as directed by the Engineer after the fill work is completed. No earth fill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by the Engineer.

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 material and source shall be subject to prior approval of the Engineer. The approved borrow pit area shall be cleared of all bushes, roots of trees, plants, rubbish etc. topsoil containing salts/ sulphate and other foreign material shall be removed. The materials so removed shall be burnt or disposed off as directed by the Engineer. The Contractor shall make necessary access roads to borrow areas and maintain the same, if such access road does not exist, at his cost.

#### **1.9. GENERAL SITE GRADING**

Site grading shall be carried out as indicated in the drawings and as directed by the Engineer. 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 earth fill 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 Engineer, 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 by ramming.

#### **1.10. 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.

**1.11. 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 centerlines 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 'kaccha' land/ route.

**1.12. QUALITY**

The borrowed soil shall be generally granular, and non-cohesive. It shall consist of sand, silty sand, murrum, ordinary soil, gravel and shingle. Dredged material shall also be free from sulphates, salts, organic, foreign and other harmful or objectionable materials. Any material rejected by the Engineer shall be removed from the site immediately.

**2. PRE-CONSTRUCTIONAL ANTI-TERMITE TREATMENT****2.1. 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.

**2.2. APPLICABLE CODES**

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:



IS: 6313 Part - I - Code of Practice for Anti-termite Measures in Buildings Constructional Measures

IS: 6313 Part - II - Pre-constructional Chemical Treatment Measures

IS: 8944 - Specification for Chlorpyrifos Emulsifiable Concentrates

IS: 4015 Part - I - Guide for Handling cases of Pesticide Poisoning First Aid Measures

IS: 4015 Part - II - Symptoms, Diagnosis and Treatment

### **2.3. GENERAL**

1. 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.
2. All work shall be done in the order of progress required by Owner's construction program.
3. Contractor shall take all necessary precautions to prevent any accident in connection with the performance of the work.
4. 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.
5. Owner 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.
6. 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.
7. 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 Owner/ Engineer.

8. 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:

**Examples:**

Chlorpyrifos 20 1 liter is diluted to 20 liters to give 1.0% emulsion.

**2.4. PRE-CONSTRUCTIONAL CHEMICAL TREATMENT**ESSENTIAL REQUIREMENTS

Hand operated pressure pump with graduated containers shall be used to ensure uniform spraying of the chemical. Continuous check shall be kept ensuring that the specified quantity of chemical is used for the required area during the operation.

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.

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.

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.

CHEMICALS, METHOD, AND RATE OF APPLICATION**(a) 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) liters of an emulsion in water of one of the following shall be used: 0.50 percent Chlorpyrifos

(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 percent</u> |
|-----------------|--|
| Chlorpyrifos    | 1.0                                    |

Treatment of Column-pits, Wall-trenches, and excavations

- a) The bottom surface and the sides (up to a height of about 300 mm) of the excavations made for column pits, wall trenches and shall be treated with the chemical at the rate of 5 liters per sq.mtr of the surface area.
- b) After the column foundations and the retaining walls come up, the backfill in immediate contact with the foundation structure shall be treated at the rate of 15 liter per sq.mtr 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 centers 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.

- c) In the case of R.C.C. framed structures with columns and plinth beams 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 shall be treated at the rate of 15 liters/sq.mtr of vertical surface. The other details of treatment shall be as laid down in clause (b) above.

#### 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 liters per sq.mtr of the surface before the sand bed/subgrade is laid. Holes up to 50 to 70 mm deep at 150 mm centers both ways shall be made with 12 mm dia. crowbar on the surface to facilitate saturation of the soil with chemical emulsion.

#### 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 up to ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 15 liters / sq.mtr 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.

#### 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 liters / sq.mtr of the surface before the apron is laid, by making rod holes 75 mm deep at 150 mm centers both ways.

#### 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 liters/meter 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 up to the original ground level to ensure continuity of chemical barrier.

#### 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 liters per linear meter of expansion joint.

#### 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 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 over 300 mm unless they stand clear of the walls of the building by about 75 mm.

### **2.5. SAFETY PRECAUTIONS**

- a) 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 vapors 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 carefully observe the safety precautions given below.
- b) 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.
- c) 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.
- d) The concentrates are oil solutions and present a fire hazard owing to the use of petroleum solvents. Flames shall not be allowed during mixing.

- e) 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.

### **3. MASONRY WORKS**

#### **3.1. SCOPE**

These specifications cover the use of Brick Masonry for the structural purposes.

#### **3.2. GENERAL**

The provision of the latest Indian Standards listed below form part of these specifications

IS: 1077 Specifications for common burnt clay building bricks

IS: 1200 Measurement for Building works

IS: 1725 Specifications for solid cement blocks used in general Building construction

IS: 1905 Code of practice for structural safety of buildings Masonry walls

IS: 2116 Sand for masonry mortars

IS: 2180 Specifications for heavy duty burnt clay building bricks

IS: 2185 Specifications for concrete masonry units Hollow and Solid concrete blocks

IS: 2212 Code of practice for brick work

IS: 2222 Specification for burnt clay perforated building bricks

IS: 2250 Code of practice for preparation and use of masonry mortar

IS: 2691 Specification for burnt clay facing bricks

IS: 3115 Specification for lime based blocks

IS: 3414 Code of practice for design and installations of joints in Buildings

IS: 3466 Specification for masonry cement

IS: 3861 Method of measurement of plinth, carpet and rent able Areas of buildings

IS: 3952 Specification for burnt clay hollow blocks for walls and Partitions

IS: 4098 Specification for lime-puzzolona mixture

IS: 4441 Code of practice for use of silicate type chemical resistant mortars

IS: 4442 Code of practice for use of sulphur type chemical resistant mortars

IS: 5495 Size & shape for fire bricks

Other I.S. Codes not specifically mentioned here but pertaining to the use of bricks for structural purposes form part of these specifications.

### 3.3. MATERIALS

#### BRICKS

Bricks shall be of regular and uniform size. Shape and colour, uniformly well burnt throughout but not over burnt. They shall have plane rectangular faces with parallel sides and sharp straight and right-angled edges. Bricks shall be free from cracks or other flaws. They shall have a frog of 10 mm depth on one of their flat faces.

They shall give a clear metallic sound when two bricks are struck. Bricks shall show a fine grained, uniform homogeneous and dense texture on fracture and be free from lumps of lime, laminations, cracks, air holes, soluble salts causing efflorescence or other defects which may in any way impair their strength, durability, appearance or usefulness for the purpose intended. They shall not have any parts under-burnt. They shall not break when thrown on the ground on their flat face in a saturated condition from a height of 60 cm.

#### Size of bricks:

The size of the conventional bricks shall be 230mm x 115mm x 75mm. The following tolerances are permitted in the standard conventional size adopted on a particular work.

Length – plus or minus 3 mm (about 1/8")

Breadth – plus or minus 1.5 mm (about 1/16")

Depth - plus or minus 1.5 mm (about 1/16")

The size of the modular bricks shall be 200mm x 100mm x 100mm.

#### Absorption

After immersion in water, absorption by weight shall not exceed 20% of the dry weight of the brick when tested according to IS: 1077-1976



#### Crushing Strength

The load to crush the brick when dry shall not be less than 75 Kg/sq.cm. and when thoroughly soaked shall not be less than 50 Kg./sq.cm.

### **3.4. CONSTRUCTION**

#### SOAKING OF BRICKS

Bricks shall be soaked in water for a minimum period of one hour before use so that they will be saturated and will not absorb water from the mortar. When bricks are soaked they shall be removed from the tank sufficiently in advance so that at the time of laying they are skin-dry. Such soaked bricks shall be stacked on a clean place where they are not spoilt by dirt, earth, etc.

#### LAYING OF BRICKS

All brick shall be laid in English bond even and true to line, plumb, level and all joints accurately kept. The bricks used on the face shall be selected whole ones of uniform size and with true rectangular face. Brick shall be laid with frogs up, on a full bed of mortar. When laying, bricks shall be slightly pressed so that the mortar gets into all the surface pores of bricks to ensure proper adhesion. All shall be properly flushed and packed with mortar so that no hollow spaces are left.

Before laying bricks in foundation, a layer of not less than 12 mm of mortar shall be spread to make the surface, on which the brickwork will be laid, even. Immediately thereafter, the first course of bricks shall be laid.

The brickwork shall be built in uniform layers, corners and other advanced work shall be raked back. Brickwork shall be done true to plumb or in specified batter. No part of it, during construction, shall rise more than half a meter above the general construction level, to avoid unequal settlement and improper joining. The height of brick works constructed shall not exceed a meter in a day.

Toothing may be done where future extensions are contemplated but shall be used as an alternative to raking back.

#### JOINTS

The thickness of joints shall not exceed 10 mm. and this thickness shall be uniform throughout.

#### JOINING WITH EXISTING STRUCTURE

When fresh masonry is to be placed against existing surfaces of structures, the latter shall be cleaned of all loose material, roughened and wetted as directed by the EIC so as to effect a good bond with the new work.

#### CURING

Green work shall be protected from rain by suitable covering. Masonry work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. The top of the masonry work shall be left flooded with water at the close of the day during hot weather. All finished or partly completed work shall be covered or wetted in such manner as will prevent rapid drying of the brick work.

#### SCAFFOLDING

The scaffolding shall be sound and strong to withstand all loads likely to come upon it and will be double or single as is warranted for the particular work. The holes, which provide resting space for horizontal members, shall not be left in masonry under one meter in width or immediately nearer the skew backs of arches. The holes left in the masonry work for supporting the scaffolding shall be filled and made good with 1:4:8 cement concrete. Double scaffolding shall be erected for external brickwork, plaster etc.

#### CONDITION OF EQUIPMENT

All equipment used for mixing or transporting mortar and bricks shall be clean and free from set mortar, dirt or other injurious foreign substances.

#### FINISHING OF SURFACES

For a surface which is to be subsequently plastered or pointed, the joints shall be squarely raked out to a depth of 15 mm while the mortar is still green. Before plastering/pointing the

raked joints shall be well brushed to remove dust and loose particles and the surfaces shall be thoroughly washed with water, cleaned and wetted.

#### **4. PLASTERING & POINTING**

##### **4.1. GENERAL**

###### SCAFFOLDING

Scaffolding shall be double and shall be erected with steel sections or pipes of adequate strength so as to be safe for construction operations. The contractor shall take all measures to ensure the safety of the work and working people any instructions of the Engineer in this respect shall also be complied with. The contractor shall be entirely responsible for any damage to property or injury to persons resulting from ill erected scaffolding, defective ladders and materials or otherwise arising out of his default in this respect. Proper scaffolding shall be provided to allow easy approach to every part of the work. Overhead work shall not be allowed.

###### TOOLS AND ACCESSORIES

Tools and accessories used in plasterwork shall conform to IS: 1630. All tools shall be cleaned by scrapping and washing at the end of each day's work or after use. Metal tools to be cleaned after each operation. All tools shall be examined to see that they are thoroughly cleaned before plastering is begun.

##### **4.2. PROGRAMME OF WORK IN RELATION TO PLASTERING**

The programme of other building operations before, during and after plastering shall be according to the instructions contained in clause 9 of IS: 1661.

##### **4.3. GENERAL PRECAUTION IN PLASTERING**

All general precautions as specified in IS. 1661, Clause 9, shall be taken and preparation of the background shall be done as laid down in IS: 1661, Clause 13. Care shall be taken to see

that other parts of the work or adjacent works are not damaged while plastering. Making good of chases made for electrical conduit laying shall be in the scope of electrical contractor.

#### PREPARATORY WORK

All joints in the face work that is to be plastered shall be raked out to depth equal to not less than the width of the joints or as directed by the Engineer. The raking shall be done taking care not to allow by chipping of masonry. In new work the raking out shall be done when the mortar in the joints is still green. Smooth surfaces of concrete, old plaster, etc. must be suitably roughened to provide necessary bond for the plaster. All dirt, soot, oil paint or any other material that might interface with satisfactory bond shall be removed. In the case of stone masonry, scrubbing on the walls to receive the plaster shall not be more than 12 mm (1 ½"). The surface to be plastered shall be cleaned and scrubbed with fresh water and kept wet for 6 hours prior to plastering. It shall be kept damp during the progress of the work. The plastering shall be commenced unless the Engineer passes the preparatory work in writing.

#### GAUGES

Patches of plaster 15 cm x 15 cm shall be put on about 3 m apart as gauges to ensure even plastering in one plane.

### **4.4. WORKMANSHIP**

#### Plastering

In all plaster work the mortar shall be firmly applied with somewhat more than the required thickness and well pressed into the joints and on the surface and rubbed and leveled with a flat wooden rule to give required thickness. Long straight edges shall be freely used to give perfectly plane and even surface. All corners must be finished to their true angles or rounded as directed by the Engineer. The surface shall be finished to plane or curved surface as shown on the plan or directed by the Engineer and shall present a neat appearance. The mortar shall adhere to the masonry surface intimately when set and there should be no hollow sound when struck. Cement plastering should be done in squares or strips as directed. Plastering shall be done from top downward. Plaster on internal surfaces of wet areas will have to be done with integrated waterproofing compound mixed with cement mortar at no extra cost.

#### First or Backing Coat

The first coat of the specified thickness shall be applied as described above. The subsequent coat shall be applied after this coat has been allowed to set for 3 to 5 days depending upon weather conditions. The surface shall not be allowed to dry during this period.

#### Plastering to Ceiling

Projecting burns of mortar formed due to the gaps at joints in shuttering shall be removed. The surface shall be scrubbed clean with wire brushes. In addition, concrete surface shall be poke marked with a pointed tool at spacing of not more than 50 mm centers, the pokes being made not less than 3 mm deep, to ensure a proper key for the plaster. The mortar shall be washed off and surface cleaned of all oil, grease etc., and well wetted before the plaster is applied. These specifications cover the use of Brick Masonry for the structural purposes.

### **4.5. SAND FACED PLASTER IN CEMENT MORTAR (APPLICABLE FOR FACADE WHERE THERE IS NO CLADDING MATERIAL AS EXTERNAL FINISHED SURFACE)**

#### BASE COAT

The base coat plaster shall be of cement mortar 1:4, Waterproofing compound of approved make shall be added according to the manufacturer's instructions to make the mortar waterproof.

The plaster with this mortar shall be laid as specified above with a thickness of not more than 40mm for brickwork and concrete surfaces, and 15 mm for rubble stone masonry. Keys shall be formed on the surface by thoroughly combing it with wavy horizontal lines about 12 mm apart and about 3 mm deep when the mortar is still plastic. The base coat shall be cured for not less than 2 days.

#### SAND FACED TREATMENT

The cement mortar for sand faced plaster shall have washed Kharasalis or similar type of approved sand with slightly larger proportion of coarse material. The proportion of cement to

sand shall be 1:4. The water is added gradually to make the mixture homogeneous. The thickness of finishing coat shall not exceed 7 mm. After application, the surface should be finished with a wooden flat, lined with cork and tapped gently to retain a coarse surface texture. When the finishing coat has hardened, the surface shall be kept moist continuously for 14 days.

#### **4.6. ROUGH COAT CEMENT PLASTER WITH CEMENT MORTAR**

##### BASE COAT

The first coat of plaster shall be of cement mortar of 1:4 mix and applied according to the relevant provisions of IS: 1661 Clause 14.1 The finished thickness of the first coat shall be 12 mm for brick masonry or concrete surface and 14 mm for rubble stone masonry. The plaster shall be laid by throwing the mortar (by using a strong whipping motion) on the prepared surface with a trowel in a uniform layer and pressed to form a good bond. The surface shall be roughened.

##### SECOND COAT

The second coat shall be the rough coat mixture consisting of aggregate, which may vary in size from 5 to 8 mm and may consist of specially graded mixture mixed with fine sand and cement. The proportion of cement to sand and aggregate shall be 1:1 ½:3. It shall be flung upon the first coat with large trowels to form an even protective coat. The second coat must be applied while the first coat is still soft and plastic. The work shall generally conform to clause 16.5 of IS: 166. The thickness of the coat shall be about 12 mm.

#### **4.7. SMOOTH INTERNAL PLASTER**

Applying one coat, 12mm thick Plaster on Internal surfaces of RCC/ brick/block walls in cement mortar 1:5, finished smooth with extra cement finishing, with cement not less than 2.2 kg per sqm. Scope shall include for scaffolding, grooves, sills, pattas, curing, surface

preparation before the application of plaster, providing galvanized chicken wire mesh as mentioned in the notes above to a width of 150mm at the junctions of masonry and concrete works including tying in position by using suitable nails / clamps / screws and as directed etc. complete at all levels. The contractor shall make good the grooves, pockets etc. after the scaffolding is removed.

## **5. CONCRETING AND ALLIED WORKS**

### **5.1. 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; grouting as well as mode of measurement and payment for completed 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 or as directed by ENGINEER-IN-CHARGE from time to time. The decision of ENGINEER-IN-CHARGE 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.

### **5.2. 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 | Specification 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<br>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<br>(Part 1 to 12) | Method of measurement of building and engineering works (Part 2 and 5) |
|----|---------------------------|--|

### **5.3. GENERAL**

ENGINEER-IN-CHARGE 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 ENGINEER-IN-CHARGE's approval obtained, 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 after approval of the ENGINEER-IN-CHARGE and after establishing their performance suitability based on previous data, experience or tests.

#### **5.4. MATERIALS**

##### CEMENT

Unless otherwise specified or called for by ENGINEER-IN-CHARGE/OWNER, 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 as directed by ENGINEER-IN-CHARGE. 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 unless specifically approved by ENGINEER-IN-CHARGE. The source of supply, type or brand of cement within the same structure or portion thereof shall not be changed without prior approval from ENGINEER-IN-CHARGE.

Cement, which is not used within 90 days from its date of manufacture, shall be tested at a laboratory approved by ENGINEER-IN-CHARGE and until the results of such tests are found satisfactory, it shall not be used in any work.

##### AGGREGATES

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.

Aggregates shall be washed and screened before use where necessary or if directed by the ENGINEER-IN-CHARGE.

Aggregates containing reactive materials shall be used only after tests conclusively prove that there will be no adverse effect on strength, durability and finish, including long term effects, on the concrete.

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.

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 20mm aggregate is suitable. Where there is no restriction to the flow of concrete into sections, 40mm or larger size is permitted.

In concrete elements with thin sections, closely spaced reinforcements or small cover, consideration should be given to the use of 10mm nominal maximum size.

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 unless specified by ENGINEER-IN-CHARGE.

#### WATER

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.

The pH value of water shall not be less than 6.

Seawater shall not be used for concrete mixing and curing.

The proposed admixtures shall comply with requirements specified by Engineer-in-charge.

#### REINFORCEMENT

All reinforcement steel procured shall be produced by primary manufacturer viz. SAIL, TATA, Jindal, RINL, JSW, Essar & Arcelor Mittal.

Reinforcement bars shall conform to IS:432 and/ or IS:1786 and welded wire fabric to IS:1566 as shown on the drawing.

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.

Special precaution like coating of reinforcement may be provided with the prior approval of ENGINEER-IN-CHARGE.

#### WASTAGE

Wastage allowance for cement and steel (supplied by OWNER) shall be as specified under Instruction to Bidders.

### **5.5. SAMPLES AND TESTS**

All materials used for the works shall be tested before use. The frequency of such confirmatory tests shall be decided by ENGINEER-IN-CHARGE.

Manufacturer's test certificate shall be furnished for each batch of cement/steel and when directed by ENGINEER-IN-CHARGE samples shall also be got tested by the CONTRACTOR in a laboratory approved by ENGINEER-IN-CHARGE at no extra cost to OWNER. However, where material is supplied by OWNER, all testing charges shall be

borne by OWNER, but transportation and preparation of material samples for the laboratory shall be done by CONTRACTOR at no extra cost.

Sampling and testing of aggregates shall be as per IS: 2386 under the supervision of ENGINEER-IN-CHARGE. The cost of all tests, sampling, etc. shall be borne by CONTRACTOR. For coarse aggregate crushing value shall be tested.

Water to be used shall be tested to comply with clause 5.4 of IS: 456.

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.

#### 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 cement even if cement is supplied by OWNER. 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 OWNER, 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 arrangement shall be approved by ENGINEER-IN-CHARGE. 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.

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.



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.

The reinforcement shall be stacked on top of timber sleepers to avoid contact with ground/ water. Each type and size shall be stacked separately.

## **5.6. CONCRETE**

### 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 up to grade M15 shall be NOMINAL MIX CONCRETE whereas all other grades, M20 and above, shall be DESIGN MIX CONCRETE.

### 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/sq.mm 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.

### MIX DESIGN & 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.

| <b>Grade of Concrete, M</b> | <b>Minimum Cement Content in kg/cum. of Concrete</b> |
|-----------------------------|--|
| 20                          | 340  |
| 25                          | 360  |
| 30                          | 380  |
| 35                          | 400  |
| 40                          | 420  |
| 45                          | 440  |

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 ENGINEER-IN-CHARGE 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.

| <b>Grade of Concrete<br/>M</b> | <b>Minimum Compressive Strength N/Sq.mm at 7 days</b> | <b>Specified Characteristic compressive strength N/sq.mm at 28 days</b> |
|--------------------------------|---|---|
| 15                             | 10.0  | 15.0  |
| 20                             | 13.5  | 20.0  |
| 25                             | 17.0  | 25.0  |
| 30                             | 20.0  | 30.0  |
| 35                             | 23.5  | 35.0  |
| 40                             | 27.0  | 40.0  |
| 45                             | 30.0  | 45.0  |

A range of slumps recommended for various types of construction, unless otherwise instructed by the ENGINEER-IN-CHARGE, shall be as given below:

| <b>Slump in millimeters</b>                     |             |             |
|---|-------------|-------------|
| <b>Structure/Member</b>                         |             |             |
|   | <b>Max.</b> | <b>Min.</b> |
| Reinforced foundation walls and footings        | 75          | 25          |
| Plain footings, caissons and substructure walls | 75          | 25          |
| T. G. and massive compressor foundations        | 50          | 25          |
| Slabs, Beams and reinforced Walls               | 50          | 25          |

|   |    |    |
|---|----|----|
| Pumps & 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 is 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.

#### BATCHING & 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 ENGINEER-IN-CHARGE.

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 ENGINEER-IN-CHARGE 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 with prior consent of ENGINEER-IN-CHARGE. 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.

### **NOMINAL MIX CONCRETE**

#### **MIX DESIGN & 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 w/c 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.

#### **BATCHING & 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.

### **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 and get it approved by ENGINEER-IN-CHARGE prior to start of the Works. Any change in the source of the RMC, shall be got approved by the ENGINEER-IN-CHARGE.

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.

## 5.7. 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 ENGINEER-IN-CHARGE, the drawings and calculations for the design of the formwork shall be submitted to ENGINEER-IN-CHARGE for approval.

Formwork shall be designed to fulfil the following requirements:

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.

Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.

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.

Capable of easily striking without shock, disturbance or damage to the concrete.

Soffit forms capable of imparting a camber if required. Soffit forms and supports capable of being left in position if required.

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 ENGINEER-IN-CHARGE. 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 to the satisfaction of ENGINEER-IN-CHARGE. 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 ENGINEER-IN-CHARGE, the open excavation is firm enough (in hard non-porous soils) to act as a form. Such excavation shall be slightly larger, as directed by ENGINEER-IN-CHARGE, 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 or as directed by ENGINEER-IN-CHARGE. 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.

Under normal circumstances (generally where temperatures are above 20 Deg. C) forms may be struck after expiry of the period given in IS: 456 unless directed otherwise by ENGINEER-IN-CHARGE. For Portland Pozzolana/slag cement the stripping time shall be suitably modified as directed by the ENGINEER-IN-CHARGE. 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.

## **5.8. 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 °C. Suitable preheating may be permitted if steel bar bending is to be done at below 0 °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 or as directed by ENGINEER-IN-CHARGE. Bar bending machines shall be used to achieve desired accuracy.

Re-bending or straightening incorrectly bent bars shall not be done without approval of ENGINEER-IN-CHARGE.

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 approved by ENGINEER-IN-CHARGE 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 and approved by ENGINEER-IN-CHARGE.

If permitted by ENGINEER-IN-CHARGE, 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.

## **5.9. 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 25mm: +5mm and –10mm.
- b) Where grout thickness is more than 25mm: ±15mm.

#### **5.10. 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 approved by ENGINEER-IN-CHARGE. CONTRACTOR shall maintain separate Pour Card for each pour as per the format enclosed.

#### **5.11. 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 approved by ENGINEER-IN-CHARGE. 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 ENGINEER-IN-CHARGE 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 had time to settle as determined by ENGINEER-IN-CHARGE. Concrete shall be protected against damage until final acceptance.

## **5.12.PLACING OF CONCRETE BY PUMPING METHODS**

### GENERAL

Placing of concrete by pumping will be as specified or authorised by Engineer-in-charge 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 in presence of the Engineer-in-charge as per approved procedure. 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 or authorised by the Engineer-in-charge. The decision, whether or not to pump any particular mix shall rest entirely with the Engineer-in-charge and no extra claims for payment on this

account will be entertained. The pumping equipment, pipelines 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 guidelines on concrete mix. However, final selection of mix shall be as instructed by the Engineer-in-charge.

#### 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 and in a manner approved by the Engineer-in-charge.

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 Engineer-in-charge to conduct pumpability tests and necessary adjustments for the concrete mix, prior to use of the pumping for placement of concrete.

#### 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 ENGINEER-IN-CHARGE for approval.

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 m<sup>3</sup>/hr or 20 m<sup>3</sup>/hr or 15 m<sup>3</sup>/hr or 10 m<sup>3</sup>/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 up to 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 liters. 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.

#### 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 mtr. 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 and they shall be approved by the Engineer-in-charge.

- a) Rigid and flexible pipes in varying lengths, such as 3, 1.5, 0.9, 0.6 and 0.3 m lengths.
- b) 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.
- c) Swivel joints and rotary distributors.
- d) Pin and gate valves to prevent back-flow in the pipeline.
- e) Switch valve to direct flow into another pipeline.
- f) Connection devices to fill forms the bottom up.
- g) Temporary supports, rollers and other devices for protection of conduit over rock, concrete, reinforcement steel and forms. Lifting and leashing points.
- h) Extra strong coupling for vertical runs in inaccessible areas.
- i) Transition for connecting different sizes of pipes.
- j) Air vents for downhill pumping
- k) Clean-out equipment

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 pipeline with articulated inserts at boom joints and ending in a flexible hose. The boom shall be remote controlled.

#### 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 pump for flushing out the concrete in pipeline.

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 pipelines 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 pipelines 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.

#### 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 Engineer-in-charge. 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.

**Table –8 EQUIVALENT LENGTH OF CONCRETE PIPELINES**

| Characteristics of a length of concrete         | Equivalent length of horizontal |
|---|---------------------------------|
| Pipeline  | concrete pipeline in meter      |
| 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 Engineer-in-charge, the same shall not be used in the concrete pipeline till such time the defect has been removed and the damage repaired to the entire satisfaction of the Engineer-in-charge. Qualified chemical admixtures shall be used effectively to get workable concrete.

## 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.

### **5.13.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.

**Table –9**

**Grading Requirement of Coarse Aggregates for Pumped Concrete**

**Grade - A** (Maximum Size 40 mm)      **Grade –B** (Maximum Size 20 mm)

| Sieve Size       | Percent Passing<br>passing by weight | Sieve Size | Percent<br>by weight |
|------------------|--------------------------------------|------------|----------------------|
| 50 mm            | 100                                  | 25 mm      | 100                  |
| 40 mm            | 95 to 100                            | 20 mm      | 90 to 100            |
| 20 mm            | 35 to 70                             | 12.5 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               |
| <b>Table –10</b> |                                      |            |                      |

**Volume of coarse Aggregate per unit  
of volume of concrete.**

Max. size      Volume of Dry-rodded Coarse Aggregate per Unit volume of aggregates  
of concrete for different fineness moduli of sand

FMS =2.40

FMS =2.60

FMS =2.80

FMS =3.00

|      |              |      |      |      |      |
|------|--------------|------|------|------|------|
| 10   |              | 0.50 | 0.48 | 0.46 | 0.44 |
| 12.5 |              | 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 |
|      | <b>Note:</b> |      |      |      |      |

Volume 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 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

9.5 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 emphasized 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 require 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.

#### **5.14.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 Engineer-in-charge 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 jointly with the Engineer-in-charge 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 jointly in consultation with the Engineer-in-charge for every type of mix and for every new placement and set up of pump and pipelines.

#### **5.15.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 Engineer-in-charge 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/cu.m of concrete.

Cement content in case of M-50 shall be maximum of 425 kg/m<sup>3</sup>, 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 & 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.

#### **5.16.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.

Increase in the range of mix designs which may be successfully pumped using water reducing admixtures/Super plasticizers with the approval of the Engineer-in-charge.

Reducing the risk of pipeline blockages by preventing segregation of concrete mix. 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 Engineer-in-charge in consultation with the admixture manufacturer.

For improvement of pumpability the following admixtures are generally recommended. Such admixtures used shall be conform to ASTM C-494/IS 9103.

#### Water Reducing Admixtures/Super Plasticizers

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 plasticizing action.

#### 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 shutting 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 Engineer-in-charge 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.

#### Finely Divided Mineral Admixtures

Contractor, if specifically approved by the Engineer-in-charge, 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/cu.m. to increase viscosity of the mixing water and reduce the frictional resistance to flow and bleeding in the pipe system.

#### **5.17. TRIAL MIXES**

The trial mixes for pumping shall be prepared and tested in the Site laboratory by contractor in accordance with clause 14.13 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.

#### **5.18. 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 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 coarser fraction, it is worth considering the addition of a proportion of finer sand, or alternately if the sand has 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 max. 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.

#### 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 in consultation with the Engineer-in-charge. Concrete used in such tests shall not be used in the actual construction, unless specifically permitted by the Engineer-in-charge.

Following parameter shall be established by pumpability trials:

- a) Insitu compressive & 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.

#### FIELD PRACTICES

Proper planning of concrete supply, pump location, line layout, placing sequence and the entire pumping operation shall be done by the Contractor and got approved by the Engineer-in-charge on every occasion before commencement of concreting job. 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.

- a) 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.
- b) 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.
- c) 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.

- d) 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.
- e) 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.
- f) 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.
- g) 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 meter 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.

#### **5.19.QUALITY CONTROL**

- a) 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.
- b) 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 the Engineer-in-charge jointly, as frequently as the Engineer-in-charge desires to determine, if any change in the slump air content, and other significant mix characteristics occur take necessary corrective actions.
- c) 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.
- d) All the crew engaged in each of the concrete activities shall demonstrate in the presence of the Engineer-in-charge, their skills and capabilities to produce the final product as specified.

#### **5.20.MASS CONCRETE WORKS**

Sequence of pouring for mass concrete works shall be as approved by ENGINEER-IN-CHARGE. CONTRACTOR shall exercise great care to prevent shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

#### **5.21.PLACING TEMPERATURE OF CONCRETE**

Placing temperature of concrete should be maintained as specified in Bill of Quantities or as directed by ENGINEER-IN-CHARGE, 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 to approval of the ENGINEER-IN-CHARGE. 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  $-2^{\circ}\text{C}$ . 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 4.3. Ice when used shall be in flakes of size 3mm or below or crushed condition and the crushed ice shall be such as to pass completely, 10mm sieve.

#### **5.22. 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, unless directed otherwise by ENGINEER-IN-CHARGE, 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 directed to be used by the ENGINEER-IN-CHARGE, 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 ENGINEER-IN-CHARGE 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 to ENGINEER-IN-CHARGE's approval.

### **5.23.CONSTRUCTION JOINTS AND KEYS**

Construction joints (location and type) shall be as shown on the drawing or as approved by ENGINEER-IN-CHARGE. 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 with the approval of ENGINEER-IN-CHARGE.

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 or as directed by ENGINEER-IN-CHARGE.

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.

#### **5.24. 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 as directed by ENGINEER-IN-CHARGE. 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.

#### **BASE CONCRETE**

- 1.1 The thickness and grade of concrete and reinforcement shall be as specified in the item of work.
- 1.2 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.

### 1.3 MEASUREMENT

- 1.3.1 Measurement shall be in Sq.m 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.

## **5.25.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.

### Formed Surface Finishes

The surface finishes for formed and unformed surfaces are classified and defined as below:

Surface irregularities for the various classes of finishes are termed either 'abrupt' or 'gradual'. Fins or offsets caused by displaced or misplaced form sheeting, lining or form sections, by loose knots in form lumber or by otherwise defective form lumber are considered abrupt irregularities. All other cases are described as gradual

irregularities. Gradual irregularities will be measured with a template consisting of a straight edge for plain surfaces or its equivalent for curved surfaces. The length of template for testing gradual irregularities on formed surfaces shall be 1.5 m in length. The permissible gradual irregularities being measured over this length of the template shall form the base for the type of finishes.

(i.) Finishes F1, F2 and F3 shall describe formed surfaces (ii.)

Finishes U1, U2 and U3 shall describe unformed surfaces.

#### Class F3 Finish

Class F3 finish shall be formed by specialty designed close jointed rigid forms having lining or high-quality form plywood. The surface irregularities shall be limited to nil for abrupt irregularities and 3 mm for gradual irregularities. Class F3 finish may be obtained from class F2 finish by carefully removing all abrupt irregularities including fins and projections by rubbing / grinding. If steel forms are used, they shall have steel sheet backing faced with plywood. In addition, finish F3 shall include filling air holes with mortar and treatment of the entire surface with sack rubbed finish. It shall also include cleanup of loose and adhering debris. For a sack rubbed finish, the surface shall be prepared within two days after removal of the forms. The surface shall be wetted and allowed to dry slightly before mortar is applied by sack rubbing. The mortar used shall consist of one part cement to one and one half parts by volume of fine (I.S. No. 16 mesh) sand. Only sufficient mixing water to give the mortar a workable consistency shall be used. The mortar shall then be rubbed over the surface with a fine burlap or linen cloth so as to fill all the surface voids. The mortar in the voids shall be allowed to stiffen and solidify after which the whole surface shall be wiped clean with clean burlap such that all air holes etc., are filled and the entire surface presents a uniform appearance without air holes, irregularities etc.

providing and fixing formwork for Architectural exposed fair finish concrete surfaces (vertical or horizontal surface of any shape) to achieve F3 finish in desired pattern and size as per drawing and specifications using laminated shuttering plywood or suitable proprietary system formwork for all types of RCC elements like slabs, walls, columns, beams, folded staircase (all sides), sill, coping, lintels, jambs, beam hunching,

vertical fins, etc. including de-shuttering and neat cleaning/grinding the exposed concrete surface, as directed by the engineer-in-charge. Rate shall be applicable for all levels, all height, all shapes and all elements and shall include all centering materials – form liners, ties, props, bracing, staging with necessary fixtures/ fastenings, etc. all complete as per detailed technical specifications and as directed by engineer in charge. (Note: This item shall be paid extra over the relevant items of centring and shuttering)

Relevant specifications shall be followed as per CPWD specification Vol – I, clause – 5.2 and additional following specification for exposed fair finish concrete work.

**Material:**

All shuttering materials which are in contact with exposed concrete surfaces, used material brought from other projects shall not be permitted. Only new material shall be allowed.

**Workmanship:**

The laminated shuttering plywood not less than 12 mm with supporting frame work comprising of MS angle / Tee / Flat / Channel / I beam and steel sheathing and steel plates made out of CR MS sheet not less than 2 mm thickness (14 gauge) shall be used instead of ordinary shuttering plywood / steel sheathing, to obtain a desired smooth exposed surface finish.

Contractor shall prepared shop drawing based on concept design and got approved before execution. The exposed surface shall be in desired pattern and size as per the drawing.

Before re-use, all forms shall be inspected by the Engineer-in-charge and their suitability shall be ascertained. If, any of the forms are found to be unsuitable, they shall be immediately replaced. Only similar type of material shall be used for the entire work.

The surface shall be rendered and touched up to the satisfaction of the Engineer in charge. The shuttering shall have restricted reuse to obtain good surface finish. The surface shall be presentable without further treatment.

Formwork shall be done accurately and precisely so as to achieve neat, clean and

smooth concrete surface, in line, level and plumb. Crimps, twists, offsets, warps, riveting etc. in plates or forms shall not be allowed.

Before placing concrete, forms shall be thoroughly cleaned off of all rust, dust and loose materials. Mould release agent of approved make or as per the Architect / Engineer in charge shall be applied on sheathing before placing the reinforcement steel. Also the formwork material will be of laminated plywood/ best quality steel sheathing or any sort of such material, as approved by the Architect; so that all exposed concrete surfaces have uniform colour and texture.

After de-shuttering, all concrete surfaces shall be properly rendered with sand paper or emery stone. The sample of the exposed concrete shall be got approved by the architect or engineer in charge.

Mode of measurement and payment:

Payment shall be made for exposed surface concrete work as per drawing and as directed by engineer in charge. Exposed RCC area shall be measured and paid.

The rate shall be for a unit of sqm.

#### 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 as approved by the ENGINEER-IN-CHARGE shall be supplied and used as recommended by the manufacturer.

#### **5.26.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 ENGINEER-IN-CHARGE who may permit patching of the defective areas or reject the concrete work. ENGINEER-IN-CHARGE'S decision on rejection of concrete work shall be final.

- 1.4 All through holes for shuttering shall be filled with cement mortar for full depth and neatly plugged flush with surface.
- 1.5 Rejected concrete shall be removed and replaced by CONTRACTOR at no additional cost to OWNER.
- 1.6 For patching of defective areas all loose materials shall be removed, and the surface shall be prepared as directed by the ENGINEER-IN-CHARGE.
- 1.7 Bonding between hardened and fresh concrete shall be done either by placing cement mortar or by applying epoxy. The decision of the ENGINEER-IN-CHARGE 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 as directed by ENGINEER-IN-CHARGE.
- 1.8 CONTRACTOR shall submit a method statement for such repairs to ENGINEER-IN-CHARGE for approval.

#### **5.27. 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. The equipment to be used shall be subject to ENGINEER-IN-CHARGE'S approval.

#### **5.28. HOT WEATHER REQUIREMENT**

Concreting during hot weather shall be carried out as per IS:7861 (Part I).

Adequate provisions shall be made to lower concrete temperatures which shall not exceed 40 °C at the time of placement of fresh concrete.

Where directed by ENGINEER-IN-CHARGE, CONTRACTOR shall spray non-wax based curing compound on unformed concrete surface at no extra costs.

#### **5.29.COLD WEATHER REQUIREMENTS**

Concreting during cold weather shall be carried out as per IS: 7861 (PART 2).

The ambient temperature during placement and up to final set shall not fall below 5 °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.

#### **5.30.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, pipelines, 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 defect's



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 approved by the ENGINEER-IN-CHARGE. All such rectification shall be done by the CONTRACTOR to the entire satisfaction of the OWNER/ENGINEER-IN-CHARGE at no extra cost to the OWNER.

### **5.31. TESTING CONCRETE STRUCTURES FOR LEAKAGE**

Hydro-static test for water tightness shall be done at full storage level or soffit of cover slab, as may be directed by ENGINEER-IN-CHARGE, 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 hrs. 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 watertightness of the structure. The ENGINEER-IN-CHARGE 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 watertight 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.

#### **5.32.OPTIONAL TESTS**

If ENGINEER-IN-CHARGE 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, to be approved by the ENGINEER-IN-CHARGE, as per relevant IS Codes. OWNER shall pay only for the testing of material supplied by the OWNER, 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 OWNER.

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, ENGINEER-IN-CHARGE 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 OWNER. Alternately ENGINEER-IN-CHARGE 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 ENGINEER-IN-CHARGE 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 deem to provide for all tests mentioned above.

#### **5.33.GROUTING**

As directed by Engineer-in-charge.

#### **5.34.QUALITY CONTROL**

Owner / Owner's representative has developed in house quality control formats for concrete works. CONTRACTOR shall note that it required adopting all such formats. A copy of formats shall be furnished to CONTRACTOR by ENGINEER-IN-CHARGE/ OWNER after the contract is awarded.

Alternatively, if CONTRACTOR has his own QC formats, he may adopt them subjected to such modifications considered necessary by ENGINEER-IN-CHARGE.

In either case CONTRACTOR shall submit his detailed Quality Assurance Plan along with the bid. This would be reviewed, appropriately modified and approved by CONSULTANT after the award of contract.

#### **5.35.INSPECTION**

All materials, workmanship and finished construction shall be subject to continuous inspection and approval of ENGINEER-IN-CHARGE. Materials rejected by ENGINEER-IN-CHARGE shall be expressly removed from site within 3 working days and shall be replaced by CONTRACTOR immediately at no extra cost to OWNER.

#### **5.36.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.

#### **5.37.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

ENGINEER-IN-CHARGE's decision as to the acceptability or otherwise of any concrete work shall be final and binding on the CONTRACTOR.

For work not accepted, ENGINEER-IN-CHARGE may review and decide whether remedial measures are feasible so as to render the work acceptable. ENGINEER-IN-CHARGE 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 OWNER for executing remedial measures.

### **5.38. WATERPROOFING**

#### RECOMMENDED SYSTEM

Proofex PGP (PVC membrane) at 2mm thickness laid loose.

### PRODUCT DESCRIPTION

Proofex PGP (PVC membrane) Properties:

|                       |                        |
|-----------------------|------------------------|
| Thickness:            | 2.0 mm                 |
| Elongation at Break:  | >300%                  |
| Puncture resistance:  | > 1200 N               |
| Water impermeability: | no penetration @ 5 bar |
| Tensile Strength:     | >17Mpa                 |
| Tear resistance:      | > 50 N/mm              |

The membranes shall be loosely laid over the horizontal surface i.e., on the P.C.C, below the raft slab with Hot Air welded, double seam joints with minimum 80 mm overlaps and sandwiched between non-woven polypropylene geotextile fibermat 340gsm below & 140gsm.

The external surface of the retaining wall would be first covered with a geotextile layer of 340 GSM which shall be mechanically anchored to the retaining wall / shoring pile / diaphragm wall surfaces using anchors with PVC discs. Thereafter “Proofex PGP” membrane shall be applied over the surfaces by Hot Air Welded onto the PVC disc as well as overlaps between the adjacent rolls of the PVC membrane which shall also be Hot Air Welding with proper overlaps of minimum 80 mm.

### **5.39.GROUTING**

#### CEMENT PRESSURE GROUTING

Pressure grouting is method of injecting specially formulated cement based mixes under pressure to improve strength or reduce permeability of concrete structures.

Cement grouting is usually performed by drilling holes into application area to intercept open cracks, joints, fissures or cavities, then pumping under pressure balanced and stabilized grout mixes using a combination of cement, water, and additives. Pressure grouting method is widely adopted, and it is very successful in solving leakage problems.

#### MATERIALS USED FOR PRESSURE GROUTING

1. Ordinary Portland cement
2. Non shrink grout
3. Potable water

#### TOOLS AND TACKLES USED FOR PRESSURE GROUTING

- i. Air compressor with a capacity of 3 to 4 cum/ per minute and with a pressure of 3 to 5 kg per sq.cm.
- ii. Grout injecting machine or grouting pump with inlet and outlet valves and pressure gauges. It should be capable of injecting cement grout up to 5 kg/cm<sup>2</sup>
- iii. An airtight, pressure mixer chamber, with stirrer for proper mixing of the grout and keeping it in proper colloidal suspension during grouting.
- iv. Flexible pressure hose pipes for transmitting grout from pressure chamber to ports embedded in the masonry.
- v. Drilling equipment, pneumatic or electric, for drilling of holes upto 25mm dia.
- vi. 10-20mm dia G.I. pipes with couplers, or lockable type PVC nozzles.

#### Pressure grouting procedure

- PVC grouting nozzles of 130mm length & 10mm outer dia, with a stopper at the outer end, shall be fixed on the concrete surface @ 1m C/C or at the particular location of water leakage, by drilling a hole of same dia and inserting upto a depth of 80mm. Cement paste shall be used to fix and seal the sides of the nozzle.
- After 24 hrs of fixing of nozzles, grouting operation shall be carried out.
- The Grout shall be prepared with mix of OPC & non shrink grouting chemical, W/C ratio shall be maintained not more than 0.45.
- Grout mix shall be prepared of good consistency for ease in passing through grouting pipe.
- The grouting shall be done under pressure of 3 to 5 kg/cm<sup>2</sup> using grouting pump.
- Grout shall be pumped till the time it flows into the structure, filling all the gaps inside. The consumption of grout in each hole shall be recorded.
- Once completed and grout is completely set, the projected parts of the nozzles shall be removed, surface shall be cleaned and finished smooth

#### REFERENCE DOCUMENTS

The work shall be in compliance with all application governmental and local laws, regulations and standards, as well as the following:

- IS 269-1976 Ordinary and low heat Portland cement
- IS 456-1978 Code of practice for plain and reinforcement concrete
- ASTM C 109-80 Standard test method for compressive strength of hydraulic cement mortars

- ASTM C 531 Standard test method for Linear Shrinkage and co-efficient of Thermal expansion of Chemical resistant mortars, grouts and monolithic surfacing
- ASTM C 579-75 Standard test method for compressive of chemical resistant mortars and monolithic surfacing
- ASTM C 230 Specification for Flow Table in Tests of Hydraulic Cement.
- ASTM C 827 Standard Test Method for the Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
- ASTM C 1090 Test Method for Measuring Change in Height of Cylindrical Specimens from Hydraulic-Cement Grout
- ASTM C 1107 Standard Specification for packaged Dry, Hydraulic-Cement Grout (Nonshrink)
- ASTM C 1181 Standard Test Method for Compressive creep of Chemical- Resistant Polymer machinery grouts

EIC/PMC's Work Item Description

- MC-02D Grouting (Anchor Bolt Pockets & Equipment Bases)
- MC-02E Grouting below Structural Steel Column Bases & Roof Trusses
- MC-02F Grouting of Anchor Bolt below Equipment Foundation Base Plates with No shrink free flow Grout Mix

## **6. SUPPLY FABRICATION AND ERECTION OF STRUCTURAL STEEL WORKS**

### **6.1. SCOPE**

- 1.1 This specification covers the general requirements for supply where specified,



fabrication and delivery at site of structural steel.

- 1.2 This specification also covers design of all connections and substituted members, preparation of all shop fabrication drawings, inspection and shop painting of structures.

## 6.2. APPLICABLE CODES & SPECIFICATIONS

The following specifications, standards and codes are made a part of this specification. All standards, specifications and codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy between this specification and other documents referred to herein, this specification shall govern.

### 1.3 MATERIALS

- a) IS: 808 Dimensions for Hot Rolled Steel sections
- b) IS: 814 Covered Electrodes for Manual Metal Arc Welding of Carbon and Carbon Manganese Steel
- c) IS: 1161 Steel Tubes for structural purposes
- d) IS: 1239 Mild steel tubes, tubulars and other Wrought steel fittings
  - i) Part 1 - Mild steel tubes
  - ii) Part 2 - Mild steel Tubulars and other wrought steel pipe fittings
- e) IS: 1363 Hexagon Head Bolts, Screws and Nuts of product (Parts 1 to 3) Grade C (Size range M5 to M64)
- f) IS: 1367 Technical Supply Conditions for Threaded (All Part) Fasteners

- g) IS: 1852 Rolling and Cutting Tolerances for Hot Rolled Steel Products
- h) IS: 1977 Structural Steel (Ordinary Quality)
- i) IS: 2062 Steel for General Structural Purposes
- j) IS: 2074 Ready Mixed Paint, Air drying, Red Oxide Zinc Chrome and Priming
- k) IS: 3502 Steel Chequered Plate
- l) IS: 3757 High Strength Structural Bolts
- m) IS: 5369 General Requirements for Plain Washers and Lock Washers
- n) IS: 5372 Taper Washers for Channels
- o) IS 5374 Taper Washer for I Beams
- p) IS: 6610 Heavy Washers for Steel Structures
- q) IS: 8500 Structural Steel-micro alloyed (medium and high strength qualities)

#### 1.4 CODES OF PRACTICE

- a) IS: 800 Code of Practice for General Construction in Steel
- b) IS: 801 Code of practice for use of Cold formed light gauge steel structural members in general building construction
- c) IS: 803 Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded storage tanks
- d) IS: 806 Code of practice for use of steel tubes in general building construction
- e) IS: 816 Code of Practice for use of Metal Arc Welding for General construction in Mild Steel

- f) IS: 822 Code of Procedure for Inspection of Welds
- g) IS: 1182 Recommended Practice for Radiographic examination of Fusion - Welded Butt Joints in Steel Plates.
- h) IS: 1200 Method of Measurement in Building Civil Engineering Works
- i) IS: 1477 Code of Practice for Painting of (Parts 1 & 2) Ferrous Metals in Buildings
- j) IS: 2595 Code of Practice for Radiographic Testing
- k) IS: 3658 Code of Practice for Liquid Penetrant Flaw Detection
- l) IS: 4000 High strength bolts in Steel Structures - Code of Practice
- m) IS: 5334 Code of Practice for Magnetic Particle Flaw Detection of Welds
- n) IS: 7215 Tolerances for Fabrication of Steel Structures
- o) IS: 9595 Recommendations for Metal Arc Welding of Carbon and Carbon Manganese Steel

### 6.3. STEEL MATERIALS

Steel materials shall comply with the specifications laid down under clause and/or as called for on the design drawings.

All materials used shall be new, unused and free from defects. Steel conforming to IS: 1977 shall be used only for the following:

- Fe310-0(St 32-0): for general purposes such as door/ window frames, grills, steel

gates, handrails, fence posts, tee bars and other non- structural use.

- Fe410-0(St 42-0): For structures not subjected to dynamic loading other than wind loads such as: Platform roofs, foot over bridges, building, factory sheds etc.
- Fe410-0(St 42-0): grade steel shall not be used
  - if welding is to be employed for fabrication.
  - if site is in severe earthquake zone.
  - if plastic theory of design is used.

#### **6.4. USE OF STEEL SUPPLIED BY THE PURCHASER**

The VENDOR/CONTRACTOR shall use steel supplied by the PURCHASER judiciously and to the best advantage so as to minimize splicing and wastage. All steel materials remaining after completion of the report, whether in the form of balance pieces or unutilized prime steel, shall be returned to the PURCHASER's stores by the VENDOR/CONTRACTOR at his own cost. An unaccountable wastage upto a maximum of 1% of the fabricated steel will be allowed. This wastage does not include the balance cut lengths/pieces of steel returned to the PURCHASER.

#### **6.5. DRAWINGS PREPARED BY THE OWNER**

Design drawings will be furnished to the VENDOR/CONTRACTOR and all drawings so furnished shall form a part of this specification. These design drawings prepared by the ENGINEER-IN-CHARGE will show all the, levels, forces on members where shall necessary, size and orientation of each member, location/size of openings, to enable the VENDOR/CONTRACTOR to prepare drawings for fabrication and erection. It shall be clearly understood that these drawings are not intended to show connection details, thickness of members, cuts, notches, bends and such other details.

The ENGINEER-IN-CHARGE reserves the right to make changes. Revisions to drawings, even after release for preparation of shop drawings, are 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 VENDOR/CONTRACTOR shall be considered a part of this specification and contract. The PURCHASER shall not entertain IS any extra claims on this account.

Where the fabrication drawings are to be furnished by the ENGINEER-IN-CHARGE, he will issue to the VENDOR/CONTRACTOR the required copies of such drawings in the sequence required for the fabrication of the components in the order they will be required to be erected at site. Such drawings will be issued in such numbers as required for the VENDOR/CONTRACTOR to adhere to the project schedule.

Should the VENDOR/CONTRACTOR during the execution of his work, find discrepancies in the information furnished by the ENGINEER-IN-CHARGE, he shall refer such discrepancies to the ENGINEER-IN-CHARGE before proceeding with such work.

#### **6.6. DRAWINGS PREPARED BY THE VENDOR/CONTRACTOR**

The VENDOR/CONTRACTOR shall prepare all fabrication and erection drawings for the entire work. 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.

The VENDOR/CONTRACTOR shall not commence detailing unless ENGINEER-IN-CHARGE's design drawings are officially released for preparation of shop drawings. The VENDOR/CONTRACTOR shall be responsible for the correctness of all fabrication drawings. Fabrication drawings shall be revised by the VENDOR/CONTRACTOR to reflect all revisions in design drawings as and when such revisions are made by the ENGINEER-IN-CHARGE.

All fabrication drawings shall be submitted to the ENGINEER-IN-CHARGE for approval.

No fabrication drawings will be accepted for ENGINEER-IN-CHARGE's approval unless checked and approved by the VENDOR/CONTRACTOR's qualified structural Engineer-in-charge and accompanied by an erection plan showing the location of all pieces detailed. The VENDOR/CONTRACTOR shall ensure that connections are detailed to obtain ease in erection of structures and in making field connections.

Fabrication shall be started by the VENDOR/ CONTRACTOR only after ENGINEER-IN-CHARGE's approval of fabrication drawings. Approval by the ENGINEER-IN-CHARGE of any of the drawings shall not relieve the VENDOR/CONTRACTOR from the responsibility for correctness of Engineering & design of connections, workmanship, fit of parts, details, material, errors or omissions of any and all work shown thereon. The ENGINEER-IN-CHARGE's

approval shall constitute approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and other details.

The drawings prepared by the VENDOR/CONTRACTOR and all subsequent revisions etc. shall be at the cost of the VENDOR/CONTRACTOR for which no separate payment will be made.

## **6.7. FABRICATION**

### GENERAL

All workmanship and finish shall be of the best quality and shall conform to 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. Unless otherwise directed/ approved, reference may be made to relevant IS codes for providing standard fabrication tolerance. Material at the shops shall be kept clean and protected from weather.

### CONNECTIONS

Shop/field connections shall be as per approved fabrication drawings.

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 be used under the nuts or the bolt heads whichever are turned to tighten the bolts. The length of the bolt shall be such that atleast one thread of the bolt projects beyond the nut, except in case of high strength friction grip bolts where this projection shall be atleast 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.

All connections and splices shall be designed for full strength of members or loads indicated on ENGINEER-IN-CHARGE's design drawings. Column splices shall be designed for the full tensile strength of the minimum cross section at the splice.

All bolts, nuts, washers, electrodes, screws 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.

All members likely to collect rainwater shall have drain holes provided.

#### STRAIGHTENING

All materials shall be straight and, if necessary, before being worked shall be straightened and/or flattened by pressure and shall be free from twists. Heating or forging shall not be resorted to without the prior approval of the ENGINEER-IN-CHARGE in writing.

Cutting, punching, drilling, welding and fabrication tolerances shall be generally as per relevant IS codes.

#### ROLLING AND FORMING

Plates, channels, R.S.J. 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.

#### HIGH STRENGTH FRICTION GRIP BOLTING

Inspection after tightening of bolts shall be carried out as stipulated in the appropriate standards depending upon the method of tightening and the type of bolt used.

#### WELDING

Welding procedure shall be submitted to ENGINEER-IN-CHARGE for approval. Welding shall be entrusted to only qualified and experienced welders who shall be periodically tested and graded as per IS 817, IS:7310 (Part 1) and IS:7318 (Part 1).

While fabricating plated beams and built up members, all shop splices in each component

part shall be made before such component part is welded to other parts of the members. Wherever weld reinforcement interferes with proper fit- up between components to be assembled for welding, these welds shall be ground flush prior to assembly.

Approval of the welding procedure by the ENGINEER-IN-CHARGE shall not relieve the CONTRACTOR of his responsibility for correct and sound welding without undue distortion in the finished structure.

No welding shall be done when the surface of the members is wet nor during periods of high wind.

Each layer of a multiple layer weld except root and surfaces runs may be moderately peened with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

No welding shall be done on base metal at a temperature below -5 °C. Base metal shall be preheated to the temperature as per relevant IS codes.

Electrodes other than low-hydrogen electrodes shall not be permitted for thicknesses of 32 mm and above.

#### Inspection of Welds

All welds shall be inspected for flaws by any of the methods described under clause 8 "Inspection". The choice of the method adopted shall be determined by the PURCHASER/ENGINEER-IN-CHARGE.

The correction of defective welds shall be carried out as directed by the ENGINEER without damaging the parent metal. When a crack in the weld is removed, magnetic particle inspection or any other equally positive means as prescribed by the ENGINEER-IN-CHARGE shall be used to ensure that the whole of the crack and material upto 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 VENDOR/CONTRACTOR's account.



**TOLERANCES**

The dimensional and weight tolerances 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.

**END MILLING**

Where compression joints are specified to be designed for bearing, the bearing surfaces shall be milled true and square to ensure proper bearing and alignment.

**INSPECTION**

The VENDOR/CONTRACTOR shall give due notice to the PURCHASER/ENGINEER-IN-CHARGE in advance of the works getting ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for the PURCHASER's/ENGINEER-IN-CHARGE's approval/ inspection. The fact that certain material has been accepted at the VENDOR/CONTRACTOR's shop shall not invalidate final rejection at site by the PURCHASER/ENGINEER-IN-CHARGE if it fails to conform to the requirements of these specifications, to be in proper condition or has fabrication inaccuracies which prevents proper assembly nor shall it invalidate any claim which the PURCHASER may make because of defective or unsatisfactory materials and/or workmanship.

No materials shall be painted or dispatched to site without inspection and approval by the PURCHASER/ ENGINEER-IN-CHARGE unless such inspection is waived in writing by the ENGINEER-IN-CHARGE.

The VENDOR/CONTRACTOR shall provide all the testing and inspection services and facilities for shop work except where otherwise specified.

For fabrication work carried out in the field the same standard of supervision and quality control shall be maintained as in shop fabricated work. Inspection and testing shall be conducted in a manner satisfactory to the ENGINEER-IN-CHARGE.

Inspection and tests on structural steel members shall be as set forth below:

### Material Testing

If mill test reports are not available for any steel materials the same shall be got tested by the VENDOR/CONTRACTOR to the ENGINEER-IN-CHARGE's satisfaction to demonstrate conformity with the relevant specification.

### TESTS ON WELDS

#### Magnetic Particle Test:

Where welds are examined by magnetic particle testing, such testing shall be carried out in accordance with relevant IS codes. If heat treatment is performed, the completed weld shall be examined after the heat treatment. All defects shall be repaired and retested. Magnetic particle tests shall be carried out using alternating current. Direct current may be used with the permission of the ENGINEER-IN-CHARGE.

#### Liquid Penetrate Inspection

In the case of welds examined by Liquid Penetrant Inspection, such tests shall be carried out in accordance with relevant IS Code. All defects shown shall be repaired and rechecked.

#### Radiographic Inspection

All full strength butt welds shall be radiographed in accordance with the recommended practice for radiographic testing as per relevant IS code.

### DIMENSIONS, WORKMANSHIP & CLEANLINESS

Members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment, surface finish and painting are in accordance with the requirements shown in the VENDOR/CONTRACTOR's approved fabrication drawings and the ENGINEER-IN-CHARGE's drawings.

### TEST FAILURE

In the event of failure of any member to satisfy inspection or test requirement, the CONTRACTOR shall notify the ENGINEER-IN-CHARGE or his authorised representative. The

VENDOR/CONTRACTOR must obtain permission from the ENGINEER-IN-CHARGE before repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by the ENGINEER-IN-CHARGE.

The ENGINEER-IN-CHARGE has the right to specify additional testing as he deems necessary, and the additional cost of such testing shall be borne by the PURCHASER, only in case of successful testing.

The VENDOR/CONTRACTOR shall maintain records of all inspection and testing which shall be made available to the ENGINEER-IN-CHARGE or his authorised representative.

### **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. if so desired by the ENGINEER-IN-CHARGE. All these shop assemblies shall be carried out by VENDOR/CONTRACTOR at no extra cost to the PURCHASER.

### **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 VENDOR/CONTRACTOR at no extra cost to the PURCHASER. The information for such extra holes will be supplied by the PURCHASER/ENGINEER-IN-CHARGE.

### **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.

### **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 by the ENGINEER-IN-CHARGE as defective workmanship. In case ENGINEER-IN-CHARGE rejects such material or defective workmanship, the same shall be replaced by the materials and workmanship conforming to the ENGINEER-IN-CHARGE's requirements by VENDOR/CONTRACTOR free of cost at site.

## **6.8. PAINTING**

All fabricated steel material, except those galvanised shall receive protective paint coating as specified in specifications or as directed by Engineer-in-charge.

Galvanizing of fabricated steel wherever specified, shall be as per specifications or as directed by Engineer-in-charge.

## **7. FLOORING WORKS**

### **7.1. SCOPE**

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

### **7.2. 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<br>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.

### 7.3. Sustainability

It is recommended that the tiles shall have at least 15% recycled content by cost.

The tiles / stones used shall be procured from the manufacturing plants / quarries located within 400 Km from the project site.

### 7.4. FINISHES FOR STONES

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

| Flooring      | Finishing Material                        | Place                        |
|---------------|---|------------------------------|
| Kota          | Polished Kota Stone Flooring Material     | Inside cabins                |
| Kota          | Rough Kota Stone Flooring Material        | Outside Cabins on the Ottahs |
| Granite Stone | Ruby Red Granite Stone for Tread & Risers | Steps outside Cabin / Ottahs |
| White China   | White China mosaic flooring               | Roof top of Canopy &         |

|        |  |        |
|--------|--|--------|
| Mosaic |  | Cabins |
|--------|--|--------|

## 7.5. POLISHED KOTA STONE FLOORING

### 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 EIC/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.

### 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.

### 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.

### 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 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% woollen rags) the following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

#### POLISHED KOTA STONE IN RISERS, TREADS AND SKIRTING

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.

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.

Cutting, Polishing and finishing: Cutting, grinding and polishing of skirting shall be done in the same manner as of flooring but by hand.

### 7.6. ROUGH KOTA STONE FLOORING

#### GENERAL & CODES:

The Kota stone slabs shall be rough finish 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 EIC/PMC, before starting of work. The slabs shall conform to the size required. The thickness of the slabs shall be 20 - 25mm.

#### 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.

#### 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.

#### **ROUGH KOTA STONE IN RISERS, TREADS AND SKIRTING**

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.

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.

Cutting and finishing: Cutting and finishing of skirting shall be done in the same manner as of flooring but by hand.

### **7.7. GRANITE STONE SLAB FLOORING**

#### **MATERIAL**

Machine cut granite stone slabs shall be of 18 - 20 MM thickness Size, Colour & Pattern as specified in the item description & Approved Sample. Colour shall be uniform and the slabs free from all defects. Tiles used at site shall be machine-cut.

In machine-cut stones, 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.

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 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 EIC/PMC and the slabs to be used shall conform to the approved sample.

#### BEDDING

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.

The amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and satisfactory bedding.

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.

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.

#### LAYING

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 many 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 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 windowsill, the edges shall be nearly rounded off.

Laying shall start after due consideration is given to following points and approved by the EIC/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 tiles 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) Tiles 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.

Grouting of joints shall be carried out with coloured (pigmented cement) cement or grey cement that matches the colour of tiles. Grout shall be worked into joint. Excessive grouts shall be cleaned off.

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.

#### POLISHING

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 manufacturer. It shall be cured for a period of 7 days by keeping its moist.

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.

The final cutting/grinding shall be with a fine stone of 220-320 grade and shall be done with sample water.

Tin oxide powder shall be spread 33 gm/ sq. m and polished by machine fitted with hessian bobs. The floor shall be washed, cleaned and dried with a soft cloth or linen. Wherever corner

of tiles is slightly low and remain unpolished, they should be hand polished by using rubbing stone.

In case of wax polishing, wax polish shall be applied to the surface. It shall be rubbed with machine. Then clean sawdust 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.

#### GRANITE STONE SLAB FLOORING FOR TREADS AND RISERS

The method of laying, bedding etc. for granite stone flooring in treads and risers shall be like that for granite stone slab flooring as specified 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. 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.

### 7.8. CHINA MOSAIC FLOORING

#### 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.

#### MATERIALS

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 EIC/PMC.

## Cement

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

## WORKMANSHIP

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 EIC/PMC.

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.

## 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.

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

## 8. PARTITION WORKS

### 8.1. INSIDE AREA - Aluminium partition with 8mm thick fixed glass and door with door closer

#### **SCOPE**

The specifications refer to AL glazing / doors / windows / skylight / atrium works in the building. The work includes providing and installing an aluminium partition with 8mm thick fixed glass and door with door closer in inside cabin.

#### **GLASS**

##### General

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

Glass thickness shall not be less than 8mm and confirming to relevant standards and as approved by EIC/PMC.

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

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).

It is the responsibility of the contractor to determine the maximum design wind pressure and lateral forces applicable for that 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.

Relevant Standards:

- ASTM C1036 - Standard specification for flat glass.
- ASTM C1048 - Standard specification for heat-treated flat glass – Kind HS, kind FT, coated and uncoated glass.
- FGMA - Glazing Manual.

Annealed Glass

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.

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

Products shall be reputable proprietary products; factory manufactured under ISO 9002.

Products which may be Accepted include those manufactured by:

- a. Pilkington Glass
- b. Asahi Glass
- c. Saint Gobain
- d. Sejal Glass
- e. Graebel
- f. Emirates Glass

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.

Relevant Standards:

- a. ASTM C1036 - Standard specification for flat glass.
- b. FGMA - Glazing Manual.

Heat-Strengthened and Fully Tempered Glass: -

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.

Base material shall be an Accepted selected quality float glass.

Edge quality:

- a. All toughened glass shall have bevelled 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.

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.

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 within 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.

#### Laminated Glass

Provide all required laminated glass in accordance with AS 2208 and FGMA Glazing Manual.

The base material shall be an Accepted selected quality float glass.

Provide an Accepted polyvinyl butyral (PVB) interlayer.

Products which may be Accepted include DuPont "Butacite", or Accepted equivalent.

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.

Heat soak procedure shall be followed to minimize the incidence of NiS induced failures if specified in any 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/EIC/PMC/Architect.

Relevant Standards:

- a. FGMA - Glazing Manual
- b. ANSI Z97.1- Glazing materials used in building – Safety performance specifications and



methods of testing.

**Insulating Glass Units: -**

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.

Seal performance: Insulated glass shall have double edge seals.

1. 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.
2. Spacer bar shall be a proprietary aluminium type, desiccant filled, anodised in a colour compatible with seals. The spacer shall be of Black colour 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.
3. 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.
4. The required thickness of the secondary seal shall be determined by calculation and verified by testing of samples as specified.
5. The Glass panel shall be separated by a de-hydrated air space specified.
6. Edge seal construction of the insulated unit shall be able to withstand at least three times the stress caused by the design wind pressures.
7. 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/EIC/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.

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.

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.

Visual Effects, Opacifiers and Coatings: -

Provide coatings and visual effects of paint, coatings or interlayer to glass to match Accepted samples.

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.

Relevant Standards:

- a. PBS-4-0885.

Glass Coatings: -

Relevant Standards:

- a. PBS-4-0885
- b. BS (EN) 1096

c. ASTM 1376

Decorative Ceramic Paints: -

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.

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

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

GLAZING ACCESSORIES

General

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

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. EPDM (Ethylene Propylene Diene Monomer) rubber gaskets/beading on both sides to provide a dust-proof and rattle-free fit.

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.  |

#### Gaskets

1. Co-extrusions: Provide Accepted coextruded profiles of polypropylene and polypropylene compatible products.
2. Hard profiles: Provide dense profiles including flashings, wiper seals and the like, complying with ASTM C864.
3. Soft profiles: Provide soft profiles including bulb seals, sponge seals and the like, complying with ASTM C509.

## Setting Blocks and Side Blocks

### 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.

### 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. 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.

### 4. Shims:

- d. Shims which transfer shear forces shall be steel plates, set in a staggered pattern and fillet welded to each other and adjacent steel surfaces.
- e. Polypropylene shims may be Accepted at static connections where shims transfer only compressive loads.

5. Contact With Structural Silicone Sealants: Extruded profiles in contact with structural silicone sealants shall be black, heat cured, silicone rubber.

## Structural Silicone

Design and provide structural sealant glazing systems were 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.

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.

Silicone Sealants

Weather-grade, neutral cure silicone sealant used for finishing the joints and ensuring acoustic/airtight sealing. Provide Accepted elastomeric joint sealants and joint fillers were indicated on the Drawings and required. All silicone sealants shall be from Dow Corning, Sika or equivalent Accepted by the EIC/PMC. All sealants for each joint type shall be the same product and from the same manufacturer.

Relevant Standards:

ASTM C510 - Standard test method for staining and colour change of single or multi-component joint sealants.

ASTM C794 - Standard test method for adhesion-in-peel of elastomeric joint sealants.

ASTM C962 - Standard guide for use of elastomeric joint sealants.

ASTM D2203 - Standard test method for staining of caulking compounds and sealants.

ASTM D412 - Standard test method for vulcanised rubber and thermoplastic elastomers - Tension.

ASTM D897 - Tensile testing of adhesive bonds.

FGMA - Sealants manual.

TT-S 001543A - Sealing compound, silicone rubber base (for caulking, sealing and glazing in buildings and other structures).

TT-S 00227E - Sealing compound, elastomeric type, multicomponent (for caulking, sealing and glazing in buildings and other structures).

TT-S 00230C - Sealing compound, elastomeric type, single component (for caulking, sealing and glazing in buildings and other structures).

TT-S 01657 - Sealing compound, single component butyl rubber based, solvent release type (for buildings and other types of construction).

Movement requirements:

Where sealants are used to seal movement joints, movement capability of sealant shall be appropriate to expected maximum deflection or movement.

Unless otherwise Accepted, sealant depth for movement joints shall not exceed half the joint width.

Fire rated requirements:

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

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.

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

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

Tapes:

1. Tapes shall be by Norton or equivalent Accepted by the EIC/PMC. They are to be silicone compatible, non-gassing and non-staining.
2. Tapes shall align with the glass edge to within +/- 1mm. They shall be held by sealant or a captive edge to be prevented from dislodging in the event of a breakdown to the adhesive surfaces.
3. Tapes are not permitted to be used as an air seal or rainscreen to the building envelope system or in place of a compression gasket in a glazing rebate.

Point Supported Fixing Brackets (Spiders): -

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.
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. 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.
4. The fittings are protected from direct contact with the glass by an insulating material.
5. The glass hole is insulated from the countersunk screw by a black countersunk, U.V resistant nylon or anodized aluminium bush.
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.
7. Non-compressible vulcanised fibre gaskets insulate between metal-to-metal surfaces to eliminate undue noise.
8. A washer, manufactured from 316 grade stainless steel with a tensile strength of 600 MPa, distributes the clamping load.
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.



10. The Spider assembly is securely fastened using 316 grade nuts, with internal threads complying to BS3643.

**Tension Anchor Brackets: -**

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.

**Suspension Rods: -**

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.

**ALUMINIUM**

**General**

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.

All exposed surfaces shall be free of scratches and other serious blemishes.

**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.  |

#### 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.   |

#### Aluminium Extrusions: -

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

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

#### Aluminium Panels:

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

1. External Panels – minimum thickness

4mm solid aluminium

6mm composite aluminium

2. Internal Panels – minimum thickness

3mm solid aluminium

4mm composite aluminium

3. Perforated Panels- minimum thickness

1 mm perforated corrugated aluminium

4. Composite Aluminium Panels:

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

5. Solid Anodized Panels shall be:

Aluminium alloy 1100 - H14

25 microns clear anodized

6. Solid Painted Panels shall be:

Aluminium alloy 3003 - H14 or, 5005 - H14

7. Perforated Aluminium Panels:

i. 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.

ii. The minimum thickness of panels to be 1 mm.

iii. Coating to be two Coat of PVDF exterior coating.

Aluminium Welding: -

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.

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.

Do not weld:

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

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

#### Aluminium Anodizing

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

#### 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. |

#### 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   |

#### 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 EIC/PMC for checking). 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.
- c. 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.

#### 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.

#### Aluminium – Powder Coating

Powder-coated aluminium surfaces shall receive a super-durable polyester coating, factory-

applied by electrostatic spray. Colour to be Accepted by the EIC/PMC.

Anodized (coating thickness 15-20 microns) or Powder Coated (coating thickness 50-70 microns) to the approved by EIC/PMC.

#### Colour and Finish

- a. The colour and gloss range samples shall be submitted to the EIC/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
- d. match the factory-applied finished work.

#### 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.

Relevant standards the Façade Subcontractor shall comply with:

|                           |                                     |
|---------------------------|-------------------------------------|
| AAMA-2605:1998            | Colour uniformity                   |
| AAMA-2605<br>ASTM B244-97 | Film thickness                      |
| AAMA-2605<br>ASTM D523-89 | Specular gloss at 60° viewing angle |
| F-2H ASTM<br>D523-89      | Pencil hardness                     |

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

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

- Colour shall be in accordance with the Architect's selection.
- Powder coatings shall be in full compliance with AAMA 2605-98.
- Coating thickness for single coat system to be at least 65 to 100 microns and must be of super-durable polyester grade.
- Powders shall be of thermosetting and super durable type. It must be Lead, Cadmium and TGIC (Tri glycidyl isocyanurate) free, to ensure strict environmental compliance.
- 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.

Aluminium – Fluorocarbon Coatings

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.
2. The dry film thickness according to ASTM D1400 shall be not less than 33 microns.
3. The surface shall not have any dents, scratches, scrapes, die lines or other extrusion streaks or lines.
4. The paint film shall not show flow marks, crack, peel or blister for the warranty period.
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.
6. The paint finish shall comply with AAMA 2605.
7. Colour changes shall not exceed 5E NBS units as defined by ASTM D244-97 for the warranty period.
8. Chalking shall not exceed No. 8 rating in accordance with ASTM D659-44.
9. Site touch-up of damaged surfaces shall not be permitted without written instructions from the EIC/PMC. Where touching up is not authorised, damaged material shall be replaced.

#### Aluminium Fabrication

1. Fabrication Tolerance: Tolerances at joints and junctions shall take precedence over tolerances for components or assemblies.
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.
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. 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.
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.
6. Protection: Provide factory applied protective film, tape or coatings which will not bond to the aluminium surfaces when exposed to sunlight or weather.

Aluminium Frame Assembly: -

Fabricate aluminium in accordance with Accepted shop drawings and prototypes.

Extruded aluminium alloy sections conforming to relevant standards (such as IS 733 and IS 1285 for chemical composition and mechanical properties)

Structural wall thickness, Frame size must be as approved by the EIC/PMC.

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.

Relevant Standards: (British)

BS 4873 Specification for aluminium alloy windows.

BS 8118 The structural use of aluminium.

Joints and junctions:

1. All visible joints shall be fixed by concealed means, unless otherwise indicated on the shop drawings or accepted in writing.
2. Fit exposed joints accurately to provide close continuous contact to a fine hairline.
3. Make junctions with concealed mechanical connectors so that no fixings, pins, screws, pressure indentations and the like are visible on exposed faces.

4. Sections shall be sized to eliminate edge projection or misalignment at joints.
5. Where required, joints shall be watertight and weather tight.
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.
7. Joints between fabricated assemblies may be concealed with suitable aluminium extruded covers or clip-ons.

Fixings in aluminium work:

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. Self-tapping screws shall be stainless steel. Non-visible screws may be pan-head type.

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 "posidrive" heads, evenly and neatly located.

Testing of aluminium fixings:

Carry out testing of the tensile strength of welded aluminium stud fixings and extrusion flute connections by an Accepted testing programme.

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.

Curtain Wall System Drainage: -

1. All glazing rebates, back pan cavities, stack joints, window & door frames, working louvers and external trims shall be outward draining.
2. Drains shall have baffles to prevent the ingress of wind driven water.
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.

## BRACKETS, FIXINGS AND ANCHORS

### Scope

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.

Fixings shall be concealed unless otherwise Accepted or indicated on the Drawings.

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.

Ensure that all bolts and similar fixings are tight at completion of installation.

All items shall (be):

1. Appropriate to the substrates and members to be fixed or assembled.
2. Ensure the rigidity of the assembly.
3. Corrosion resistant equal to or exceeding the members to be fixed or assembled.
4. Structural strength capable of transmitting the loads and stresses imposed.
5. Installed to prevent galvanic corrosion.
6. Allow generous on-site adjustment in accordance with Accepted shop drawings.
7. Installed to accommodate all substrate movements and thermal movement of the members to be fixed or assembled.

Minimum Level of Protection:

1. All bolts, nuts, washers in any given assembly shall be of the same material.
2. Bolts between steel components shall be galvanised.
3. Bolts between aluminium and steel shall be stainless steel and fully insulated.
4. Bolts between aluminium and stainless steel shall be stainless steel.
5. Bolts between steel and stainless steel shall be stainless steel and fully insulated.

6. Bolts between aluminium components shall be stainless steel.
7. Apply an Accepted nut locking compound or device to all nuts.

#### Fixings

##### 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 EIC/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 EIC/PMC's drawings.

##### 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 EIC/PMC.

##### Stainless Steel Bolts, Nuts and Washers:

1. Stainless steel bolts and nuts shall comply with BS 6105, strength A4, class 80.
2. Stainless steel washers shall comply with BS1449:Pt2, Grade 316 S 31.

##### Cast-in Channels:

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.
2. Cast-in channels shall be hot dip galvanised after all the fitments have been attached.
3. Cast-in channels shall be Halfen/Jodahl hot rolled steel galvanised or equivalent Accepted by the EIC/PMC.
4. The channel shall be able to carry the design load including any prying forces at the

most eccentric setting of the channel.

#### Holding Down Bolts:

1. Holding Down Bolts and associated nuts and washers shall be galvanised Grade 4.6 to BS 4190 unless otherwise specified.
2. They shall be rigidly held in place at the top and bottom by tack welding to mild steel links before galvanising.
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.
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. Studs: Shear studs shall be Nelson Studs or an Accepted equivalent welded to the structural steel in accordance with manufacturer requirements.

#### Masonry Anchors:

1. Mechanical masonry anchors shall be Hilti HDA or Fischer FDA, Chemical anchors shall be Hilti HVU or Fischer FVU Injection anchors.
2. The Subcontractor is responsible for confirming that all edge distance, spacing and embedment requirements are satisfied.
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.

#### Anchorage to Superstructure: -

1. Provide proprietary anchorage, with corrosion-resistant finish, suitable for the substrates and conditions, with holding power at least 10 x design load.
2. Products which may be Accepted include those manufactured by Hilti or Fischer

Fasteners, or equivalent.

Channel anchorage:

1. Provide channel anchorage in hot-dip galvanised steel or Grade 304 stainless steel where required, complete with polystyrene insets and plastic end caps.
2. Channel length, tail size and tail locations shall satisfy the most extreme loading conditions allowed for in the structural calculations.

Anchorage and Bracket Installation

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.

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                      |

Anchor placement tolerances: Install anchors to not exceed:

- a. Maximum deviation from correct position: +/- 12 mm.
- b. Minimum distance from the concrete edge to the nearest part of the anchor: 100 mm.

Testing of built-in anchors:

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

#### BUILDING ENVELOPE ATTACHMENTS

##### Back-pans

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

##### Insulation

1. Any spandrel glass or other non-vision areas shall have a minimum thermal resistance of a value specified by the EIC/PMC and shall be comprised of a foil-backed insulation panel. (USG Therma fibre CW90 50mm or Accepted equivalent).
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.

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 EIC/PMC and relevant local Authorities.

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.

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.

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.

#### HARDWARE

##### Operable Vents: -

1. All window hardware shall be of a proprietary type of stainless steel, grade 316, which has been fully designed and tested.
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.
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.

##### Locking System: -

1. Locking System for operable vents shall be Ferco Multi-Point Locking System or Accepted Equivalent.
2. Locking Points shall be calculated based on acceptable vent deflection and stress limits, with a minimum of 4 locking points.
3. The locking system shall be fully concealed within the body of the vent frame and shall



lock into a concealed location.

Hinges & Limiting Devices: -

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.
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.
3. The hinges shall be free moving but shall be designed to a 'snug' fit to prevent any vibration of the vent in either closed or open positions.

Safety Rails: -

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.

Rails must be 'replaceable'.

Operable Doors & Hinges: -

1. Entry Door hinges shall be Dorma concealed spring hinges or Accepted equivalent.
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.
3. All hardware shall be Grade 316 Stainless Steel of a finish specified by the EIC/PMC.
4. Entry doors shall have a Grade 316 Stainless Steel kick-plate of at least 150mm height unless otherwise specified.

Louvres

1. Provide Accepted proprietary louver assemblies complete with all accessories and fixings, together with structural calculations for blades, frames, fixings, and blanked off sections.
2. Structural frames and stiffening rib members shall not deflect by an amount greater than span/240 when tested the required design wind pressure.
3. Where required for access, provide framed and hinged louvered access doors to match

adjacent louvers.

4. Louvers shall be waterproof and weatherproof and self-draining.
5. They shall be anodised in a colour accepted by the EIC/PMC.
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.

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.

#### Flashing

##### Scope

1. Provide all required flashings, baffles, trims, capping and the like to prevent the entry of water and weather and make neat and clean junctions with the base-structure and adjoining work.
2. All flashings shall be cut and folded to Accepted profiles out of noncorrosive materials, with protective coatings as required.
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.
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.
5. Where flashings are fitted to pre-formed rebates, co-ordinate cast-in grooves or reglets as required.
6. Construct weepholes as required to enable the passage of moisture to the outside of the building.

##### Relevant Standards:

BS 6561 - Specification for zinc alloy sheet and strip for building.

ASTM D1149 - Test method for rubber deterioration -Surface ozone cracking in a chamber (Flat Specimens).

Locations: Unless otherwise indicated on the Drawings, types and locations shall be as follows:

1. Concrete wall flashings at every second storey: Stainless steel sheet.
2. Louver flashings: Stainless steel sheet.
3. Continuous horizontal and vertical smoke flashings: Zinc anneal steel.
4. Feature column flashing at every second storey: Stainless steel sheet.
5. Materials: Unless otherwise indicated on the Drawings, types and locations shall be as follows:
  6. Lysaght "Zinc anneal" steel, or equivalent, steel base grade G2, coating class Z 275.
  7. Stainless steel sheet, 0.8 mm thick, Grade 304.
  8. Lysaght "Galva bond", or equivalent, steel base grade G2, coating class Z 275.
  9. 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%.
10. Neoprene strip shall be 3 mm minimum thickness and shall comply with ASTM D1149 about ozone and flame resistance.

#### Anti-Carbonation Coating

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.

The surface protection shall be an anti-carbonation coating by Sika or Accepted equivalent.

Carbon Dioxide Diffusion resistance: the anti-carbonation coating shall have a minimum equivalent Air Layer thickness  $R > 100\text{m}$ .

Moisture vapour Diffusion resistance: the anti-carbonation coating shall have a maximum equivalent Air Layer thickness  $SD < 2\text{m}$ .

Earthing Tabs: The Façade Subcontractor shall co-ordinate with the Electrical Sub-Subcontractor for details of connection tabs for earthing strap connection.

Triangles for F.A.P.: Provide and install triangles for the marking of Firemen Access Panels, in accordance with local Authorities requirements.

## STEELWORK

### SCOPE

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.

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.

### 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.

### 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   |

#### MATERIALS:

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.

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

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).

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.

Forged Steel: Steel forgings and forged steel pins shall comply with BS 29.

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.

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.

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.

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.

Internal & External Exposed Steelwork: -

- a. The coating system is to be by Dulux, Taubman's, 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.

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 micrometres dry film thickness of Dimethoate 6.

Fire-Proofing Material: All structural steelwork where specified shall be protected by Accepted fireproofing material and must be Accepted by local authorities.

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 always shall be securely protected from the ingress of water or deleterious materials.

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.

Temporary Supports: -

As each section of steel is erected, all members shall be line, levelled 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.



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.

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.

Erection of Steelwork:

- a. The position in plan of vertical components at the base shall be within 10mm of the specified position along either principal setting out axis.
- b. 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.
- c. The thickness of packing plates shall not vary from the specified nominal thickness or 10mm, whichever is less.
- d. 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.
- e. 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.
- f. 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.
- g. 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.

#### STAINLESS STEEL

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.

Relevant Standards:

- AS 1449
- BS1449: Part 2.
- ASTM A666.

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.

Flatness of Architectural stainless steel shall be not less than "stretcher level" grade.

## 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.

### General

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.

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.

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

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

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

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.

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

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.

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

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.

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.

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.

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.

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.

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.

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.

#### 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.

#### 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.

#### 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 were indicated on accepted shop drawings.
- e. Ensure that weepholes are located to prevent staining of finished coated surfaces.

- f. Where sub-framing has been installed by others, inspects the sub framing before fixing any cladding to ensure that sub-framing is plumb, level and aligned with required tolerances.

#### Vapour barrier

- a. Where required, install a cavity membrane / vapor barrier to face of sub framing 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.

### **8.2. Cabins External Side- UPVC Partition with three-layer clear glass**

A technical specification for a uPVC partition featuring three-layer (triple-glazed) clear glass requires precise structural, acoustic, and material details to ensure durability and soundproofing.

#### **General System Description**

- **Partition Type:** Fixed or demountable full-height/half-height modular partition system.
- **Structural Thickness:** Frame profile depth of 60mm to 100mm, depending on system height and structural load requirements.
- **Frame Material:** Unplasticized Polyvinyl Chloride (uPVC), multi-chambered profile with fusion-welded corners.

#### **2. uPVC Profile Specifications**

- **Wall Thickness:** Main profile wall thickness of 2.5 mm  $\pm$  0.3 mm.
- **Reinforcement:** All uPVC hollow chambers must be reinforced with Galvanized Iron (GI) stiffeners with a minimum thickness of 1.2 mm to 1.5mm to prevent bowing.
- **Finish/Color:** White, wood-grain, or custom powder-coated finishes, highly UV-stabilized to prevent yellowing or cracking over time.

#### **3. Glass Specifications (Three-Layer / Triple Glazing)**

- **Configuration:** Hermetically sealed Triple-Glazed Unit (TGU).

- **Glass Composition:** 3 panes of clear glass separated by spacers, creating isolated air or argon-filled gaps.
- **Glass Type:** Toughened (tempered) or Laminated safety glass to ensure impact resistance.
- **Total Glass Thickness:** Typically ranges from 24mm to 36mm total thickness to fit deep-glazing uPVC beads.
- **Performance:** Exceptional sound insulation (STC rating often >42 dB) and thermal retention.

#### 4. Hardware & Glazing Accessories

- **Gaskets:** EPDM (Ethylene Propylene Diene Monomer) high-quality gaskets used for dual-sealing between the glass and uPVC frame to ensure an airtight, dustproof, and acoustic seal.
- **Glazing Beads:** Snap-in uPVC glazing beads accommodating multi-layered glass, secured with co-extruded seals.
- **Fasteners:** Heavy-duty 304 Grade stainless steel screws and brackets for structural anchorage to the floor, walls, and ceiling.

#### 5. Compliance & Installation

- **Acoustic Rating:** Designed to meet industry-standard laboratory acoustic insulation.
- **Fire Safety:** uPVC profile should ideally be self-extinguishing and compliant with local commercial building codes.
- **Sealants:** Weather-grade neutral cure silicone sealants used at the perimeter (floor/ceiling/wall junctures)

## 9. PAINTING WORK

### 9.1. External and Internal Plastered surface

#### SCOPE

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

#### 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<br>Specification for External Paint |
|----------|---|

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

## MATERIALS

Materials shall strictly conform to the relevant IS: Specifications.

### 9.2. PLASTERED OR CONCRETE SURFACES

#### General

- Wherever scaffolding is necessary, it shall be erected in such a way that as far as possible no part of scaffolding shall rest against the surface to be painted.
- For painting on external surfaces secured double scaffolding to be used.
- 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.

#### Preparation of surfaces

- 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 sandpaper and made smooth.
- The surface shall be allowed to dry thoroughly before the regular cost of paint is allowed.
- 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.

- The masking tape / plastic shall be removed without damaging the finishes.

### 9.3. Asian Paints (Apex Ultima) for External Surface

Asian Paints Apex Ultima is a premium water-based, 100% acrylic exterior emulsion enhanced with PU Serum. It is engineered for harsh weather, providing excellent dust resistance (DPUR), a rich sheen, and advanced anti-algal protection.

#### Physical & Chemical Properties

- **Composition:** Water-based, 100% acrylic smooth emulsion with silicone additives & PU Serum.
- **VOC Level:** Low VOC content; complies with LEED VOC criteria.
- **Flash Point:** Not Applicable (NA, as it is water-based).
- **Stability of Thinned Paint:** To be used within 24 hours.

#### Application & Drying Times

- **Surface Dry Time:** 30 minutes.
- **Recoat Period:** 4 to 6 hours
- **Dilution:** Maximum 40% with water.
- **Shelf Life:** 3 years from the date of manufacture (in original, tightly closed containers away from direct sunlight).

#### Finish & Performance

- **Finish:** Matt to soft sheen finish.
- **Sheen Levels:** 3 – 12 at 60 deg Gardner Head (GH) (Note: Suprema and Protek variants may feature higher sheen).
- **Colour Range:** 1,700+ tinted shades available.
- **Performance Warranty:** Typically comes with a 7 to 8-year comprehensive performance warranty (depending on the specific variant/region)

**Coverage & Pack Sizes**

- **Coverage Rate:**
  - *Brush application (1 coat):* 10 – 12 M2/Litre
  - *Brush application (2 coats):* (5 - 6 M2/Litre)

**Recommended Application System**

- **Primer:** 1 coat of Asian Paints Exterior Wall Primer.
- **Putty / Filler:** Optional, use Asian Paints Wall Putty or SmartCare Primero for leveling.
- **Top Coat:** 2 coats of Apex Ultima (diluted with water). Allow 4–6 hours between coats.
- **Horizontal Surfaces:** Ensure areas like ledges and window tops are painted with 3 coats of Ultima for added protection

**9.4. Asian Paints (Royale Glitz) for Internal Surfaces**

Asian Paints Royale Glitz is a premium interior emulsion designed to provide a luxurious, high-reflectivity ultra-sheen finish. It features Teflon™ Surface Protector for unmatched stain repellency, high washability, and an antibacterial formulation. Available in over 2,200 shades, it requires a dilution of 30–35% with water and dries surface-fast in just 30 minutes.

**Finish and Appearance**

Royale Glitz delivers a smooth, reflective, and rich ultra-sheen finish, allowing it to act as a centrepiece for upscale interior wall designs. It comes in a vast spectrum of over 2,200 colours, including specialized palettes inspired by Indian design aesthetics.

**Performance and Durability**

Enriched with Teflon™ technology, the paint forms a tough, stain-repellent film that resists deep penetration by everyday household stains, making it effortless to wipe and clean. It also offers anti-bacterial and anti-fungal properties to maintain a healthy indoor environment. When paired with the Royale Wall Base Coat, the system provides crack-free performance against hairline and shrinkage cracks (up to 0.5 mm).

**Technical Data and Coverage**

- **Coverage:** Delivers approximately 260 to 280 sq. ft. per liter for a single coat, and 140 to 160 sq. ft. per liter for the recommended two coats on normal masonry surfaces.
- **Drying Time:** Surface dry time is 30 minutes. The recoat period requires a minimum of 6 hours at 30°C and 50–60% relative humidity.
- **Sheen Levels:** 15 to 20 on a 60-degree glass head (GH).
- **Shelf Life:** 3 years from the date of manufacture in original, tightly closed containers kept away from direct sunlight.

**Application and Thinning**

Application can be done via brush, roller, or airless spray. For a brush or roller application, the recommended dilution is 30–35% with water. For airless spray, the dilution ratio is 10–20%, maintaining a pressure of 1200–1500 PSI. It is not recommended to apply the paint if room humidity exceeds 90%, as this leads to prolonged drying and moisture condensation. Thinned paint must be used within 24 hours. For brand-new cement plaster surfaces, a mandatory curing period of 28 days is required before application.

**Recommended Application System**

- **Putty / Filler:** Optional, use Asian Paints Wall Putty or SmartCare Primero for leveling.
- **Primer:** 1 coat of Asian Paints interior Wall Primer.
- **Top Coat:** 2 coats of Royale Glitz

**9.5. Hydrophobic Silicone Paint**

Providing and applying Hydrophobic Silane - Siloxane coating of approved make, to exposed concrete surfaces at all heights & leads and wherever instructed by Engineer-in-charge. The treatment shall be in two coats wet-on-wet or as recommended by approved manufacturer including preparation of surfaces by cleaning, curing, protecting, independent double legged scaffolding etc complete. The rate includes the cost of all materials, its application by specialized applicators by spray coating with airless sprayer, cleaning the substrate of all laitance, construction dust, contaminants, double scaffolding, labour etc., all complete and

at all levels, leads and heights as per technical specification & directions of Engineer-in-charge. Contractor shall furnish guarantee against performance of the application for 5 years.

#### Materials

##### Silicone paint

1. Silicone Paint shall be of approved make.

#### Workmanship

The silicone paint shall be diluted with water or solvent (benzene or toluene) based in proportion as per manufacturer's specifications. The paint shall be sprayed with spray gun as directed. As far as possible ready mix paint shall be used.

Concentration of silicon content shall be in proportion so that after the application, surface is clear and as it is. The sample shall be approved by architect or engineer-in-charge. Normally 5% concentration is sufficient for not to have change in parent color.

Before applying the surfaces should be thoroughly cleaned of dust, dirt, concrete slurry or any other foreign material or efflorescence from within the brick if any, using method like pressurized water jets, rubbing with gunny bags and soft brush, washing with biowash chemical etc. as approved by the EIC. Pressurized water jet shall be applied in such a way that the surface on which it is applied does not get damaged.

Before applying the specified coats of silicon paint the efflorescence of the exposed brick work should be removed in the following manner

- 1) Apply solution of - mixer of liquid ammonia and soft water (1:6) + mixer of teapol (mild detergent) and water (1:6) on brick surface using brush.
- 2) After required / specified time interval the surface treated as mentioned in 1 above should be washed with soft water using brush or spray.

The concrete surfaces shall also be thoroughly cleaned of dust, dirt, rust, concrete slurry or any other foreign material using appropriate method so as not to damage the RCC work, as approved by the EIC.

Rate shall be inclusive of moping, cleaning, masking the door windows/floor/plants etc during and after the execution for protection.

Unless otherwise specified silicone paint shall be executed through approved specialized agency. Contractor shall furnish a guarantee of 5 years on stamp paper to the employer directly and the tender rate shall be inclusive of the same which is also to be signed by the specialized agency. However, soul responsibility shall be of main contractor for any leakages.

#### **9.6. Pinewood texture finish Paint**

Providing and applying pinewood texture finish painting of approved make, to exposed surfaces at all heights & leads and wherever instructed by Engineer-in-charge. The treatment shall be in two coats wet-on-wet or as recommended by approved manufacturer including preparation of surfaces by cleaning, curing, protecting, independent double legged scaffolding etc complete. The rate includes the cost of all materials, its application by specialized applicators by spray coating with airless sprayer, cleaning the substrate of all laitance, construction dust, contaminants, double scaffolding, labour etc., all complete and at all levels, leads and heights as per technical specification & directions of Engineer-in-charge.

The work shall include surface preparation, priming, filling, sanding, and application of approved wood finish coatings on all kind of surfaces as specified in drawings and schedule.

Paint shall be applied by brush, roller, or spray equipment as recommended. Finish shall be uniform in colour, gloss, and texture. No brush marks, sagging, runs, pinholes, blistering, or peeling shall be visible. Adjacent surfaces shall be protected from paint splashes and damage. The Surface shall be visually inspected under normal lighting conditions. Colour, shade, gloss level, and finish quality shall match approved samples. Any defective work shall be rectified at the contractor's expense.

### **10. Miscellaneous**

#### **10.1.WATER PROOFING:**

##### **Seven layers waterproofing All roof tops**

Scope:

This specification covers the general requirements of waterproofing treatments for various components of buildings/ structures. The works under this specification shall consist of furnishing of all tools, plants, Labour, materials, and everything necessary for the complete work.

Providing and applying a complete seven-layer waterproofing system on all roof terraces, including surface preparation, treatment of cracks and joints, waterproofing membrane application, protection screed, testing, and warranty. All materials shall be from a single approved manufacturer and approved by EIC.

While specific chemical brands as approved by EIC may use proprietary liquid mixes, the standard architectural sequence involves the following stages:

**Layer 1: Surface Preparation & Repair:** The surface is thoroughly cleaned, washed, and prepped. Any visible cracks or damaged joints are filled and patched to provide a smooth, sound base.

**Layer 2: Penetrating Primer Coat:** A deeply penetrating base solution (e.g., a liquid acrylic or polymer mix) is applied. This saturates the concrete, curing micropores and acting as a bonding agent for the layers above.

**Layer 3: First Polymeric Coat:** The primary waterproof coating is applied to establish the first heavy line of defense against water.

**Layer 4: Fiber Mesh Reinforcement:** A high-tensile fiberglass or polyester mesh is laid down into the wet coating. This structural webbing absorbs stress, preventing the waterproofing from tearing when the concrete expands or contracts.

**Layer 5: Second Polymeric Coat:** A second heavy coating of the waterproof polymer is applied directly over and through the mesh to lock it in place and add thickness.

**Layer 6: UV-Resistant or Sealing Coat:** An intermediate protective layer (often a heavy or dark-coloured elastomeric/bitumen coat, especially around vulnerable skirtings) is applied to shield the base coats from extreme temperature shifts and wear.

**Layer 7: Top Protective/Reflective Layer:** The final finish is applied—frequently a heat-reflective, solar-reflective, or specialized protective topcoat (like three micro-layers of acrylic finish) to ensure foot traffic and sun exposure do not degrade the underlying system.

**TESTING:**

- Conduct ponding test by retaining water for minimum 72 hours.
- No dampness, leakage, or seepage shall be observed below the slab.

**WARRANTY**

- Contractor shall provide a minimum 10-year waterproofing warranty jointly backed by the manufacturer.

**Dr. Fixit Pidifin 2K Waterproofing for All Exposed RCC Works****Scope**

Providing and applying two-component polymer-modified cementitious waterproof coating using Dr. Fixit Pidifin 2K (or approved equivalent) on all exposed RCC surfaces.

**Materials**

- Dr. Fixit Pidifin 2K consisting of:
  - Component A: Polymer liquid
  - Component B: Cement-based powder
- Repair mortar for patch repairs.
- Approved crack-filling materials.
- Clean potable water where required.

**Surface Preparation**

- Remove dust, grease, loose particles, curing compounds, and laitance.
- Repair honeycombs and damaged concrete using approved repair mortar.
- Open and treat cracks before application.
- Saturate surface with water and allow it to become SSD (Saturated Surface Dry).

**Mixing**



- Mix liquid and powder components in manufacturer's recommended proportions.
- Use mechanical mixer to obtain homogeneous slurry.
- Pot life shall be as specified by manufacturer.

**Application****First Coat**

- Apply first coat uniformly by brush or roller.
- Coverage approximately 0.75–1.0 kg/m<sup>2</sup>.

**Second Coat**

- Apply second coat after first coat becomes touch dry.
- Apply in perpendicular direction to first coat.

**Total Consumption**

- Minimum total consumption: 1.5–2.0 kg/m<sup>2</sup>.
- Achieve dry film thickness as recommended by manufacturer.

**Curing**

- Protect coating from direct rain and mechanical damage.
- Cure as per manufacturer's instructions.

**Performance Requirements**

- Excellent waterproofing and anti-carbonation properties.
- Crack-bridging capability.
- Resistance to chloride ingress.
- Good adhesion to concrete substrate.
- UV-resistant for exposed applications.

**Inspection and Acceptance**

- Coating shall be continuous and free from pinholes, blisters, cracks, and holidays.

- Any defective areas shall be repaired and recoated.

**Warranty**

- Minimum 5-year performance warranty from contractor, subject to manufacturer's approved application procedures.

**Applicable Standards (where relevant):**

- IS 2645
- IS 3067
- IS 456
- Manufacturer's latest technical data sheet and application guidelines.

**10.2.ALUMINIUM COMPOSITE PANEL WORK****GENERAL**

An Aluminium panel used for the exterior cladding of building shall be 4 mm thick Aluminium Composite Panel (ACP) 25 micron anodised aluminium sheet as manufactured treated and supplied by ALPOLIC or equivalent approved.

Work shall include following:

- Aluminium cladding system as of ALPOLIC or equivalent approved
- All hardware
- All anchors fixing, attachments, reinforcements, sections as required in supports & backing

- Finishes, protections coatings & treatments
- All thermal insulation and firesafing
- Co-ordination with the work of other agencies
- Final cleaning interior and exterior prior to handover
- Guarantees
- Fixing to be done in conjunction with existing Wall system.

All work in this section shall comply with the standards, codes specified and also with local codes requirements and regulations.

## **MATERIAL/PRODUCTS**

### **General**

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. Submit details including proposed alloy types with supporting justification data for review and Acceptance.

All aluminium materials shall be of consistent high quality regardless of source.

Manufacturers shall be Accepted established manufacturers with a reputation for producing high quality materials. Submit details for review and Acceptance.

### **Relevant Standards**

#### British Standards

- 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.

#### American Standards.

- ASTM B221 - 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.

#### **Sheet**

Unless otherwise indicated or accepted, sheet alloy that is to be anodised shall be Grade 1100-H14.

Where thickness of sheet is less than 1.6 mm, bending radii for coated sheet shall not exceed  $T=1$  where T is the thickness of sheet.

#### **Aluminium Panels:**

General:

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

External Panels – minimum thickness

4mm solid aluminium

6mm composite aluminium for soffit

4mm composite aluminium

Internal Panels – minimum thickness

3mm solid aluminium

4mm composite aluminium

Perforated Panels- minimum thickness

1 mm perforated corrugated aluminium

#### **Composite Aluminium Panels:**

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

|   | <b>4mm Panel</b> | <b>6mm Panel</b> |
|---|------------------|------------------|
| <b>Minimum Radius</b>                                   | 450mm            | 600mm            |
| <b>Modulus of Rapture(Bending)</b>                      | 190 MPa          | 190 MPa          |
| <b>Bending Stiffness (EI x 1000)</b>                    | 245 Nmm_/mm      | 615 Nmm_/mm      |
| <b>Ultimate Shear Resistance<br/>(in plane of core)</b> | 11.5 MPa         | 11.5 MPa         |

#### **Curved Shapes – Physical and Mechanical Properties**

Tensile stress in a panel under maximum wind load shall not exceed 71 MPa.

Thermal Expansion - Coefficient of thermal expansion:  $22 \times 10^{-6}$  mm/mm/°C

Thermal Resistance - stable up to a temperature of 150°C. 4mm - 0.018m/°K/W

Acceptable Products / Manufacturers :

- Alpolic
- Alucobond

- Reynobond

#### Acoustic Properties

4mm - 29dB; 6mm - 30dB

AS1530.3-1989

#### Tests for Early Fire Hazard Properties of materials:

- Ignitability Index (Range 0 - 20) - Rating 0
- Spread of Flame Index (Range 0 - 10) - Rating 0
- Heat Evolved Index (Range 0 - 10) - Rating 0
- Smoke Developed with Index (Range 0 - 10) - Rating 0 – 1

#### BS476-Part-6

- Method of test for fire propagation of materials.
- Result: Index i1 - 0.0, Index i2 - 0.5, Index i3 - 0.2
- Fire propagation Index - 0.7

BS476 Part 7 1987: Method for classification of the surface spread of flame of products.

Classification - Class 1.

Durability: No change in bond strength after 1000 hours of acid salt spray exposure in accordance with ASTM B287-74.

#### Dimensional tolerance

- Width: + 2.0 mm
- Length: + 4.0 mm
- Thickness: + 0.2 mm for 3 mm and 4 mm thick panel + 0.3 mm for 6mm thick panel
- Bow: maximum 0.5% of the length and/or width
- Squareness: maximum 5.0 mm
- Surface defect: The surface shall not have any irregularities such as roughness, buckling and other imperfections.

Principal properties; -

|     |                        |   | 3 mm                  | 4 mm                  | 6 mm                  |
|-----|------------------------|---|-----------------------|-----------------------|-----------------------|
| (1) | Penal weight (Minimum) | : | 4.6 kg/m <sup>2</sup> | 5.5 kg/m <sup>2</sup> | 7.4 kg/m <sup>2</sup> |
| (2) | Thermal expansion      | : | 1.2 mm / m 50o C      |                       |                       |

Mechanical properties; -

|     |                                 |   | 3 mm                    | 4 mm                    | 6 mm                   |
|-----|---------------------------------|---|-------------------------|-------------------------|------------------------|
| (1) | Tensile strength (ASTM E8)      | : | 6.2 kg/mm <sup>2</sup>  | 4.9 kg/mm <sup>2</sup>  | 3.5 kg/mm <sup>2</sup> |
| (2) | Yield strength (ASTM E8)        | : | 5.9 kg/mm <sup>2</sup>  | 4.5 kg/mm <sup>2</sup>  | 3.1 kg/mm <sup>2</sup> |
| (3) | Elongation (ASTM E8)            | : | 12%                     | 14%                     | 17%                    |
| (4) | Flexural elasticity (ASTM C393) | : | 5000 kg/mm <sup>2</sup> | 4060 kg/mm <sup>2</sup> | 2970kg/mm <sup>2</sup> |

Mechanical properties of skin aluminium; -

|     |  |   |  |      |      |
|-----|--|---|--|------|------|
| (1) | Yield strength (ASTM E8)                             | : | 12.0 kg/mm <sup>2</sup> (1100 H14)<br>15.5 kg/mm <sup>2</sup> (3105 H14) |      |      |
| (2) | Modules of elasticity (ASTM C393)                    | : | 7000 kg/mm <sup>2</sup>  |      |      |
| (3) | Bond Integrity (Vertical pull, ASTM C297)            | : | 120 kg/cm <sup>2</sup> ( = 12.2 N/cm <sup>2</sup> )                      |      |      |
| (4) | Sound transmission loss in accordance with ASTM E413 | : | 3 mm   | 4 mm | 6 mm |
| (5) | Sound transmission loss (STC)                        |   | 25   | 26   | 26   |

Fire Performance shall confirm to:

A AS1530.3 1989:

## Tests for Early Fire Hazard Properties of Materials:

- B BS476 Part 6:  
Method of test for fire propagation of materials
- C BS476 Part 7 1987:  
Method for classification of the surface spread of flame of products.  
Classification - Class I
- D Building Code of Australia:  
Requirements regarding materials suitable for the exterior cladding of a building facade. See CSIRO Opinion Number FCO-1024 for full details.

## Anchors and Connections

- Anchors and connections shall be provided to fully satisfy their required purpose of adjustability, movement and load transfer.
- Anchors and connections that do not provide for movement shall prevent such movement by appropriate means.
- Anchors and connections that are designed for movement shall be of such construction that friction is low enough to allow for such movement without bucking and other damage and without causing binding and noises
- Self-drilling, Self-threading fasteners will not be permitted for use into concrete or masonry.
- Metal surfaces shall be separated in such a manner that metal does not move on metal. Materials used for this purpose shall be low friction components, sealants or gaskets as applicable.
- Anchorages to Structural Steel and Architectural Steel shall not induce rotational forces in supporting members.
- All anchors, connections and fixings outboard of the air seal shall be stainless steel/Hot dip galvanised

## Corrosion Protection



- Ensure by design that no metals, including alloys of the same base metal, are placed together in a manner, combination or location likely to give rise to damage by electrolytic action or other corrosion. In particular, avoid metal to metal contact between aluminium and metals other than an appropriate grade and composition of stainless steel and between certain grades and compositions of stainless steel and unprotected mild steel, as per the recommendations of the material manufacturer and to approval of the Client/Engineer. Ensure that dissimilar aluminium alloys in contact with each other are compatible. Any other dissimilar materials are to be treated or protected in such a manner as necessary to prevent corrosive action.
- Isolation of dissimilar metal surfaces to prevent electrolytic action shall be accomplished by materials, which are impervious to moisture and non-absorptive.
- All steel parts shall receive a protective treatment commensurate with their respective functions and locations. The treatment shall be one or more of those described above, and approved by the Client/Engineer.
- Where used to the exterior of air seals, or in any location vulnerable to moisture, steel shall be hot-dip galvanized after fabrication.
- Aluminium surfaces in contact with mortar, concrete, fireproofing, plaster, masonry, or absorptive materials of any kind shall be coated with an anti-galvanic material, impervious to moisture.

#### Lightning Protection

- All metal cladding components, including panels, glazing frames, mullion, transoms, fixing and support structure shall be fully bonded electrically to ensure electrical continuity of the building envelope.
- All metal cladding components, as above shall be connected to building ground by earthing jumper cables and connections.
- Provide for the installation of lightning arrestors, air terminals and the like by others without electrical bonding to the metal cladding components.

#### Storage and Handling

- Materials shall be stored in a dry, well ventilated location. Handling of materials shall be kept to a minimum and all materials shall be carefully protected from soiling and from condensation and other harmful moisture.

## ALUMINIUM COMPOSITE PANELS (ACP) CLADDING

### GENERAL

- All composite aluminium panels shall have a thickness of 4.00mm.
- The composite cladding panels shall be of cassette type, framed with an extrude aluminium profile.
- All fasteners shall be concealed within the panel joints. All fixing and joint details shall be designed to provide for the expected thermal expansion and contraction. The fixing of these panels shall accommodate the expected structural movements in the building.
- With a gloss of 30% according to Gardner Scale, the installed composite panel surface
- shall not have irregularities such as oil canning, waves, buckles, and other irregularities
- when viewed at any position not less than 15 degrees to the true plane of the panel.
- All fasteners, anchors, brackets and similar attachments used for the fixing and erection of these panels shall be of aluminum, non-magnetic stainless steel, or hot dip galvanized steel.

### Materials

Aluminium Composite Panel (ACP) cladding in pan shape in metallic colour of approved shade, made of Aluminium Composite Material (ACM), made out of 4 mm thick aluminium composite panel consisting of 3 mm thick fire retardant (FR) grade mineral filled thermoplastic inorganic core of grade B1 sandwiched between two thin coil coated aluminium sheets (Top i.e. face # 1 & rear i.e. face # 2) of alloy, Grade 3003 and H-16 temper and minimum thickness of 0.5 mm each as specified in the nomenclature of item. The ACPs are used for the external cladding surface like column, wall, jambs, sills, projected area, ceiling, decorative cladding on any surface to any profile and shape ( pan shape) at horizontally / vertically / sloped / curved / circular etc. ( linear as well as curvilinear shape).

The ACP fire retardant core of B1 grade contain 70% of Non-Combustible Inorganic compound & 30% of virgin LDPE. The main ingredient of the non-combustible compound are Aluminum Oxide (AlO) and Magnesium Oxide (MgO), when this ACP are put on fire at self ignition temperature of 460° C, it can be caught on fire after 5 minutes and when the fire leave the panels, the fire on the wall extinguish after 10 seconds.

The ACP top face (exposed surface) coil should have Kynar 500 PVDF(Polyvinylidene fluoride)/Lumiflon based fluoropolymer resin (high surface energy) coating of approved colour and shade of 30 microns to ensure corrosion resistance and weather proof and thus shall confirm to relevant ASTM or DIN or EN or BS code. The back face (rear side) of the cladding panel surface facing to the wall shall have polyester based wash (service) coating of 7 microns preferably grey in colour to protect against possible corrosion problems. The finished surface (Top face) shall be protected with a self adhesive peel off film with two layers of white & black tested to with stand local weather conditions without losing the original peel off characteristic or causing stains or other damages.

The weight of the Aluminum Composite Panel (ACP) should not be less than 7.50 Kg/Sqm. The ACP shall confirm to ASTM E84-08 or EN13501-1 or DIN4102 resulting in fire resistant properties. The complete system shall be designed to with stand the design wind pressure as per relevant IS code or international code (Test pressure shall be 1.5 times of the design wind pressure). Necessary pull out test of anchor fastener shall be carried out on the masonry wall /RCC structure to check the load carrying capacity of the bolt designed under suction pressure for designing the supporting and anchoring system.

#### Movement

System shall be designed to accommodate movement due to any force including the movement resulting from the exterior skin temperature ranging from 15°C to 85°C and also to accommodate the horizontal building movement of 10 mm per panel & vertical movement of 20 mm between floors on the aluminium framing system with support brackets, glass, gaskets and fastening devices. System shall be designed to accommodate the size and shape of the Laminated sandwiched composite panel as per the approved drawings including approved modifications as may be required during execution as well as all other incidental forces and stresses likely to be experienced under service conditions, i.e. Lateral force, Dead weight and Thermal expansion due to building movement both vertical and horizontal etc. Grooves shall be

designed in such a way to accommodate weather silicon sealant/ Non staining sealant of approved make.

#### Testing

The mechanical properties of 4mm thick ACP or ACM with core and aluminium coil/sheet shall confirm to the requirement as given in table below.

| S. No. | Description                                      | Specification for 4mm        |
|--------|--|------------------------------|
| A      | Physical Tests for ACM                           |                              |
| 1      | Over all thickness of ACM                        | 4mm (Tolerance + 0.2mm)      |
| 2      | Aluminium Skin thickness (each side)             | 0.5mm (Tolerance +/- 0.03mm) |
| 3      | Panel weight (ACM)                               | 7.5 Kg/m <sup>2</sup> (+5%)  |
| B      | Mechanical Properties of ACM                     |                              |
| 1      | Peel off strength (Drum Peel Test) (ASTM D903)   | Min. 4 N/mm                  |
| 2      | Tensile strength (ASTM E8)                       | Min. 40 N/mm <sup>2</sup>    |
| 3      | Yield strength (ASTM E8)                         | Min. 40 N/mm <sup>2</sup>    |
| 4      | Elongation (ASTM E8)                             | Min. 6%                      |
| 5      | Flexural strength (ASTM C393)                    | Min. 130 N/mm <sup>2</sup>   |
| 6      | Shear strength with punch shear test (ASTM D732) | Min. 18 N/mm <sup>2</sup>    |
| C      | Properties of Aluminium skin                     |                              |
| 1      | Tensile strength (Rm) (ASTM E8)                  | Min. 150 N/mm <sup>2</sup>   |
| 2      | Modules of elasticity (ASTM E8)                  | Min 70000 N/mm <sup>2</sup>  |

|   |                                     |                            |
|---|-------------------------------------|----------------------------|
| 3 | Elongation (ASTM E8)                | Min. 2%                    |
| 4 | 0.2% proof stress (ASTM E8)         | Min. 110 N/mm <sup>2</sup> |
| 5 | Yield strength (ASTM E8)            | Min. 124 N/mm <sup>2</sup> |
| 6 | Sound Transmission loss (ASTM E413) | Max. 26 dB                 |

#### Performance Certificate

Requisite performance certificate from the manufacturer of ACM stating compliance with ACM technical specification as per Table 5 above shall be submitted by the contractor to the Engineer-in- Charge before fixing at site of work.

The contractor shall provide curtain wall with aluminum composite panel cladding, having all the performance characteristics all complete as per the Architectural drawings, as per items description, as specified, as per the approved shop drawings and as directed by the Engineer-in-charge.

#### Marking

The ACP sheet should have a following laser marking and should be at repeated interval at the rear face of ACP sheet.

1. Total thickness with coil and core materials.
2. Size of ACP sheet.
3. Fire Retardant (FR) grade.
4. Date of manufacturing.
5. Batch number.
6. Make of manufacturer.

#### Installation

The installation system of ACP as external cladding with tray type (rout and return) panels and sealing joint is one of the most common method and it is available for a wide range of new

buildings and renovation projects. The ACP sheet under this system is first fixed on the substructure i.e. of steel members/RCC structures/brick walls with the help of base aluminium member frame work using necessary clamps, brackets, anchor fasteners, stainless screws, nuts and bolts, weather silicon sealant backer rods etc. as per approved design & drawing at all height and elevation which include all labours, materials, equipment's, handling, transportation, workmanship, design & preparation of working drawings, staging, scaffolding etc. all complete as per specification, drawings and instructions of the Engineer-in-Charge.

#### Frames:

Providing and fixing Aluminium extruded members (Box Tube) designed to with stand design wind pressure and movement as specified as continuous member for cladding the Aluminium Composite Panel. Aluminium member shall be fixed into masonry wall / RCC member / steel structures with brackets / clamps and it shall be of chromicised finish aluminium. All fastening straps, nuts & bolts, rivets, washers/other fastening materials shall be of nonmagnetic stainless steel and aluminium brackets shall be considered for ACP cladding with standard dimension and after the site survey if any undulation is observed intern that doesn't allow to fix the aluminium bracket only in these areas the additional support with locally fabricated hot dip galvanized bracket can be considered.

The bidder shall include the provision for these brackets also with in the quoted rate for ACP cladding works. Aluminium shim shall be used for level adjustment of bracket but more than 20 mm is not acceptable. If more than 20 mm, bracket shall be designed according to site condition.

Aluminium brackets / clamps shall be fixed with chemical injection technique threaded anchor rods of approved make to the base structure in the case of masonry wall / RCC members and SS anchor bolts in the case of steel structure. Extruded member shall be designed to accommodate laminated sandwiched composite panel as per the approved shop drawings and extruded aluminium member shall be 6063 T6 or 63400 (H9) grade conforming to BS 1467 or IS 8147, finished with transparent electrolytic colour anodic coating AC15 grade conforming to IS 1868.

#### Composite Panel:

Aluminium composite panel cladding of approved make as specified in BOQ to be fixed on the framing system described above. Lamination process of Aluminium panel shall only be glue technology and the source of complete composite panel shall only be accepted. The Laminated sandwiched composite panel suitably stiffened internally on the back side for preventing deformation due to design wind pressure beyond permissible limits by using aluminium flat 25 mm wide, 4 mm thick gloved with double adhesive tape in order to maintain panel flatness and to avoid permanent deformation over a period. Stiffener shall be provided at 600 mm c/c behind ACP panel irrespective of structural check of the panel against stability and deflection. Aluminium flat of size 25 mm wide and 3 mm thick shall be provided to a length 100 mm bent to shape, wherever the inner skin is cut to bend the ACP at the corners and as per approved shop drawing. Methodology of fixing the stiffener/flat in the corner panel shall be established in the drawing or to be glued to ACP on the backside of the panel in such a way the fixing mechanism of stiffener / flat shall not be visible on the elevation of the panel / outside.

#### Sealing:

After fixing the ACP on the sub structure, then a suitable sealing material i.e. Non-structural weather silicon sealant/Non staining sealant filled to the joints of panel with baker rod of approved make to ensure water tightness to the panel. Sealing shall be carried out with Non-structural (weather) sealant / Non staining sealant with PE baker rods, wherever the system is interfacing with glazing, cladding groove and any other groove.

Flashing: Fixing flashing at terrace level as part of the system made to profile as shown in the approved shop drawings and the profile shall be made out of hot dip galvanized sheet 1.2 mm thick and galvanizing coating thickness shall be in accordance with IS 2629 & 4759. In general, the flashing shall be provided to the entire length of cladding horizontally at terrace level with necessary anchoring system with SS fastening devices of approved make. Also, the flashing shall be provided at parapet top below the coping to drain the water during any seepage through the sealant joints with overlap of 100 to 125 mm in plan with sealant at joints to make sure that no water leakage through coping / flashing joints.

Field Test: Conduct field test at site on the installed system as per the criteria set out in the particular specification in the presence of Engineer in charge. Methodology for carrying out the test shall be submitted to Engineer-in Charge for approval prior to testing. Record the results and submit the report to the Engineer-in Charge for approval. If Field test fails, correct the

defects revealed to the satisfaction of the performance data as set out in the technical specification with the prior approval of Engineer-in Charge on defects rectification methodology.

General Guideline: System design in total, including Aluminium extruded member, type & thickness of Aluminium composite panel, Aluminium sleeves at connections, inserts, Sealant, supporting system/bracket including fastening and anchoring system & materials specified in the schedule and the system details as shown in the tender drawing are only tentative and is meant to set out a general outline of the proprietary system. Since the cladding system in terms of design, materials, all fixing details, methodology of execution are proprietary in nature, the onus of the design and performance requirements, shop drawing, execution etc. satisfying the design intent, particular specification and site conditions lies solely with the Contractor.

#### Precautions

1. Do unpacking and repacking of ACP sheet work in a clean place.
2. Remove dust and chips from ACP sheet and the packing paper.
3. Handle ACP sheet on a worktable. Do not handle it on the floor.
4. ACP sheets should always be handled by two people with external face upward to avoid possible rubbing of the ACP surface during handling.
5. Prior to fabrication, clean off the worktable, temporary stand and both side of ACP sheet.
6. Ensure that cutting chips generated from saws, routers and drills are completely removed from the interface between ACP sheet and tools.
7. The arrow should be followed as marked on the rear (back) face coil/ sheet to avoid the variation in colour.
8. Protective film of 75 microns should be removed within 45 days after the installation.
9. Do not use adhesive tapes made of PVC (Polyvinyl Chloride) on the surface of protective film or any time during storage, fabrication or installation.
10. Aluminium composite material (ACM) manufacturer shall provide warranty of ten years for any manufacturing defects.



**10.3.PVC PIPE:**

Providing, lowering, laying, jointing ISI marked uPVC pipes of approved make brand like Prince, Astral, Supreme, Dutron or Finolex as per the levels including all necessary fittings, formation of spouts with proper finishing by cement mortar and specials like bends, tees, couplers, reducers, etc. cost of labour, material, cement solvent, etc. as directed by the Engineer-in-charge.

**10.4.SCAFFOLDING:**

Work to be carried out at any height and any lead. The work also includes specific scaffolding and staging arrangements up to all heights, and no extra payment shall be made for the same. Work to be executed as per technical specifications and as directed by Engineer-in-Charge.

The work shall include the design, supply, erection, maintenance, inspection, modification, and dismantling of scaffolding required for construction, maintenance, finishing, and repair activities. The scaffolding system shall provide safe access and working platforms for personnel, materials, and equipment.

Scaffolding materials, design, erection, and use shall comply with the latest editions of:

- Bureau of Indian Standards IS 3696 (Part 1 & Part 2) – Safety Code for Scaffolds and Ladders
- Bureau of Indian Standards IS 2750 – Steel Scaffolding
- Occupational Safety and Health Administration Scaffolding Regulations (where applicable)
- Relevant project safety specifications and local statutory requirements.

Initial Inspection

- Scaffolds shall be inspected by a competent person before first use.



## **SECTION - 4: TECHNICAL SPECIFICATIONS**

### **MEPF WORKS**

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## **1. Intent**

This specification defines technical requirements for Design, Supply, Installation, Testing & Commissioning of complete MEPF works for North Entrance at GIFT City; power arrangement for access control system, External & Internal Lighting and wiring for offices & cabin at North Entrance Gate on EPC lump sum basis. Contractor is single-point responsible for performance, statutory approvals, and handovers.

## **2. Scope of Work**

1. This Scope defines the minimum MEPF work to be executed by the Contractor on a lump-sum EPC basis. Contractor shall carry out detailed engineering, obtain approvals, and deliver a fully functional system.
2. The scope of work covers the complete design, supply, installation, testing, commissioning and maintenance during DLP of MEPF works for the North Entrance Gate at GIFT City.
3. Design & Engineering: Detailed engineering for all MEPF disciplines based on site condition, load calculation, lux level design, hydraulic calculation, LPS risk assessment as per IS/IEC 62305. Submit GA drawings, SLDs, load schedules, pipe routing, lighting design for Client approval before procurement.
4. Statutory Approvals: Obtain approval from Local Electrical Inspectorate, Fire Department, and any other authority. All the approvals, permission, NOC's, certificates, etc. as require.
5. Coordination: Interface with Civil, Structural, Landscape, Access Control, IT team and vendors. Ensure no clashes and timely handover.
6. Supply & Installation: All materials, labor, tools, testing equipment, consumables. Only new, BIS/ISI marked materials of approved make and model.
7. Testing & Commissioning: Carry out all site tests, trial run, training to Client and end user staff. Submit O&M manuals, as-built drawings in AutoCAD, PDF and 5 set of hard copies.
8. Preventive and Corrective Maintenance, repair or replacement of all MEPF equipment and system during defect liability period. The contractor shall provide all required services, maintenance, and replacement in the DLP period and beyond the Defect Liability Period, as applicable, in accordance with the guarantee/warranty period specified in the technical specifications and approved TDS of MEPF works.
9. ELECTRICAL WORKS:

- North Entrance Offices/Security Cabin: Complete internal electrical wiring, lighting, power, fans, Split type AC, fire extinguisher, etc. as required.
- Complete design of SLD and layout for electrical power distribution for internal offices and security cabin area, external area and Gate structure.
- External lighting: Street light with poles, Bollards, Post Top Light with poles, Spike lights, Uplighters, LED strip – Aluminum profile light on Gate, Downlights, Façade lighting etc. with complete wiring/cabling, protection switchgears, IP rated junction box, fixing arrangements, foundation if require and accessories as required. As mentioned above are indicative lighting fixtures for external lighting, actual lighting fixtures shall be as per the approved drawings.
- Power Distribution: The scope includes SITC work of main incoming power panel/DB to receive supply from GIFT PCL near by source with all the required cabling work from GIFT PCL power source, necessary termination, etc. Complete Panel/DB including all the necessary switchgears (MCCB / MCB / ELCB / RCCB / RCB / RCBO), SPD, relays, contactors, connectors, DinRails, terminal block, wiring/cabling, termination with lugs and glands, earthing, etc.
- Raw Power DB for Offices and Security cabin: Required Nos. of TPN and SPN DB as per approved SLD and drawing including switchgears like MCCB, MCB, RCCB, RCB, RCBO, DinRails, connector, terminal block, necessary wiring/cabling, termination with lugs and glands, earthing and SPD Class-II.
- UPS Power DB: Required TPN/SPN DB as per approved SLD and drawing including switchgears like MCCB, MCB, RCCB, RCB, RCBO, DinRails, connector, terminal block, necessary wiring/cabling, termination with lugs and glands, earthing and SPD Class-II.
- External Lighting DB: If required separate DB for external lighting as per approved SLD and drawings including switchgears like MCCB, MCB, RCCB, RCB, RCBO, timer, contactor, DinRails, connector, terminal block, necessary wiring/cabling, termination with lugs and glands, earthing and SPD Class-II.
- Centralized single UPS System for North Entrance Gate work: Single required kVA Online UPS with minimum 1 hour backup at full load and dedicated UPS DB to feed computer plug points in offices and security cabin, printer/xerox machine in offices and security cabin, Boom Barrier, Flap Gate, Biometric device, routers, servers and Data Network Rack. UPS load calculation and battery sizing shall be provided by bidder for approval.
- UPS Power supply arrangement for Access Control: Boom Barrier, Flap Gate, Biometric of Access control system.

- Complete wiring/cabling with modular type switchboard, switch-socket & accessories, PVC conduit/Metal conduit/DWC for offices and security cabin power plugs, lighting fixture, switchboards, Computer/Printer/Xerox machine power plug, Ceiling Fans, Exhaust Fans, Water cooler & RO power plug, Geyser power plug, HVAC system power plug, Freeze and induction stove plug point, Plumbing motor & pumps, etc.
- SITC of Modular type required module switchboard with necessary switches(1 way/2 way/bell switch), socket (5/16/20 Amp), MCB, cover plate, metal box of same make for light points, Fan points, Bell points, AC points, Geyser points, Freeze/Stove points, Computer/printer/Xerox machine points, power plug-points, etc. as required.
- For each office minimum 4 nos. UPS power plug-points shall be in scope for computers and printers, For Security cabin minimum 6 nos. UPS power plug-points shall be in scope for computers and printers, minimum 1 no. UPS power plug-points for xerox machine shall be in scope in each office and security cabin. For each office minimum 2 nos. and for security cabin minimum 4 nos. raw power plug points shall be provided for routine requirements like laptop or mobile charging. Each switchboard for fan and light operation shall be with 6Amp plug point with switch in offices and security cabin.
- Power Points & Equipment Supply: Provide wiring and power outlet for:
  - UPS power 6A/16A sockets – min. 3 Nos. 6A + 1 No. 16A for each office
  - UPS power 6A/16A sockets – min. 4 Nos. 6A + 2 No. 16A for security cabin
  - UPS power 16A sockets – min. 1 No. 16A for each office and security cabin
  - Raw power 6A sockets – min. 2 Nos. 6A for each office
  - Raw power 6A sockets – min. 4 Nos. 6A for security cabin
  - Raw power 16A sockets – min. 1 No. 16A for each office
  - AC Point: min. 20/25A socket for AC in each Office/Cabin as require and suggested by EIC
  - Geyser Point: 16A socket with indicator in toilet as required
  - Water Cooler, RO Unit - 1 No. 6A + 1 No. 16A
  - Data Network Rack – circuit from UPS DB
  - Access Control: Boom Barrier, RFID Reader, Flap Gate – min. 20A circuit from UPS DB for each controller/point.

- Attendance Punching/Biometric Device – 5A socket if require
- SITC of Ceiling Fan 1200mm sweep, BIS, energy efficient, <50W, with electronic 2M regulator as per requirement for offices and security cabin. Minimum 1 no. ceiling fan shall be provided for each room of office and security cabin.
- SITC of Exhaust Fan in each toilet area shall be in scope of work. Supply and installation of mirrors with wooden frames for toilet area shall be in scope of work.
- SITC for Geyser with require accessories and water pipes, valve and tap in toilet-washroom as per standard practice & technical specifications.
- SITC of bell point including electronic bell and necessary wiring for offices.
- External Lighting: Design to achieve Lux level as mentioned in technical specification. Submit lighting design using Dialux/Relux for approval. Design, supply, installation, testing & commissioning Includes but not limited to following indicative external lighting fixture:
  - LED Street Light with Pole, RCC foundation, JB, protection switchgears cabling, accessories, etc.
  - LED circular Post Top fixture on Pole with RCC foundation, JB, protection switchgears cabling, accessories, etc.
  - LED Bollard Light with RCC foundation, JB, cabling, accessories, etc.
  - Spike light, Uplighter, Wall washer for landscape and façade with JB, cabling, accessories, etc.
  - LED Strip Light IP65 on Gate structure in Al profile with driver, cabling, accessories, etc.
  - Downlight under structure and outside Cabin with necessary accessories and cabling as required
  - Civil foundation design and execution for Poles, Bollards, Post Top Lanterns, etc.
- Internal Lighting: Design to achieve Lux level as mentioned in technical specification. Design, supply, installation, testing & commissioning Includes but not limited to following indicative internal lighting fixture:
  - Office/Cabin: Minimum 18W LED Downlight recessed/surface mounted with necessary wiring and accessories as required
  - LED Tube/Batten: Minimum 20W with necessary wiring and accessories as required.
- Earthing & LPS work, DBs, cabling in DWC pipe, wiring in conduit, testing & commissioning,



documentation, as-built drawings.

- For earthing system, whole design for earthing shall be done by the contractor based on IS codes & standards. As per the approved design, SITC of whole earthing system with necessary Cu. Bonded electrode, chemical compound, GI/Cu. Earthing strip, Cu. Wire/cable, earth pit, etc. Necessary excavation and boring shall be in scope of contractor. Separate earthing shall be provided for UPS system.
- LPS – Lightning Protection System: As per IS/IEC 62305. Contractor to do risk assessment and design. Supply, installation and commissioning of LPS Includes Air Terminal, Down Conductor, GI Strip, Test Joint, Separate Earth Pit with 3m cu. Bonded rod Electrode, etc.
- Scope covers all the necessary cabling/wiring for complete work. The cables/wires shall be 1.1 kv, copper, FRLSZH for power, UPS and lighting requirements. Cabling/wiring shall be in manner as per following:
  - Indoor concealed: Heavy Duty PVC conduit in wall/slab
  - Outdoor/Exposed: GI conduit
  - Underground: DWC Pipe, min. 750mm deep, with sand, brick
  - Inside Office/Cabin: Raceway/Trunking for desk wiring as suggested by EIC
  - Cable Tray if required and as suggested by EIC
- Testing of Insulation Resistance, Earth Resistance test, Polarity, Continuity, Lux level test, UPS backup test, RCCB trip test, etc. shall be in scope of work.

#### 10. HVAC WORKS:

- The scope covers work for the split-type air conditioning for North Entrance Gate offices & security cabin of GIFT City.
- Scope includes design, supply, installation, testing and commissioning of split inverter type Hi Wall AC (3-star rating). This also includes installation of fabricated stand for outdoor unit, core-cut, and supply & installation of refrigerant pipe, drainpipe, control cable to outdoor unit, supply and laying of electrical power cable and other accessories as per site requirement and as directed by Engineer-in-charge.
- Documentation reports & drawings: Preparation and submission of Material datasheets & technical submittals, project schedule, procurement plan, Material Supply, Installation, testing & commissioning reports, etc.

- Handover of the system: After successful completion of testing & commissioning of HVAC work, the contractor shall handover the entire works under the scope of this contract to DCS operation and maintenance contractor for operation and maintenance.

#### 11. Plumbing, Sanitary and Water System:

- The scope includes the design, supply, installation, testing, and commissioning of required plumbing, sanitary and water system.
- The scope includes CP sanitary fitting, EWC, Washbasin, water supply & storage arrangement, drainage, geyser, Water cooler & RO and exhaust fan.
- The scope covers and includes the design, supply, installation, testing & commissioning for the concern system as indicative following:

##### - Water Storage & Supply:

1. Overhead Tank: min. 500 Liter HDPE, 3-layer, UV stabilized on 1m MS frame as require.
2. Inlet: 25mm HDPE pipe from GIFT main source with Brass Valve.
3. Distribution: CPVC SDR-11 pipes IS 2527. 20mm for hot/cold to fixtures, 15mm for cold to WC, cooler with all require accessories and fixing arrangements.
4. Valves: Brass Ball Valve at entry to each toilet/fixture for every supply line.

- SITC of Water Cooler & RO system as per technical specifications with require accessories, stand, piping work, etc. Connection from 15mm CPVC for water cooler and RO. Drain to floor trap with complete require piping.

- Sanitary & Fittings – The scope includes the sanitary fittings as mentioned in the technical specifications. The indicative items for toilet/washroom sanitary fittings are as following:

1. EWC: Vitreous China with Flush Cistern, necessary trap, piping and accessories
2. Urinal: Urinal with auto flush cistern & necessary piping & accessories, if space permits
3. Wash Basin: Pedestal type with fixing arrangement, Waste coupling and bottle trap, necessary accessories and piping as approved by the EIC.
4. CP Fittings: Pillar Tap for Basin, Angle Valve, Bib Tap, Health Faucet, Shower, etc. as suggested by EIC

5. Accessories: SS304 Toilet Paper Holder, Soap Dish & soap dispenser, Mirror
6. Floor Trap with CP grating and necessary piping arrangements
- Drainage System: The scope covers the complete work including design, supply, installation, testing & commissioning for the Drainage System as mentioned below.
  1. Soil Pipe: 110mm SWR PVC IS 13592 for WC. Waste Pipe: 75mm SWR for Basin. All complete work including fixing arrangements & necessary accessories.
  2. Vent Pipe: 75mm up to 1m above roof with cowl and necessary fixing accessories.
  3. Final Disposal: Connect to GIFT STP/Sewer line. If not available, provide 1000L RCC Septic Tank + Soak Pit as per IS 2470.
5. Rainwater: PVC Rainwater Downtake from roof to ground, discharge to storm water drain.
  - Testing shall be in scope of contractor including Hydraulic test at 1.5x working pressure for 2 hrs, Smoke test for drainage, Flow test for cooler, temperature test for geyser, etc.
  - Plumbing work scope covers all the required fitting, accessories and fixing arrangements.

## 12. FIRE FIGHTING WORKS:

- The scope covers the design, supply, installation, testing and commissioning of portable fire extinguisher as per IS 2190 & NBC 2016. The scope includes following:
  - 6kg ABC Dry Powder Extinguisher – 1 No. near entrance of each Office/Cabin
  - 6kg ABC Dry Powder Extinguisher – 1 No. near electrical panel
  - 3kg CO2 Extinguisher – 1 No. near electrical panel
- 2. Mounting & Signage: Mounting height 1.2m to handle. Wall signboard + floor marking.
- 3. Maintenance: Service and refilling as require during DLP.

13. Modular type RJ45 and RJ11 socket with necessary concealed conduiting shall be in scope of the work for data and telephone for offices and security cabin. Qty. shall be as per actual requirement.
14. The scope covers any core-cutting required for the MEPF work including fixing-closing of core in proper manner up to the satisfaction of EIC after passing the utility from core.
15. The scope covers the submittal for Approval like Lighting design, SLDs, Load calculation, Battery

sizing, Pipe sizing, LPS risk assessment, Layout drawings, TDS of all materials, etc.

16. The scope covers the submittal at Completion like As-built drawings, Test reports, O&M Manuals, Warranty certificates, Training record, etc.
17. This Scope is to be read in conjunction with technical specifications, approved Drawings, and General Conditions of Contract.

### 3. **GENERAL REQUIREMENTS**

1. This specification indicates the General requirement for indoor and outdoor work including distribution boards, wiring system, cable laying, raceways-trunking installation, Fan and lighting, Plug points, Split Air-conditioner (AC) provision, UPS, earthing & lightning protection, Water storage, Plumbing, sanitary and other related works.
2. This specification is drawn to indicate essential requirements and precautions to be taken regarding internal and external electrical installation for ensuring efficient, safe, economical and practicable use of electrical materials and equipment, in conformity with statutory regulations and easy maintainability of the installations.
3. Complete work shall be carried out conforming to the provisions of Indian Electricity Act and relevant Indian standard Specifications (ISS).
4. On completion of works, as built drawings for complete installation shall be prepared by the contractor and 5 copies of the same shall be submitted to GIFT.
5. All the design drawings, calculation sheets and bill of quantities for the works shall be prepared by the contractor, and approval shall be taken from client.
6. Location of distribution boards, switchboards, light fittings, cable routes, raceways & junction boxes, conduit wiring routes, earth pits etc. shall be as per approved GFC drawing & marked at site and approval of Engineer-in-charge obtained before proceeding with the installation work.
7. List of documents to be submitted after Award of Contract.

Following sets of drawings shall be submitted for approval before procurement, fabrication and Installation of equipments at site.

|     |   |
|-----|---|
| 1.0 | 415V Distribution Boards for Lighting & power, UPS & Raw Power, Land scape and lighting power, External Lighting DB, etc.   |
| a.  | Dimensional layout drawing  |
| b.  | Complete assembly drawings of the switchboard/distribution board showing plan, elevation and typical sectional views and location of cable boxes and control cable terminal blocks for external wiring connections, etc.  |
| c.  | Foundation plan showing the location of channel sills, foundation, anchor bolts and anchors, floor plans and openings.  |
| d.  | Schematic power and control wiring diagrams with control, interlocks, instruments, starters with Bi-metallic relay ratings and contactor ratings, timer, busbar fault level & rating with material etc.   |
| 2.0 | Earthing and Lightning Protection System.   |
| 3.0 | Lighting system includes Indoor Lighting Fixtures with necessary accessories, Outdoor/Landscape lighting fixtures with necessary accessories, Street lighting, Bollard Lighting, Post-top lanterns, Gate lighting, Façade lighting, Conduiting, Point wiring, Lighting control switches, Receptacle Units/Socket Outlets. |
| 4.0 | Cable carrier system.   |
| 5.0 | Raceway layout with necessary junction boxes of required size.  |
| 6.0 | 1.1 kV power cable laying layout  |
| 7.0 | 2 Way Weather Proof, Outdoor Junction Boxes with necessary terminal and fuse/MCB for Landscape Lighting with IP rating  |
| 8.0 | Overall power distribution of North Entrance, office, Landscape & outdoor lighting, Access control & IT rack.   |
| 9.0 | Total MEP work planning layout marking all the MEP services and items   |

#### 4. **Contractor's / Bidder's Responsibility**

- a. Detailed engineering: load calculation, voltage drop calculation, lux level calculation, SLD, shop drawings.
- b. Obtain Client's approval for all drawings, make, materials prior to procurement.
- c. Supply all materials, labor, tools, testing equipment, consumables, etc.

- d. Execute the work as per approved drawings, standard practices & codes and client's instructions.
- e. Testing & commissioning, training to the end user, submission of O&M manuals, as-built drawings & warranty-guarantee certificates.
- f. Maintenance during Defects Liability Period from date of Taking Over.

## **5. CODES & STANDARDS**

All work shall comply with latest editions of:

- 1. IS:13947/BS:5486/IEC:60947 - Switchgear General Requirements
- 2. IS:8623/BS:5486/IEC:60439 - Factory Built Assemblies of SWGR and Control gear for Voltages upto and including 1000V AC & 1200V DC
- 3. IEC 61439 – Electrical Panels & DB
- 4. IS 2516 / IEC 60947-2/ BS EN 60947-2 - Moulded Case Circuit Breaker
- 5. IS:13703/BS:1362/IEC:60269-1 - Low voltage Fuses
- 6. IS:8828/BSEN:60898 - Miniature Circuit Breakers
- 7. IS:6875 / BSEN 60947 - Control Switches / Push buttons
- 8. IS:1248/BS:89/IEC:60051 - Indicating instruments
- 9. IS:11353/BS:159 - Marking and Identification of Conductors and Apparatus Terminals
- 10. IS:13947/IEC:60947 - Degree of Protection
- 11. IS:10118 - Selection, installation and maintenance of switchgear and Control gear
- 12. IS:613 - Specification for copper rods and bars for electrical purposes
- 13. IS 732 – Code of Practice for Electrical Wiring Installations
- 14. IS 3043 – Code of Practice for Earthing
- 15. IS 3646 – Code of Practice for Interior Illumination
- 16. IS 10322 – Luminaires – General Requirements & Tests

17. IS 14930 – DWC Pipes for Underground Cabling
  18. IS 2190 – Fire Extinguishers – Selection & Maintenance
  19. IS 12640 – RCCB/ELCB
  20. IS 456 – RCC Foundation Design
  21. IEC 62040 – UPS Systems
  22. NBC 2016, ECBC 2017 norms where applicable
  23. CEA Regulations, Local Electrical Inspectorate rules
  24. CPWD General Specifications for Electrical Works, Part-I, IV, V
- In case of conflict, more stringent requirements shall govern.

## **6. DETAIL TECHNICAL SPECIFICATION**

### **6.1 Distribution Boards (415V) for Lighting & power, Raw & UPS Power, Landscape – Street Light external Lighting DB.**

This section relates to specifications for supply of lighting distribution board (LDB) & Power distribution board (PDB) TPN/FP/DP/SP MCB isolator & ELMCB, earthing terminal, connector strip for phase neutral and earth for each circuit, CRCA sheet steel housing and complete the item supply. Common banking of neutral and earth conductor is not allowed.

There shall be separate indoor DB for office power and lighting requirements, separate DB for UPS power and separate external DB/panel for external Landscape and street lighting, Gate lighting, façade lighting, etc. Contractor shall prepare and submit the detail SLD for power arrangement for the works within 14 days after receiving LOI. If require LV panel for external electrical power and lighting circuit distribution, LV panel shall be as per the latest GIFT LT panel specifications.

#### **i. CODES & STANDARDS**

The Distribution Board shall comply with the latest edition of relevant Indian Standards and Indian Electricity Rules and Regulations. The following Indian standards shall be complied with:

| Sr. No. | Item   | Relevant IS        | Relevant IEC |
|---------|--|--------------------|--------------|
| 1.      | General requirements for switchgear and control gear for voltages not exceeding 1000 V AC or 1200 V DC | IS: 4237           | IEC 61439: 3 |
| 2.      | Switchgear bus bars, main connection and auxiliary wiring, marking and arrangement.                    | IS: 375            |              |
| 3.      | Terminal marking for electrical measuring instrument and their accessories.                            | IS: 8197           |              |
| 4.      | Miniature circuit breakers.  | IS: 8828           |              |
| 5.      | Lighting Distribution Board  | IS : 8623 part III |              |

## ii. Features of Construction

### General

- (a) Indoor Power & Lighting DB shall be wall mounted, IP43 with Metallic Double door with TPN MCCB as Incomer and SP, SPN, DP outgoings with RCCB for receptacle feeder, if required RCBO for socket and SPD Class-II min. 40KA as per approved



drawing designed by contractor. DB shall be constructed from minimum 2 mm CRCA sheet and shall be powder coated.

- (b) Outdoor Power and Lighting DB shall be with minimum IP 54 with Metallic double door and canopy structure with minimum 2 mm CRCA sheet and powder coated.
- (c) DB/panel shall be Epoxy Powder coated with paint shed RAL 7032. Din rails shall be provided for mounting of MCB/MCCB/RCCB as applicable.
- (d) DB/panel shall have copper Bus bars which shall be sized considering design ambient temperature of 50 Deg C. It shall be Electrolytic Cu. for rated full load + 25% spare load.
- (e) Panels shall have separate terminal strips for circuit neutrals and earth connection.
- (f) For termination of incomer and outgoing cables / wires adequate space shall be provided including proper clamping and dressing arrangements for cores. The bus bar Links shall be fork type, tin plated copper and shall have end caps. For 50 sq mm and above-size cable terminations entry terminals shall be used.
- (g) In case of Aluminum cables being terminated on tinned copper bus bar, the tinning shall withstand the temperature rise and aberration so as to avoid bi-metallic corrosion.
- (h) External Earthing stud shall be provided on both sides of panels.
- (i) Labeling: Circuit chart inside door, ferrules on cables, Danger notice.
- (j) Panels shall be wall mounted on metallic brackets, which shall be painted with anti-corrosive epoxy paint.
- (k) The MCBs shall be IP20 with current ratings and kA ratings as approved by EIC. For lighting circuits MCBs with Characteristic 'C' shall be used. For Power circuits MCBs with Characteristics "D" shall be used.
- (l) MCB shall have Label Holder, Combined head screws, and two positions Dole.
- (m) All MCCBs shall have extended Rotary Handle & Extension Links/Spreaders.
- (n) Current density for busbars shall be minimum  $0.7\text{A/mm}^2$ .
- (o) All identical equipment and corresponding parts shall be fully interchangeable without any modifications.
- (p) Busbar material shall be copper up to & including 100A and above 100A, it shall be Aluminium.
- (q) The neutral bus of the main 3 phase, 4 wire distribution board shall be rated not less

than 50% of the phase bus bars. The neutral bus of the 1 phase ways lighting panel shall be rated same as the phase busbars. The neutral bus should have sufficient terminals and detachable links for full number of single- phase outgoing lighting circuits.

- (r) Where a board has more than one switch gear, each such switch gear shall be marked to indicate which section of the installation it controls. The main switchgear shall also be suitably marked. Where there is more than one distribution board in the building, each such distribution board shall be marked to indicate which section of the installation and building it controls.
- (s) All distribution boards shall be marked 'lighting' or 'power' & essential lighting / power as the case may be and also marked with the Voltage and number of phases of the supply. Each distribution board shall be provided with a circuit list giving details of each circuit which it controls and the current rating of the circuit and size of the fuse element. All marking required must be clear and permanent.
- (t) All internal electrical connections shall be carried out using 1100 volt grade, FRLSZH insulated, Copper conductor of ISI approved make, having rated current carrying capacity to carry continuous full current of respective switch Fuse rating at operating conditions prevailing at the project site.
- (u) All non-current carrying metal surface of the DB's shall adequately be treated and painted.
- (v) The DB internals shall be earthed with use of Copper wires/strips running throughout the length. Size of the earthing strip/wire shall be shown in the respective approval drawing. The front plate and door shall also be earthed through earth wire.
- (w) The DB shall totally be enclosed and made dust, vermin and weatherproof such that it meets to IP43 / IP 54 protection classification for installation.

### **iii. Bus bars**

The phase and neutral busbars shall be of rating indicated in the corresponding single line diagram. Busbars shall be of copper/aluminium depends upon current rating and shall be provided with minimum clearances as specified.

All busbars and bus taps shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free, heat shrunk PVC insulation of high dielectric strength, to provide a permanent non-

ageing and non-tracking protection, impervious to water, tropical conditions and fungi. The insulation shall be non-inflammable and self-extinguishing type and in colours to indicate phases. The dielectric strength and properties shall hold good for the temperature range of 0 to 95 degree centigrade. If the insulating sleeve is not coloured, bus bars shall be colour coded with coloured PVC tape at suitable intervals.

Busbar joints shall be of the bolted type. Spring washers shall be provided to ensure good contact at the joints. Busbars shall be thoroughly cleaned at the joints and suitable contact grease shall be applied just before making a joint.

Direct access to, or accidental contact with busbars and primary connections shall not be possible. All apertures and slots shall be protected by baffles to prevent accidental shorting of busbars due to insertion of maintenance tools.

Sequence of red, yellow and blue phases and neutral for four-pole equipment shall be left to right and top to bottom, for horizontal and vertical layouts respectively.

#### **iv. Moulded Case Circuit Breaker (MCCB)**

- (a) MCCBs shall be of the air brake, quick make, quick break and trip free type and shall be totally enclosed in a heat resistant, moulded, insulating material housing. MCCBs shall have an ultimate short circuit capacity, not less than the short circuit current Specified. MCCBs shall have a service short circuit breaking capacity (ISC) equal to the ultimate short-circuit capacity ( $I_{CU}$ ).
- (b) Each pole of MCCB shall be fitted with a bi-metallic thermal element for inverse time delay protection and a magnetic element for short circuit protection. Alternatively, they shall be fitted with a solid-state protection system. Such a protection system shall be fully self-contained, needing no separate power supply to operate the circuit breaker tripping mechanism. Thermal element shall be adjustable. Adjustments shall be made simultaneously on all poles from a common facility. Thermal elements shall be ambient temperature compensated.
- (c) The MCCBs shall be provided with the following features:
  - (i) Common trip bar for simultaneous tripping of all poles
  - (ii) Shrouded terminals
  - (iii) Time for clearing short circuit current of 20 msec.

- (iv) 2 NO + 2 NC auxiliary contacts

**v. Miniature Circuit Breaker (MCB)**

- (a) MCB shall be hand operated, air break, quick make, quick break type. Operating mechanisms shall be mechanically trip-free from the operating knob to prevent the contacts being held closed under overload or short-circuit conditions.
  - (b) Each pole shall be fitted with a bi-metallic element for overload protection and a magnetic element for short-circuit protection. Multiple pole MCBs shall be mechanically linked such that tripping of one pole simultaneously trips all the other poles. The magnetic element tripping current classification shall be of the type suitable for the connected load. Where this is not specified, it shall be Type
- C. The short circuit rating shall be not less than that of the system to which they are connected.

**vi. Current & Voltage Transformers**

- (a) Current & Voltage Transformers shall be Cast Resin type.
- (b) Current transformers shall have polarity markings indelibly marked on each transformer and at the lead terminations at the associated terminal block.
- (c) Current transformers shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary duties of the switchgear, as indicated in the Technical Specification.
- (d) CT core laminations shall be of high-grade silicon steel.
- (e) Identification labels shall be fitted by giving type, ratio, rating, output and serial numbers.
- (f) Secondary and tertiary windings of voltage transformers shall be rated for a three-phase line to line voltage of 110 V.
- (g) It shall be possible to replace voltage transformer fuses easily without having to de-energize the main busbars.

**vii. Indicating Instruments & Meters**

Electrical indicating instruments shall be 110 mm square with 240° scale. Taut band type of instruments is preferred. Taut band moving coil instruments for use on AC systems shall incorporate built-in transducers. Instrument dials shall be white with black numbers and lettering. Normal maximum meter reading shall be of the order of 60 % normal full-scale deflection. Ammeters for motor feeders shall have suppressed scale to show current from full load up to six times the full load current. Watt hour meters shall be of the induction type and shall be provided with reverse running stops. Instruments shall have an accuracy of Class 1.0.

#### **viii. Indicating Lamps**

Indicating lamps shall be of the cluster LED type, with low watt consumption. Indicating lamps shall be of the double contact, bayonet cap type rated for operation at either 240 V AC or at the specified DC system voltage as applicable. Lamps shall be provided with translucent lamp covers. Bulbs and lenses shall be interchangeable and easily replaceable from the front.

#### **ix. Safety Arrangements**

All terminals, connections and other components, which may be “live” when front access door is open, shall be adequately screened. It shall not be possible to obtain access to an adjacent cubicle or module when any door is opened. Components within the cubicles shall be labelled to facilitate testing.

#### **x. Power and Control Cable Terminations**

- (i) Equipment terminal blocks for power connections shall be complete with adequate phase segregating insulating barriers, shrouds and suitable crimping type of lugs for terminating the cables. Double compression type cable glands shall be provided for all power and control cables.

- (ii) Earthing connectors between cable armour and earth shall be routed outside the cable gland in an approved manner. Gland insulation shall be capable of withstanding a high voltage test of 3000 V for one minute.

#### **xi. Wiring for Control and Protective Circuits**

- (iii) All wiring for control, protection and indication circuits shall be carried out with 650 V grade, PVC insulated cable with stranded, tinned copper conductor of minimum 1.5 sq. mm size. The size of conductor for CT circuits shall be minimum 2.5 sq. mm.
- (iv) All wiring shall be run on the sides of panels and shall be neatly bunched and cleated without affecting access to equipment mounted in the panel. All wiring shall be taken to terminal blocks without joints or tees in their runs.
- (v) All wiring shall be colour coded as given below.

Instrument Transformer: Red, Yellow or Blue determined by the Circuit phase with which the wire is associated

AC phase wire: White

AC neutral: Black

DC circuits: Grey

Earth connections: Green

- (i) Engraved core identification ferrules, marked to correspond with the wiring diagram, shall be fitted to each wire and each core of multicore cables terminated on the panels. Ferrules shall fit tightly on wires, without falling off when the wire is removed. Ferrules shall be of yellow colour with black lettering.
- (ii) All wires forming part of a tripping circuit shall be provided with an additional red ferrule marked 'T'. Each wire shall be identified by a letter to denote its function followed by a number to denote its identity, at both ends. Unused core of multicore cables shall be ferruled U1, U2 etc., at both ends, and connected to spare terminals.
- (iii) Spare auxiliary contacts of electrical equipment shall be wired to terminal blocks.

#### **xii. Control Wiring Terminal Blocks**

- (i) Terminal blocks shall be of the 650 V grade and stud type. Brass stud of at least 6 mm dia. with fine threads shall be used and securely locked within the mounting base to prevent turning. Each terminal shall comprise two threaded studs, with a link between them, washers, and matching nuts and locknuts for each stud. Connections to the terminals shall be at the front.
- (ii) Terminals shall be numbered for identification, grouped according to function. Engraved 'black on-white' labels shall be provided on the terminal blocks describing the function of the circuit.
- (iii) Terminals for circuits with voltage exceeding 110 V shall be shrouded. Terminal blocks at different voltages shall be segregated into groups and distinctively labelled.

- (iv) Terminals used for connecting current transformer secondary leads shall be ‘disconnecting and shorting’ type with a facility grounding the secondary.
- (v) Terminal blocks shall be arranged with 100 mm clearance, between any two sets.
- (vi) Separate terminal stems shall be provided for internal and external wiring respectively.
- (vii) All wiring shall be terminated on terminal blocks, using crimping type lugs or claw type of terminations.

### **xiii. Test Terminal Blocks**

- (i) Test terminal blocks, if any, shall be provided for secondary injection and testing of relays. A suitable metering block shall be provided where specified for the connection of a portable precision instrument to be operated when required for specific plant testing purposes.

### **(viii) Internal Wiring**

The internal wiring shall be carried out with 1100V grade, FRLSZH PVC insulated, stranded conductor wires. The minimum size of conductor for power circuits shall be 2.5 Sq.mm copper conductor. The minimum size of conductor for lighting circuits shall be 1.5 Sq.mm copper conductor. Control circuits shall be wired with copper conductor of at least 2.5 Sq.mm. All the wiring drawings shall be approved from the client before the installation work.

### **xiv. Earthing of Switchboards/DB/Panels**

- i. Each switchboard, DB, control panel, etc. shall be provided with an earth busbar running along its entire length. The earth busbar shall be located at the bottom of the board/panel.
- ii. Earth busbars shall be of copper and shall be rated to carry the rated symmetrical short circuit current of the associated board/panel for one second, unless otherwise specified. Earth busbars shall be properly supported to withstand stresses induced by the momentary short circuit current of value equal to the momentary short circuit rating of the associated switchboard/panel.
- iii. Positive connection of the frames of all the equipment mounted in the switchboard to the earth busbar shall be maintained through insulated conductors of size equal to the earth busbar or the load current carrying conductor, whichever is smaller.
- iv. All instrument and relay cases shall be connected to earth busbar by means of 650 V grade, green coloured, PVC insulated, stranded, tinned copper, 2.5 sq. mm conductor looped through the case earth terminals.

## 6.2 1.1kV Power and Control Cables & its Installation

All the cables required for the work shall be included in the scope of work. Cables required for the supply of DB, Panels, equipment power arrangement shall be included in the scope. Incoming power cable from the nearest source of GIFT PCL is included in the scope of work. Cable required for external lighting, façade lighting, Gate lighting, Access control system and any MEP equipment shall be in scope of bidder.

### 6.2.1 Applicable Standards

The cables shall conform to the latest applicable standards specified below.

|  |           |
|--|-----------|
| PVC insulated cables<br>(for voltage up to 1100 V)       | IS:694    |
| HRPVC & PVC insulated cables:                            | IS:1554   |
| Heavy-duty Cross-linked polyethylene insulated:          | IS: 7098  |
| PVC sheathed cables Low frequency cables and wires with: | IEC:60189 |
| PVC insulation and sheath                                | IEC-60189 |
| PVC insulation and sheath of electric cable:             | IS: 5831  |
| Polyethylene insulation and sheath for: electric cables  | IS:6474   |
| Conductors for insulated electric cables:                | IS:8130   |
| Methods of test for cables:                              | IS:10810  |
| Specification for drums of electric cables:              | IS:10418  |
| Specification for PVC insulated cables:                  | BS:634    |
| Specification for PVC insulation and Sheath:             | BS:674    |



### 6.2.2 Features of Construction

(a) LT Power Cables

(i) PVC Insulated Cables:

The Cables shall be 1.1 KV Grade, heavy duty, Stranded Copper Conductor, FRLSZH PVC Compound insulated, PVC Tape inner sheathed, galvanized steel wire /strip armoured, black FRLSZH PVC compound outer sheathed.

(ii) XLPE Insulated Cables:

The Cable shall be 1.1 KV Grade, heavy duty, stranded Copper Conductor, XLPE insulated, Extruded PVC inner sheathed, galvanized steel wire / strip armoured, Extruded black FRLS PVC Compound outer sheathed.

(b) Control Cables:

The Cables shall be 1.1 KV grade, heavy duty, stranded copper conductor, FRLSZH PVC Compound Insulated, galvanized steel wire/ strip armoured extruded FRLSZH PVC outer sheathed.

### 6.2.3 Cable Rating

The Contractor shall ensure that cable and wires associated with the distribution and control systems, wiring and all other installations throughout the Works are adequately rated for their use.

In assessing the rating of any cable or wire, the following factors shall be considered:

- Supply voltage and frequency
- Maximum voltage drops permissible
- Type and magnitude of load
- Fault level and duration related to circuit protection relays and fuses
- Circuit Overcurrent protection
- Route length and disposition of cables

- Ambient temperature
- Method of installation

All the cable selection shall be approved by the EIC before installation. Contractor shall provide details of a cable selection design sheet with voltage drop calculation.

All power cables shall be sized for continuous current carrying capacity at an ambient temperature of 50°C. The design current of any circuit shall exceed the full load current of the supplied device by at least 10%. Power cables shall be sized to limit the maximum voltage drop to no more than 3 %.

Under motor starting conditions the corresponding voltage drop shall not affect the operation of the motor controls or the ability of the motor to start and run effectively and in any event shall not exceed 10%. The Contractor when sizing cables for the remote operation of shunt trip coils shall take due account of the voltage drop caused by the momentary current surge taken at the instant of energization. LV cables shall be sized for a fault clearance time of 0.5 seconds for the incoming feeders and 0.16 seconds for switchboard feeders controlled by circuit breaker.

#### **6.2.4 Cable Colours**

All cable cores shall be colour coded throughout their length and shall be so connected between switchboard, distribution board, plant and accessories, that the correct sequence or phase colours are preserved throughout the system.

The colour coding should be as follows:

- 3 Phase – Red, Yellow and Blue
- Single Phase or DC – Red and Black
- Earth – Green/Yellow
- Control – Blue (DC), Red (AC)

#### **6.2.5 Cable Conductors**

Copper conductors shall be used for cables of sizes up to 16 Sqmm. Aluminium conductors can be used for cables of size above 16 sqmm. Cores of cross-sectional areas greater than 1.5 mm<sup>2</sup> shall be stranded. Lighting and Power final distribution circuits shall be of a minimum cross-section of 2.5 mm<sup>2</sup>.

#### 6.2.6 Cable Numbering

All cables shall be allocated a unique number which shall be fixed to each end of the cable using a corrosion resistant label. Cables of different categories shall be tagged with the following subscripts and three digit numbers.

|                 |          |
|-----------------|----------|
| LV power        | P _ _ _  |
| Control         | C _ _ _  |
| Instrumentation | I _ _ _  |
| Protection      | PR _ _ _ |

#### 6.2.7 Cable Drums

Cables shall be supplied in non-returnable wooden drums. The wood used for construction of the drum shall be properly seasoned and free from defects and wood preservative shall be applied to the entire drum. All ferrous parts shall be treated with a suitable rust preventive coating to avoid rusting during transit or storage.

The Bidder shall indicate in the offer the maximum length for each size of cable, which can be supplied on one drum. The actual length supplied on each drum shall be within tolerance limit of 5% without any tolerance on total ordered quantity of each size of cable. However, before winding the cables on drums. Contractor shall obtain Employer's approval for the drum lengths.

Each drum or coil of cable shall be accompanied by a certificate stating the manufacturer's name, cable size, number of cores, length, result and date of tests as required in the Employer's Requirements. Cables manufactured more than 12 months before delivery will not be accepted. All cables shall be delivered with cable ends effectively sealed by hygroscopic sealing caps. When a cable is cut from a drum both ends shall be immediately sealed to prevent ingress of moisture. Cables shall not be transported to site in loose coils but a number of short lengths of cable may be transported on the same drum. The Contractor shall

be wholly responsible for the purchase and/or hire costs of all cable drums and for the removal of these drums from site after use.

### 6.2.8 Cable Installation

#### (a) General

Cables shall be installed in such a way that the minimum bending radii are not reduced when installed or during installation. Cables shall not be installed in ambient temperatures below that recommended by the cable manufacturer.

Cables grouped together shall have insulation capable of withstanding the highest voltage present in the group.

Cables of different categories shall be installed so as to maintain satisfactory clearances for safety and in order to reduce the possibility of electrical interference. The following Table details the distances in mm that shall be maintained between the different categories of cable.

Table of Separation Distances in mm between different Categories of Cable

| <b>Cable Category</b> | <b>HV Power</b> | <b>LV Power</b> | <b>C&amp;I/Protection</b> |
|-----------------------|-----------------|-----------------|---------------------------|
| HV Power              | N/A             | 300             | 500                       |
| LV Power              | 300             | N/A             | 300                       |
| C&I/Protection        | 500             | 300             | N/A                       |

These separations are minimum and special circumstances such as the presence of high current flows, or harmonic content may necessitate larger separation distances.

In order to make economic use of the cable support system, cables shall be arranged in groups of 50 mm maximum overall diameter. These groups shall be securely tied to the cable support system at intervals not exceeding 900 mm for horizontal runs and 300 mm intervals on vertical runs.

Cables shall be laid in a manner such that any electrical interference between cables shall not have a detrimental effect on the life and operation.

Where practical a separate cable support system shall be provided for power and non-power cables. Where this is not practical a separation of 150 mm shall be maintained between power and non-power cables when run on the same support system.

Heavy duty galvanised iron cable tray and ladder racking shall be used for cable support systems. These systems shall be used to route cables around walls and within cable trenches. Cables shall be securely fixed to the support systems. Bundling of cables shall be permitted where allowance for this practice has been made in sizing the cables.

(b) Cables Laid Direct in Ground

Buried cable up to 1100 V shall have a minimum cover of 500 mm measured to the top of the highest cable. On crossing roadways, the cable shall be run through a Hume Pipe of minimum diameter 100 mm with a minimum of 1000 mm cover and encased on all sides by 150 mm of concrete.

Cables of greater than 650/1100 V shall be buried with a minimum cover of 1 m. After cable laying 75 mm of sieved sand shall be laid above the cable.

Interlocking cable protective covers, minimum 1 m long x 300 mm wide, marked

'Danger -Electric Cable' in English and the vernacular shall be laid on top of the sieved sand.

Half RCC pipe is to be placed on cable for protection of cable as protective covers. Warning tape shall be laid a minimum of 200 mm above the protective covers.

Cables are to be installed without tees or through joints unless otherwise approved by the Engineer. Single core cables shall be run in trefoil formation.

(c) Cables installed in Conduit

(i) General

Conduits shall be galvanised heavy gauge solid drawn or welded screwed steel type and be in accordance with IS 9537 Part 2 or BS 4568 or DWC pipe as approved by EIC.

Accessories shall either be malleable cast iron screwed type or pressed steel and galvanized.

A space factor of 40% shall not be exceeded, but in any case conduit of less than 20 mm diameter shall not be permitted. The tubing shall be perfectly smooth inside and out and free from flaws and imperfections of any kind. Both ends of every length of tubing shall be properly reamed with all sharp edges removed before erection.

Where a number of conduits converge, malleable cast iron or heavy gauge sheet steel adaptable boxes shall be employed in order to avoid crossings. Conduits shall be connected by means of male brass bushes and couplings.

Where conduits are greater than 25 mm, straight through joint boxes shall be of the trough type. Where conduit and/or fittings are attached to equipment casings, the material or case of the casing shall be tapped for a depth of not less than 10 mm or male bushes and flanged couplings shall be used.

Heavy hexagonal lock nuts shall be used at all positions where running joints are required and great care shall be taken to ensure that they seat firmly and evenly on to the mating faces of coupling or other adjacent accessories. All junction boxes, draw-in boxes, and inspection fittings, shall be so placed that the cables can be inspected and, if necessary, withdrawn and re-wired throughout the life of the installation.

Generally not more than two bends or offsets or one coupling will be permitted without a suitable inspection accessory. Fish wires shall not be left in conduits after erection. The whole of the installation shall be arranged for a loop-in type of system with joints being carried out at switches, isolators, etc. Intermediate joints in the cable will only be allowed by arrangement with the Engineer. Where terminal blocks are necessary, they shall be of the porcelain type with brass pinching screws.

Ends of conduits which are liable to be left open for any length of time during building operations shall be plugged to prevent the ingress of dirt, cement, etc. and covers, either temporary or permanent, shall be fitted on all boxes.

Generally, conduits shall not cross expansion joints of buildings, but where they cannot be installed in any other manner then a flexible conduit shall be used across the expansion joint. A total 150 mm movement shall be allowed.

(ii) Surface Installation

Surface conduits shall be secured and fixed by means of distance spacing saddles or approved purpose made clips which allow the conduits to be taken directly into accessories without sets or bends. Conduits shall be run in a square and symmetrical manner. An efficient means shall be adopted to provide for the drainage of condensation and the runs shall be properly ventilated. All surface conduit runs shall be marked out for approval by the Engineer before the installation is carried out. Where large multiple parallel conduit runs would occur, use may be made of galvanised cable trunking. Conduits installed on structural steelwork shall be secured at spacings not exceeding those for surface conduit by girder clips, otherwise fixing shall be as for surface conduits on walls, drilled and tapped to the metalwork. Power driven fixings shall only be used with the express permission of the Engineer. Any drilling or access which is required through any structural member of the building shall be agreed with the Engineer before carrying out the work.

Exposed threads and places where galvanising has been damaged shall then be painted with two coats of an approved metallic zinc based paint. This treatment shall be applied as the work proceeds.

(iii) Concealed Installation

Concealed conduits shall be securely fixed to prevent movement before laying of screeds, floating of plaster, casting of columns or other building operations necessary after the conduit installation. Crampets or similar fixings shall be used for attaching the conduit to blockwork, etc. Building nails will not be accepted.

At least 15 mm cover shall be allowed for finishes over the conduit. Where this cover cannot be maintained then expanded metal shall be fitted with the conduit. Conduit cast into reinforced concrete floors shall be fixed to the steel reinforcing with binding wire and the conduit boxes filled with expanded polystyrene or enclosed in a plastic bag to prevent the ingress of concrete when poured. Where possible, the conduit boxes shall be fixed to shuttering to give a flush finish.

Conduit installed in voids, false ceilings, and other concealed routes shall be installed as specified for the surface conduits. Wiring shall be carried out after the false

ceiling or permanent ducts have been completed. Conduit installed in floors shall be sealed against ingress of moisture.

The conduit installation shall be inspected by the Engineer before the building operation conceals the work.

(d) Cable Installed on Cable Tray

If required cable laying on cable tray, Cable tray shall be of perforated sheet steel with formed flanges and of minimum thickness not less than 1 mm for trays up to 100 mm width, not less than 1.25 mm for trays from 100 mm to 150 mm width and not less than 1.5 mm for trays from 150 mm to 300 mm width.

Cable tray shall be hot dipped galvanised. Cable tray supports shall be of a compatible finish with the associated cable tray.

All cable tray tees, intersection units, bends, turns and sets shall, whenever possible, be purpose made by the manufacturer and shall be of a matching design to the main section of cable tray.

Tray shall only be joined by couplers supplied by the manufacturers. The joint shall be secured in accordance with the manufacturer's instructions.

Cable tray supports supplied by a manufacturer or made up on Site shall be of ample strength to maintain rigid support to the fully laden cable tray along its entire length and shall ensure that the deflection of any one section does not exceed 15 mm at midspan.

Wherever possible, cable trays shall be installed in full length without cutting. Should it be necessary to cut or drill the length of tray, then for galvanised trays, the bared ends or damaged section of the tray shall immediately be given a coat of zinc rich cold galvanised paint. All site manufactured accessories, supports and metal fittings required to ensure correct installation of the cable trays shall be similarly treated.

All cables shall be firmly secured to the tray using purpose made saddles, as approved by the Engineer, together with proprietary nylon fasteners and/or cable cleats. Following installation of cables, the tray shall remain rigidly supported and the deflection of any section shall not exceed 15 mm at midspan. All brackets and tray work shall be suitable for withstanding a temporary weight of 125 kg.



Cable trays shall not be cut to allow the passage of cables through the surfaces of the tray.

The sizing of the cable tray shall provide a minimum of 25% spare capacity.

The tray shall be run at least 150 mm clear of plumbing and mechanical services.

(e) Cable Installed on Ladder Rack Systems

If require, Ladder racking either light or heavy weight shall be proprietary item and installed in accordance with manufacturer's instructions. Bends in the installation shall take account of the minimum bending radii of cables to be installed.

Cables shall be clipped to the ladder rack using clips designed for the system in use and appropriate to the type and size of cable installed. The sizing of the cable rack system shall provide a minimum of 25% spare capacity. The ladder racking shall be run at least 150 mm clear of plumbing and mechanical services.

(f) Cable Clipped Direct

All cable hangers, clips, cleats and saddles shall be of an approved type and appropriate to the type and size of cable installed.

Their spacing shall be such as to ensure a neat appearance and prevent sagging of the cables at all times during their installed life.

(g) Cables/Wires Installed in Internal Floor Trunking (Raceway)

General

Trunking and fittings shall comply with a 1.6 mm thick Aluminium sheet. Trunking shall be top accessed. Inverted trunking is acceptable only by prior approval of client.

Trunking shall be manufactured using anodized aluminum sheet. The trunking shall normally be supplied in 2500/3000mm lengths with a material thickness of 1.6mm. Lengths of trunking, shall be coupled together by means of joint sleeves, made of anodize aluminum of same manufacturer.

Manufacturer's standard fittings shall be used for all connections and changes of direction. Trunking shall not be cut or bent to form bends, flanges or attachments. Gusset bends shall be used wherever necessary to provide sufficient bending radius for the cables. Site fabricated items shall not be accepted. Separate raceways shall be used for Power, data and telecom cables.

All inside edges of trunking shall be smooth and provision shall be made to prevent abrasion at bends.

Cable retaining straps supplied by the trunking manufacturer shall be fitted at intervals not exceeding 1m. Where trunking passes through walls, floors proprietary fire barriers shall be installed in the trunking. The fire barrier shall have a rating not less than that of the original construction of the opening.

Trunking shall be adequately supported throughout its length. Trunking support and channel shall be quick-fixing type and shall be such as to space the trunking a minimum of 13mm from any part of the wall or bulkhead.

A minimum of two fixings shall be provided between joints in the trunking except where the distance between is less than the maximum spacing.

Where trunking is cut or drilled, the cut edges of the trunking shall be smoothed to prevent abrasion of the cables/Wires and shall be painted with anti-corrosion paint like aluminium coating, to the same colour as the adjacent surfaces, such painting to be carried out as the work proceeds. In no circumstances will rough screw edges and nuts be allowed in the interior of the trunking.

Flush or buried trunking and under floor metal ducts shall comply with BS 2989.

(h) Junction Boxes

Junction boxes are made of very high-quality materials to withstand heavy load and corrosion, manufactured from high-pressure die cast material for strength & durability.

The trap lid is self-adjustable to any floor finish thickness using the levelling screws on all the four corners. The trap cover is made of 2.0mm thick stainless-steel plate to provide rigidity & added strength. The Trap covers to have flexibility for quick mounting on to the base box requiring minimum maintenance.

The trap cover screws must be made from Stainless Steel for extra protection. The complete system must have excellent protection against rust.

The one-piece base frame design ensures minimum openings to prevent concrete seepage into the box during casting of concrete or screeding.

For the junction boxes coming in the passages shall have SS cover while junction boxes in the other areas (under workstation etc.) shall be provided with finish as per interior requirements.

Standards & Approvals – The system must comply with the relevant specification & IEC 61084 standards.

### **6.2.9 Cable Terminations and Joints**

#### **(a) Multi core or Control Cable Terminations**

A sufficient number of terminals shall be provided to terminate all cable cores. For control and auxiliary wiring an additional 20% of this number shall be provided as spares.

Not more than one core of internal or external wiring shall be connected on any one terminal. Where duplication of terminal blocks is necessary, purpose-made solid links shall be incorporated in the design of the terminal blocks.

Terminals which remain energised when the main equipment is isolated shall be suitably screened and labelled. Terminal blocks for different voltages or circuit type shall be segregated into groups and distinctively labelled.

#### **(b) Cable Fixings**

Ties and strapping shall be suitable for securing cable and cable groups to cable tray or ladder. They shall be resistant to chemical and marine corrosion. Plastic coated metal ties used in order to obtain corrosion resistance shall not be acceptable. Nylon ties shall be resistant to the effects of ultra-violet light and shall be self-extinguishing.

Large single cables shall be secured with cable clamps or cable cleats.

#### **(c) Cable Identification**

At each end of each cable, in a uniform and visible position a label shall be fixed on the cable in accordance with the cable schedule. Labels shall be made of PVC and shall be indelibly marked to the approval of the Engineer. The label shall be retained using proprietary

nylon strips passing through two fixing holes at either end of the label. If the cable gland is not normally visible, then the label shall be fixed inside the panel by means of screws.

(d) Cable Glands

Glands shall generally be of the mechanical compression hexagon type double compression glands. Earth continuity of brass glands shall be assured. This may be achieved by the rigid clamping of the armour within the gland and the intimate contact between the threaded components of the gland and the equipment. Each gland shall be installed complete with proprietary earth tag providing a ready means of connecting a flexible strand or strip earth bond to the gland at any position around the gland in relation to the associated apparatus. Adequate earth continuity shall be assured between the earth tag, the gland and the armour wires of the cable where applicable.

Glands for single core cables shall be constructed from non-magnetic materials.

Each gland shall be installed complete with a proprietary non-ferrous lock-nut to secure the gland body to the equipment where the entry hole is plain, i.e. not tapped.

Where holes for cable entries are not provided it shall be the responsibility of the Contractor to mark out and drill such holes. Burrs and swarf shall be removed, care being taken to ensure that swarf and filings, etc do not enter the equipment.

For non-hazardous areas cable glands in situations where moisture may be present shall be double seal weatherproof type, gland shrouds shall be used and entry shall be sealed.

For dry indoor situations, standard industrial glands with shrouds are acceptable.

For hazardous areas, glands used shall be used with double seal and shroud.

Power cable glanding arrangements in hazardous areas shall incorporate an insulated adapter and earth link. This shall provide the facility to disconnect the armouring from the glanded device in order that a true earth loop value may be measured when carrying out tests on the installation.

(e) Marking Locations of Underground Cables

The location of all underground cables shall be engraved on brass or other non- corrodible plates to be fixed to the exterior surface of all walls of buildings 300mm above ground level and directly above the point where cables pass through the wall.

In addition, concrete marker posts shall be installed at intervals of not more than

50 m at all junctions and changes of direction along the cable route. Such marker posts shall be not less than 200 mm high and of substantial construction. A drawing or sample of a typical marker post shall be submitted for the approval of the Engineer. The markers shall be marked 'electric cable' in English and the vernacular.

#### **6.2.10 Cable Racks and Trays**

- (a) Typical cable tray arrangements / trench arrangements / directly buried cable arrangements etc. are as per approved drawing prepared by contractor.
- (b) Cable racks/trays shall be fabricated from standard structural steel members as approved by EIC.
- (c) All cable trays, vertical raceways, cable racks and cable tray supporting structures shall be hot dip galvanized.

### **6.3 TECHNICAL SPECIFICATIONS FOR DWC PIPE**

Providing, supplying and Fixing Corrugated DWC Pipes of Class SN7 Structured Wall polyethylene Piping systems (Pipe with online/offline coupler and elastomeric sealing ring) with non-smooth External Annular Corrugated and Smooth Internal Surfaces (Double Wall) for non-pressure underground Sewerage & Drainage application as per EN:13476-3 including all local and central taxes, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to the departmental stores etc. complete. Including Lowering, laying and jointing of class SN 7 structured wall ( External Annular Corrugated & Smooth Internal surface) Polyethylene Piping and fittings with the help of coupler ( on line / off line ) attached with one end of pipes, sliding over the

elastomeric sealing rubber ring placed on the specified valley of the corrugation at the spigot end, lowering the same into the trench, laying on the lower bedding (constructed at bottom of trenches) at prescribed gradient, depth& alignment ,testing the water tightness of the joints, ensuring the continuity tests of specified pipe segments etc. complete as per drawing, specifications& detailed engineering, including carriage of pipes & fittings from site stacks to the place of laying etc. as per direction of Engineer-in-charge.

### 6.3.1 Scope

This specification covers the requirements for manufacturing, supplying, transportation, handling, stacking, installation, jointing, and testing of Class SN 7 Structured Double Wall (Non-Smooth External Annular Corrugated wall & Smooth Internal wall) Polyethylene/Polypropylene Piping System for Electrical cable laying.

### 6.3.2 Applicable Codes

The manufacturing, testing at factory, supplying, transportation, handling, stacking, installation, jointing, and testing at sites shall comply with all currently applicable National statutes, standards & codes. If requirements of these specifications are at variance with any other standards, this particular document shall supersede.

|                        |   |
|------------------------|---|
| IS 16098(Part 2): 2013 | Part 2: Pipes and fittings with non-smooth external surface, Type B |
| ISO 9001: 2008         | Quality Management Systems  |

Other Indian standards which are integral part of above standard as normative references form a significant portion of this specification document.

### 6.3.3 Manufacturing

The DWC Piping System of stiffness class designation SN 7 shall confirm to the Indian standards as mentioned above and shall be configured as per the indicative Cross-sectional & Profile Drawings (Annexure A & B) annexed herewith. Each pipe shall be Socket (On-line or Off-line

Coupler) and spigot type along with elastomeric rubber sealing ring (as designated under Clause 8.3 of above specifications).

#### **6.3.4 Transportation**

The arrangement of loading the pipes in a telescopic manner is advised, i.e. smaller diameters inserted into the next higher sizes of pipes. While loading the pipes onto the truck, care should be taken that the coupler- end should be arranged alternatively in the corresponding layers so as to avoid the damage to the coupler/ socket ends.

#### **6.3.5 Handling**

Following Recommendations shall be followed while handling the pipes:

- Adherence to National Safety requirements Pipes to be smoothly lowered to the ground
- Pipes should not be dragged against the ground to avoid the damages to the Coupler/pipes.
- For smaller diameters one lift point shall be sufficient & can be handled either manually or mechanically
- Do not use a loading Boom or Forklift directly on or inside pipe.

### **6.4 ERECTION, TESTING & COMMISSIONING OF ELECTRICAL INSTALLATIONS**

#### **6.4.1 Scope Of Work**

The intent of this specification is to define the requirements for the installation, testing and commissioning of the electrical system like L.T. panels/DB, Cables, earthing network, Internal and External lighting, Light fixtures, electrical wiring, etc.

#### **6.4.2 Standards**

The work shall be carried out in the best workman like manner in conformity with this specification, the relevant specification / codes of practice of the Indian Standards Institution, approved drawings and the instructions issued by the authorized representative, from time to time. Some of the relevant Indian Standards are listed elsewhere in this tender document.

In addition to the standards mentioned in 2.1, all works shall also conform to the requirements of the following:

- Indian Electricity Act and Rules framed thereunder.
- Fire Insurance Regulations.
- Regulations laid down by the CEI of the State / GIFT PCL.
- Regulations laid down by the State Factory Inspector.
- Any other regulations laid down by the local authorities.
- Installation & operation manuals of manufacturers of equipment.

#### **6.4.3 Material Procurement & Storage**

The contractor shall procure the material on time before installation to avoid any delay in work execution. Prior material approval shall be planned by contractor with respect to material procurement schedule. The contractor shall make his own arrangement for safe transportation of all the items to the erection site and also carry out complete loading / unloading during transportation. Equipment shall not be removed from packing cases unless the floor has been made ready for installing them. The cases shall be opened in presence of the client or his authorized representative. The empty packing cases shall be returned to the stores and any document if found with the equipment shall be handed over to the client's representative. Any damage or shortage noticed shall be reported to the client / consultant in writing immediately after opening of packing cases.

#### **6.4.4 DISTRIBUTION BOARDS Erection & Testing**

- Electrical panels/DB shall be delivered in convenient shipping packing by the manufacturer. The contractor shall make his own arrangement for safe transportation of all the items to the erection site and also carry out complete loading / unloading during transportation. The contractor shall be



responsible for final assembly and interconnection of busbars / switchgears/ wiring. Switchgear shall be aligned and levelled on their base channels. Loosely supplied instruments shall be mounted and connected on the switchgear/DB.

- After erection, the switchboard/DB shall be inspected for dust and vermin proof. Any hole which might allow dust or vermin etc. to enter the DB shall be plugged suitably at no extra cost. The contractor shall fix the cable glands appropriately.
- Proper procedure shall be carried out to start and test the panel/DB. The panels shall be checked for all electrical parameters, and proper earthing shall be done.
- All cables shall be dressed properly and shall be terminated from top/bottom as required complete with cable gland and lugs. The gland plate shall be properly closed with required gaskets.
- The panels shall be erected on the floor/wall inside room or external as required.
- Before electrical panel is energised, the insulation resistance of each bus shall be measured from phase to ground. Measurement shall be repeated with circuit breakers in operating positions and contacts open.
- Before switchgear is energised, the insulation resistance of all control circuits shall be measured from line to ground.
- The following tests shall be performed on all circuit breakers during erection.
- All adjustable direct acting trip devices shall be set using values given by the consultant/ manufacturer.
- Before switchgear is energised, the following tests shall be performed on each circuit breaker in its test position.
- Close and trip the circuit breaker from its local control switch push button or operating handle or manually. Switchgear control bus may be energised to permit test operation of circuit breaker with A.C. closing with prior permission of the client / consultant.
- Test tripping of the electrically operated circuit breaker by operating mechanical trip device.
- Trip breaker either manually or by applying current or voltage to each of its associated protective release.

- Before switchgear is energised, the tests covered above shall be repeated with each breaker in its normal operating position.

#### **6.4.5 Concealed / Surface Conduit Works**

##### **LAYING OF CONDUITS**

Conduits shall be laid before casting in the upper portion of a slab / in PCC if below flooring or otherwise, as may be instructed in accordance with approved drawings, so as to conceal the entire run of conduits and ceiling outlet boxes. Conduits shall be so laid that they are interconnected. This is required to facilitate pulling of wires from different openings in case of any of the outlet is outlet is blocked during slab casting. Vertical drops shall be cut by the contractor to sufficient depth to allow full thickness of plaster over conduits. The width of the chases will be made to accommodate the required number of conduits. The chases will be filled with cement, coarse after installation of wire chickenmesh.

1. When the conduit is to be embedded in a concrete member it shall be adequately tied to the reinforcement to prevent displacement during casting. Tie wire to be supplied by the contractor.
2. Cutting of chases in any RCC member / finished floor / already finished surface is not allowed unless prior approval of Site Engineer is taken in site instruction book. If a chases is cut in an already finished surface, the contractor shall fill the chases and finish it to match the existing finish including painting at his cost to Site Engineer's satisfaction.
3. Contractor shall not cut any iron bars to fix the conduits. Puncher of wooden / steel shuttering for RCC slab / beams / column etc. for conduit work is also not allowed, unless Site Engineer permits in site instruction book under special conditions.
4. Run of conduit pipe through expansion joints in RCC members should be avoided as far as possible and if unavoidable, flexible metal corrugated conduit pipe should be used with ceiling outlet box on both sides of expansion joints with prior approval.
5. Conduit on surface of RCC walls / RCC members shall be avoided as far as possible and if unavoidable prior approval of Site Engineer on sample saddles, clamps screws and a minimum 5 mtr. conduit laid on surface shall be taken, to achieve best possible workmanship. Distance between 2 consecutive clamps for fixing conduit on surface shall not exceed 900 mm. wooden patties for fixing saddles / clamps shall be used. Use of roll plug / steel fastener with hard setting / sealing compound is recommended.

6. In case of stone masonry, necessary conduits with M.S. boxes should be placed as the masonry is in progress, since after completing masonry, it is very difficult to cut chases in wells. Special location of cement concrete shaft is also recommended to conceal conduit in stone masonry and the same shall be provided by client / consultant.
7. In ground floor conduiting below the flooring should be avoided. Wherever it is unavoidable G.I. pipe should be used with prior approval of Site Engineer.

#### **CEILING / WALL OUTLET BOXES FOR LIGHTS / FANS**

1. Outlet boxes shall be of steel with aluminium cover and so installed as to maintain continuity throughout. These shall be protected at the time of laying by filling with jute / earth / cotton etc. so that no cement mortar finds its way inside during concreting or plastering etc. Typical sketches for such outlet boxes shall be supplied alongwith other working draws. In beams conduit socket shall be provided in place of outlet boxes. The same shall be used for installation of luminaire.
2. For fixing light fixtures / brackets, outlet boxes complete with check nut for holding conduits shall be used. For lighting fixture suitable for 20 watts fluorescent tubes / incandescent lamps / mercury vapour lamps, only one outlet box is required. For fixing lighting suitable for 40 watts fluorescent lamps, two numbers outlet boxes should be provided at a distance of 300 mm. away from the centre in the longitudinal direction of the fixture, so that the use of patties / roll plug etc. may be avoided, as well as wiring from outlet box to the light fitting is to be installed in RCC beam and due to heavy reinforcement at the bottom of beam it is not possible to provide outlet boxes simple conduit should be provided. However alternative fixing arrangement shall be made in consultation with client / consultant.
3. For fixing ceiling fans, circular outlet boxes, 100 mm. diameter, complete with 12 mm. dia. Mild Steel rod 300 mm. long, for holding 12 mm. dia. Mild Steel cover 125 mm. dia. at bottom shall be used.

#### **DRAW OUT JUNCTION BOXES**

1. Steel drawout boxes at angle dimensions shall be provided at a convenient points on walls / ceilings to facilitate pulling of long runs of cables / wires. These shall be completely concealed with Anodised Aluminium, flush with plaster works. These draw boxes should be five sided. The location of these boxes is to be decided prior to fixing, as per site requirement and following should be treated as general guidance for deciding the location of these :

2. These should be provided at a place where these are not in direct view. Recommended place is 400 / 450 mm. below ceiling, if conduits are running vertically.
3. Junction box in the offset of bottom of RCC beam and vertical wall should not be provided.
4. If junction boxes are coming side by side for two or more conduits, one common M.S. box of proper size can be used to act as junction box.
5. If junction box is to be provided in ceiling, its position should be so located that it is in line with other light / fan points.
6. Junction boxes should never be used for splitting one conduit into two or more. Junction box for such functions is avoidable and for this, number of conduits to be connected to one switch board should be calculated correctly as per drawing before laying conduits in ceiling.
7. Locating junction boxes on outer surface of exterior walls of building should be avoided as these are in direct view and are also exposed to weather.
8. Junction boxes should never be closed permanently by plaster. Removable covering of aluminium should be provided for conduit junction boxes for M.S. junction boxes removable hylem plate should be provided. This cover may be painted with wall colour.
9. Junction boxes in important areas should be avoided and can be located in toilets / corridors / service shafts and stores etc.

### **SWITCH BOXES**

Steel boxes of required sizes shall be provided to house speed regulators of fans, switches for lights, fans, plug sockets etc. as per requirement of drawings. These should be so designed that accessories on Anodized aluminum sheet could be mounted with tapped holes and brass machine screws, leaving ample space at the back and on the sides for accommodating wires and check nuts at conduit entries. These shall be attached to conduits by means of check nuts on all walls of the boxes through which the conduits are entering. These shall be completely connected leaving edges flush with finished wall surfaces. Anodized aluminum cover should be fixed to these switch boxes by means of brass chrome plated machine screws and cup washers. Utmost care shall be taken by contractor to ensure that all switch boxes are in line and level. Inside each switch box, one bolt shall be welded to receive earthing wire.

### **SWITCH AND SOCKET**

Switches shall be installed at 900 mm above finished floor level unless otherwise indicated on the drawings.

- The switch controlling the light point or fan shall be connect on to the phase wire of the circuit and neutral shall be continuous, having no fuse or switch installed in the line except at the D.B. All fan regulators shall be fixed inside the switch boxes on adjustable flat M.S. strips / plates with tapped holes and brass machine screws, leaving ample space at the back and side for accommodating wires.
- The cover plates to the switch box shall be fixed by means of sunk head brass cadmium screws.
- Where two or more switches and fan regulators are installed together, they shall be provided with one gang cover plate with knockouts to accommodate required number of switches, sockets and regulators.
- The switch controlling the socket outlet shall be on the phase wire of the circuit. The third pin of the socket shall be connected to the earth continuity conductor of the circuit

The switch boxes, installed back-to-back in the same wall shall be offset from each other, 150 mm horizontally, to preclude noise transmission.

### **CLEANING AND PROTECTION OF CONDUIT SYSTEM**

The entire conduit system including outlet boxes, junction boxes and switch boxes shall be thoroughly cleaned after completion of erection and tested for not blockage by air / sound or steel wire prior to finishing of building by air / sound or steel wire prior to finishing of building and before drawing in of cables / wires to safeguard conduit system against filling up with the plaster / cement slurry / water etc. all the outlet and switch boxes will have to be provided with temporary jute / cotton filling, covers and plugs etc.. Within tendered cost which shall be replaced later on by hylem / sheet cover after wiring as required.

### **TESTING OF INSTALLATION**

Before a completed installation is put into service, the following tests shall be complied with:

### **INSULATION RESISTANCE**

The insulation resistance shall be measured by applying 500 volt megger with all fuses in places, circuit breaker and all switches closed.

The insulation resistance in megohms of an installation, measured shall not be less than 50 megohms divided by the number of points on the circuit.

The insulation resistance shall be measured between

- EARTH TO PHASE
- EARTH TO NEUTRAL
- PHASE TO NEUTRAL
- PHASE TO PHASE

#### **EARTH CONTINUITY PATH**

The earth continuity conductors shall be tested for electrical continuity and the electrical resistance of the same along with the earthing lead but excluding any added resistance or earth leakage circuit-breaker, measured from the connection, with the earth electrode to any point in the earth continuity conductor in the completed installation and shall not exceed one ohm.

#### **POLARITY OF SINGLE POLE SWITCHES**

A test shall be made to verify that every no-linked, single pole switch is connected to one of the phase of the supply system.

#### **COMPLETION CERTIFICATES**

All the above tests shall be carried out in presence of client, and the results shall be recorded in prescribed forms. Any default during the testing shall be immediately rectified and that section of the installation shall be retested. The completed test result shall be submitted to the client.

On completion of an electric installation a certificate shall be furnished by the contractor, countersigned by the certified supervisor under whose direct supervision the installation was carried out. This certificate shall be in a prescribed form as required by the local electric supply authority.

#### **INSTALLATION OF LIGHTING FIXTURES / FANS**

- **INSTALLATION OF LIGHTING FIXTURES**

Scope of work under this item shall start from light point, with a 5 A bakelite connector, 2 core x 1.5/2.5 mm.<sup>2</sup> FRLSZH PVC insulated wires from this connector to the connector inside the lighting fixture, connections, fixing of lighting fixture complete with all accessories, lamps on wall / roof / steel truss etc. testing the lighting fixture and commissioning. If wire length of light point is enough to reach connector of light fitting, connector in light point can be deleted.

- **INSTALLATION OF EXHAUST FANS**

Scope of work under this system shall start from exhaust fan point, with a ceiling rose, 2 core 2.5 mm.<sup>2</sup> PVC insulated wire from ceiling rose to connector of exhaust fan, connections, making fan opening in walls including repair / finishing fixing of exhaust fan complete with accessories and louvers on walls with hold-fasts, testing the exhaust fans and commissioning.

- **INSTALLATION OF EXTERNAL LIGHT FIXTURES**

**BRACKET FOR STREET LIGHT FITTINGS**

The brackets shall be made of 38 mm. NB MS class “B” pipe approx. 1.8 mtr. Or more long bent at the centre at an angle 120° C. with necessary holding brackets, hold fasts etc. with special reducer at the end to accommodate type of streetlight fitting to be fixed. Bracket shall have 1 coat of anti-corrosion paint before despatch to site and 2 coats of approved make and shade of aluminium paint. This bracket shall also be provided with one M.S. watertight box complete with the connector, neutral link, rewirable fuse etc. See enclosed drawings of street light poles. Bracket shall be single arm or double arm as approved by EIC.

- **INSTALLATION OF POLES**

Installation of poles shall be done as per enclosed drawings of street light poles. The depth of pole to be buried in ground shall be 1/5th of the total pole length or as specified in drawing, whichever is more. Special care shall be taken in erecting poles so that these are not strained or damaged during erection and are firmly stayed till the foundation are secured. The pole shall be grouted inside ground pit (cross-section 600 x 600 mm.) with cement concrete 1:2:4. Before the placement of concrete around pole in the pit, necessary conduit pipes (not less than 25 mm. dia.) shall be placed for facilitating drawing of cables. Separate conduit shall be provided for incoming and outgoing cables. The cement concrete shall be protected from prematured drying by curing for atleast 7 days after pouring. All concrete surface from 150 mm. below ground level to top shall be finished smooth with cement mortar 1:4.

- **INSTALLATION OF STREET LIGHT FIXTURES**

This includes fixing of street light fittings complete with accessories and fixture at the end of the pole / bracket, connecting it with 3 x 2.5 mm.<sup>2</sup> copper conductor, FRLSZH PVC insulated cable from water tight M.S. box, testing, commissioning. Third core shall be connected with earthing point of light fitting at one end and earthing point of marshalling box at the other end.

**GENERAL NOTES FOR STREET LIGHTING**

1. For supplying and laying of cables, technical specification (wiring) shall be applicable reference shall be made under heading Cable Work elsewhere in the tender.
2. For street light poles along roads, nearest finished road level shall be taken as ground level and for poles along compound wall / away from roads, existing ground / finished ground shall be taken as ground level.
3. Distance of min. 1 mtr. shall be maintained between centre of pole and centre of curb of road. For compound wall poles, distance between compound wall and poles shall be min. 3 mtrs.
4. A loop of 1.5 mtr. of cable shall be provided near each street light pole for all incoming and outgoing cable.

### **COMPLETION TESTS**

After supply and installation of complete project or a particular building / area work, following tests shall be carried out by the contractor before switching on the power to installation and the results shall be recorded and submitted to the Site-Engineer. If results are not satisfactory / as per standards set herewith, the contractor shall identify the defects / short coming and shall rectify the same. Nothing extra shall be paid for carrying out these tests and contractor must arrange all necessary instruments.

### **INSULATION RESISTANCE TO EARTH**

This is to be measured with all fuse links in place, all switches ON, all lamps and appliances in position by applying a voltage not less than twice the working voltage (subject to a limit of 500 V). Insulation resistance of the whole or any part of the installation to earth must not be less than 50 mega-ohms divided by the number of outlets (points and switch positions) except that it need not exceed one mega-ohm.

### **INSULATION RESISTANCE BETWEEN CONDUCTORS**

Tests to be made between all the conductors connected to one pole or phase conductor of the supply and all the conductors connected to the middle wire or neutral or the other pole or phase conductors of the supply. For this test, all lamps shall be removed and all switches put ON. The result of the test must be 50 mega-ohms divided by the number of outlets (points and switch positions) but need not exceed 1 mega-ohm for the whole installation.

### **POLARITY OF SINGLE POLE SWITCHES**

Tests shall be made to verify that all non-linked single pole switches are on phase conductor (live) and not on neutral or earth conductor. This can be done by connecting test lamps between two terminals of



switch and earth. If the lamp lights up when switch is ON and either terminal is touched, the switch is correctly installed.

### **RESISTANCE OF METAL CONDUITS / SHEETS (EARTH CONTINUITY TEST)**

In case of cables encased in metal whether conduit of metallic sheathing, the total resistance of the conduit or sheathing from the earthing point any other position in the completed installation shall not exceed 2 ohms. This can be carried out by following circuit :

One end of the lead is connected to the ECC and its connection with the electrode and the other to the farthest point of the ECC. First, current through the circuit is measured with the resistance of 2 ohms short circuited by the link. Next, current is measured through the two ohms resistance by disconnecting the two leads from the ECC and joining them together. If current is more in the first case, the resistance of ECC is less than 2 ohms.

### **HANDING OVER / TAKING OVER**

After completion of works and tests specified above, the various individual area of the project cannot be taken over by the employer, whole project work can be taken over as and when these are ready in all respects.

## **6.5 Earthing System & Lightning Protection System**

Supply and erection of Maintenance free earthing system using required Nos of Copper Coated Steel Rods, compression couplers etc., and shall conform to GIFT specifications with all amendments or latest. The Maintenance free earthing system shall be supplied along with the test certifications of manufacturers.

The Scope covers the design, approval, supply, installation, testing, commissioning & erecting of UL Listed Copper bonded Solid Steel Rods to be used as vertical electrode for earthing system. These electrodes shall be made of high tensile low carbon steel rod, molecular bonded with 99.9% electrolytic copper with minimum coating thickness of 254 microns. 14.2mm dia copper bonded rod with minimum length of the earth rod shall be 3.0 meters which is a single rod. Universal clamp of required size should be made up of SS304. Earth enhancement compound of 25kg (2 nos of 12.5kg bag) should be used conductive based mineral compound producing low resistance of an

earth termination system. Material of the earthing enhancing compound shall be chemically inert to subsoil. It shall not pollute the environment. Earth Chamber Should have an outer dimension of 300 mmX 300 mm X 190 mm made of HDPE/FRP/block masonry material, Flush Mounted, removable and lockable cover mentioning “Electrical Earth pit” on cover. Earthing system shall be design by the contractor and submit for approval. Necessary earthing pit shall be design by the contractor based on the actual technical requirement. Each DB/Panel shall be earthed properly. A separate earthing system shall be design for UPS and UPS power application.

The earthing and lightning protection system covers earthing conductors, earth electrodes and accessories. Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system. Crane rails, tracks, metal pipes and conduits also shall be earthed at two points. Steel RCC Columns, metallic stairs and rails of the building housing electrical equipment also shall be connected to nearby earthing grid conductor. Metallic sheaths/ screens and armour of multicore cables shall be earthed at both ends. Metallic sheaths and armour of single core cables shall be earthed at the switchgear end only. Each Continuous laid length of cable tray shall be earthed at minimum two places by GS Flats to earthing system, the distance between the earthing points shall not exceed 30m. Lightning Protection System shall compromise vertical / horizontal air terminations, down conductors, test limits and earth electrodes. Air terminations, down conductors and test links material shall be approved by EIC. Lightning Protection System down conductors shall not be connected to other earthing conductors above the ground level.

Hot dip GI/Cu. Earthing strip or copper cable shall be considered for the earthing system network connection. Each equipment and system shall be properly earthed through the earthing network. Size of GI/Cu. Earthing strip or Cu. Cable shall be considered as per technical requirement. Necessary jointing shall be done by the bimetallic strip only. Selection of earthing strip or copper cable size shall be as per the technical requirements and technical calculation for the size selection shall be submitted to client for approval before the execution of works.

- The plate/pipe/rod electrode, as far as practicable, shall be buried below permanent moisture level but in no case not less than 3 M below finished ground level.
- The plate/pipe/rod electrode shall be kept clear of the building foundation and in no case, it shall be nearer by less than 2 M from outer face of the respective building wall / column.

- The plate/electrode shall be installed vertically and shall be surrounded with 150 mm. thick layers of Charcoal dust and Salt mixture or chemical compound.
- 19 mm. dia. G.I. pipe for watering, shall run from top edge of the plate / pipe electrode to the mid-level of block masonry/HDPE chamber.
- Top of the pipe shall be provided with G.I. funnel and screen for watering the earth / ground through the pipe.
- The funnel with screen over the G.I. pipe for watering the earth shall be housed in a block masonry chamber.
- The masonry chamber shall be provided with a Cast Iron hinged cover resting over the Cast Iron frame which shall be embedded in the block masonry.
- Construction of the earthing station shall in general be as shown in the approved drawing and shall conform to the requirement on earth electrodes mentioned in the latest edition of Indian Standard IS : 3043, Code of Practice for Earthing Installation.
- The earth conductors (cu. Strips / Wires copper / Hot dip G.I.) inside the building shall properly be clamped / supported on the wall with Galvanised Iron clamps and Mild Steel Zinc Passivated screws / bolts. The conductors outside the building shall be laid atleast 600 mm. below the finished ground level.
- The earth conductors shall either terminate on earthing socket provided on the equipment or shall be fastened to the foundation bolt and / or on frames of the equipment. The earthing connection to equipment body shall be done after removing paint and other oily substances from the body and then properly be finished.
- Over lapping of earth conductors during straight through in joints, where required, shall be of minimum 75mm. long.

The earth conductors shall be in one length between the earthing grid and the equipment to be earthed.

➤ Test Parameters:

The Earth rod should be tested for CPRI tested 31kA Ipeak and 14kA rms and Marking, Dimension, Electrical resistance before and after salt mist test, tensile strength, bend test, adhesion test as per IEC 62561-1&2. The compound shall be tested for electrical resistivity less than 1  $\Omega$ m and certified as per IEC 62561-7 and also fulfill Toxicity Characteristic Leaching Procedure (TCLP) requirements. The Earth Chamber able to withstand 50kN.

The entire earthing installation shall be tested as per requirements of Indian Standard Specification IS: 3043.

The following earth resistance values shall be measured with an approved earth megger and recorded.

- Each earthing station
- Earthing system as a whole
- Earth continuity conductors
- Earth conductor resistance for each earthed equipment shall be measured which shall not exceed 5 ohm in each case.
- Measurements of earth resistance shall be carried out before earth connections are made between the earth and the object to be earthed.
- All tests shall be carried out in presence of the Client.

➤ Lightning Protection System:

This section covers Design, Supply, Installation, Testing & Commissioning of a complete Lightning Protection System for North Entrance with dedicated earth pits, to protect structure, personnel, and equipment from lightning strikes. A separate earthing shall be provided for LPS system as per standard practice and approval of EIC. Lightning protection system shall be design by the contractor and submit for approval of client. Lightning Protection System (LPS) shall be design as per standard practice and following codes.

- IS/IEC 62305: Lightning Protection
- NFPA 780 – Standard for installation of Lightning Protection System
- IS 3043 – Code of Practise for Earthing
- NBC 2016, Part 8 – Lightning Protection
- IEC 62561-1: Lightning protection system components (LPSC) - Part 1: Requirements for connection components
- IEC 62561-2: Lightning protection system components (LPSC) - Part 2: Requirements for conductors and earth electrodes
- IEC 62561-7: Lightning protection system components (LPSC) - Part 7: Requirements for earthing enhancing compounds

- In case of conflict, IS/IEC 62305 shall govern.

Scope includes the work as following:

1. Carry out detailed risk assessment as per IS/IEC 62305 and design the LPS. Contractor is fully responsible for adequacy of design.
2. Submit LPS design report, layout drawings, calculations, material schedule for Client approval prior to procurement.
3. Supply, install, connect, test, commission complete LPS including air terminals, down conductors, earth pits, bonding, test joints, etc.
4. Provide as-built drawings, test reports, O&M manual, warranty.
5. Performance: System shall comply with Protection Level III or IV as per IS/IEC 62305 unless risk assessment demands higher.

**Down Conductors:** Copper bonded steel conductor of 8/10 mm solid round shall run inside columns on the periphery of the building as per the design, connected to the down conductor for lightning protection. Selection shall be made based on the LPL results in risk assessment.

**Air termination system:** Solid copper rod 16mm dia or aluminum rod 20mm dia, or ESE terminal with 316 SS body mounting on 1m GI mast fixed on parapet/roof, Height to provide rolling sphere protection as per chosen Protection Level. Qty. and location of Air terminal shall be as per approved design. Lightning interception system (Horizontal/Vertical) in the roof at highest point shall be according to LPL based on the risk assessment. The air termination system consisting of vertical rods and/or mesh shall be connected to the down conductor through earth studs provided at the parapet of the building. For this purpose, sufficient earth studs with provision of mechanically strong connection need to be provided at the parapet / wall at the top of the building. Air termination system shall be installed strictly after completion of the installation of all roof mounted electrical / metal installations.

**Lightning Flash Counter:** Each protection system shall be supplied with Lightning strike counter. The counter shall have a register that activates one count for every discharge where the peak

current exceeds 400A at the 8/20us standard. The lightning flash counter shall be robust and easy to install. The counter shall operate from the energy of the lightning discharge and should not work on external or battery power to operate. The lightning flash counter shall be installed to the manufacturer's instructions in a readily accessible manner (always 2mts above the Ground) so that reading can be taken at regular intervals. It shall be positioned such that its operating temperature is within the range -200C to + 600 C.

Approved Makes for LPS: ABB, JEF, OBO, DEHN

## **6.6 TECHNICAL SPECIFICATIONS OF UPS**

This section covers Design, Supply, Installation, Testing & Commissioning of a complete Online Double Conversion UPS system with battery bank and dedicated UPS Distribution Board for backup of critical loads.

### **6.6.1 Scope Of Work**

1. Carry out detailed load survey, load calculation, battery sizing for minimum 1-hour backup at full load, voltage drop, heat dissipation calculations.
2. Select UPS capacity, battery type, model based on calculated load + 25% future spare. Submit calculations, SLD, datasheets for Client approval prior to procurement.
3. Supply, install, connect, test, commission complete UPS system including UPS, batteries, battery rack, UPS DB, cabling, earthing, signage.
4. Provide training, O&M manuals, as-built drawings, warranty.
5. Performance guarantee: System shall deliver minimum 1-hour backup at 100% connected load at 50°C ambient.

### **6.6.2 Indicative Loads to be backed up by UPS**

1. Data Network Rack / Switch / Router in Gate Room
2. Computer power plugs in Offices at North Entrance

### 3. Boom barrier and Flap Gate controller of Access control system

- Actual load shall be verify at site during detailed engineering by contractor.

Contractor shall confirm final connected load and submit load schedule for approval.

### 6.6.3 CODES & STANDARDS

UPS and batteries shall comply with latest editions of:

1. IEC 62040-1, IEC 62040-2, IEC 62040-3 – UPS General and Performance Requirements
2. IS 16242 – Safety of UPS
3. IEC 60896-21/22 – Stationary Lead Acid Batteries
4. IS 15549 – VRLA Batteries
5. IS 732, IS 3043 for wiring and earthing
6. CEA Regulations, Local Electrical Inspectorate rules

### 6.6.4 SYSTEM REQUIREMENTS & DESIGN CRITERIA

UPS Topology

- Type: Online Double Conversion, IGBT based, DSP controlled
- Input: 415V/230V  $\pm 15\%$ , 3/1-Phase, 50Hz  $\pm 3$ Hz
- Output: 230V  $\pm 1\%$ , Single Phase, 50Hz  $\pm 0.1$ Hz, PF 0.95
- Efficiency:  $>94\%$  at 100% load,  $>96\%$  in Economy mode
- Overload: 125% for 10 min, 150% for 1 min
- Harmonic Distortion: THDi  $<3\%$  at full load with input filter
- Crest Factor: 3:1
- Transfer Time: Zero, true online

### 6.6.5 Capacity & Redundancy

- Contractor to calculate total critical load and select UPS kVA rating with minimum 25% spare capacity.
- Minimum acceptable: 5kVA. If calculated load + 25% exceeds 10kVA, propose 10kVA or higher.
- Parallel redundant configuration not required unless load exceeds 15kVA.

#### 6.6.6 Battery Backup

- Minimum backup: 1 hour at 100% of calculated UPS load at 50°C ambient, end of battery life.
- Battery Type: Sealed Maintenance Free VRLA, AGM technology, 12V blocks.
- Battery Life: Minimum 5 years at 35°C, 3 years at 50°C.
- Battery shall be sized as per IEC 62040 considering end voltage 1.75V/cell, temperature correction, aging factor.
- Submit battery sizing calculation sheet for approval.

#### 6.6.7 Charger & Recharge

- Built-in battery charger with temperature compensation.
- Recharge time: 90% capacity within 8 hours after full discharge.
- Charger shall have current limit to prevent overloading UPS during recharge.

#### 6.6.8 Alarms & Monitoring

- Front panel LCD display: Input/Output Voltage, Current, Frequency, Load%, Battery Voltage, Backup time, Faults.
- Audible & visual alarms for: Mains fail, Battery low, Overload, UPS fault, Battery disconnect.
- Potential free contacts for remote alarm annunciation.



#### 6.6.9. Environmental

- Operating Temperature: 0°C to 50°C, derating above 50°C.
- Humidity: 0-95% RH non-condensing.
- Audible Noise: <55 dBA at 1m.
- Protection: IP20 for indoor installation.

#### 6.6.10 MATERIALS & COMPONENTS

##### 1. UPS Unit

- Make: Emerson, Numeric, APC by Schneider, Fuji
- Construction: constructed with powder coated CRCA sheet steel of min. 1.6mm.
- Cooling: Forced air with speed-controlled fans.
- If require, provide stand to place the UPS.

##### 2. Batteries

- Type: SMF VRLA, 12V blocks, AGM, maintenance free.
- Make: Exide, HBL, Tata
- Battery Rack: MS powder coated, 2-tier, with polycarbonate sheet between tiers, cable routing, insulated tools provided.
- Battery Interconnects: Flexible copper cable with crimped lugs, heat shrink.

##### 3. UPS Distribution Board

- Enclosure: 2mm CRCA, powder coated, IP43 indoor.
- Incomer: MCCB/MCB rated for UPS output current.
- Outgoing: MCB + 30mA RCBO for each circuit.
- Indicative circuits to include as minimum:

1. Computer sockets – min. 3 circuits

2. Data & Network Rack – 2 circuit
  3. Boom Barrier – 2 circuit
  4. Flap Gate – 2 circuit
  5. 25% spare ways
- SPD: Class-II, 40kA on incomer.
  - Circuit chart with load schedule inside door.

#### 6.6.11 Cables & Earthing

- UPS to UPS DB: 1100V FR-LSZH Cu cable, size as per current + voltage drop <1%.
- Separate earth from Main Earth Pit to UPS frame and UPS DB. Earth resistance <1 Ohm.

#### 6.6.12 INSTALLATION REQUIREMENTS

1. UPS to be installed on anti-vibration pads and stand, with minimum 600mm clearance at rear and sides for ventilation.
2. Battery rack placed adjacent to UPS in same room.
3. Battery installation as per manufacturer's guidelines, polarity checked before connection.
4. UPS DB mounted on wall near UPS. All circuits shall be labelled.
5. Run dedicated circuits from UPS DB to load points in GI conduit laid in DWC pipe if underground or road crossing.
6. Provide danger notice, operating instructions, single line diagram pasted inside UPS DB.

#### 6.6.13 TESTING & COMMISSIONING

- Factory Tests: Submit routine test report for UPS as per IEC 62040-3. Battery manufacturer test certificate.
- Site Tests:
  1. Visual & mechanical inspection.

2. Insulation resistance test for all cables >100 M-ohm.

3. Earth resistance test <1 Ohm.

- Functional test: Simulate mains failure, verify zero transfer, check output voltage/frequency.
- Backup Test: Disconnect mains at full connected load. Record time till low battery alarm. Must achieve minimum 1 hour. Repeat test after 2-hour recharge.
- Load test at 100% for 30 minutes, record temperature, noise, voltage regulation.
- 72-hour continuous trial run before handover.

#### 6.6.14 Documentation

Submit test reports signed by Contractor's & witnessed by Client. Provide O&M manual, battery maintenance card, as-built SLD.

#### 6.6.15 WARRANTY & MAINTENANCE

1. UPS: 24 months warranty from date of Taking Over.
2. Batteries: Minimum 2 years warranty against manufacturing defect.
3. Contractor to provide OEM engineer's 2 site visits per year during DLP for inspection, cleaning, terminal tightening, routine service, etc.

#### 6.6.16 SUBMITTALS REQUIRED

For Approval:

1. Load calculation sheet with connected load, demand factor, future spare.
2. Battery sizing calculation as per IEC 62040.
3. UPS SLD showing input, output, battery, UPS DB.
4. Technical datasheets for UPS and batteries.

At Completion:

1. As-built drawings

2. O&M manuals
3. warranty certificates
4. test reports

## **6.7 Lighting Fixture & Ceiling Fans**

This section covers Design, Supply, Installation, Testing & Commissioning of complete external and internal lighting fixtures and ceiling fans for North Entrance Gate, Offices, and external area on EPC basis.

### **6.7.1 General Requirements**

- All light fittings shall be LED fittings only.
  - Luminaires shall be designed for continuous trouble-free operation without reduction in life or without deterioration of materials and internal wiring. Outdoor fittings shall be weather-proof and rain-proof.
  - External lighting: Street light with poles, Bollards, Post Top Lanterns with poles, Spike lights, Uplighters, LED strip light on Gate, Downlights, Façade lighting etc. as required and approved by EIC.
  - Office Internal Lighting: Recess / Surface mounted LED light fitting of square/circular shape as approved by EIC. LED Tube Light fitting if required.
- (a) The Lighting system includes the following items.
- (i) LED Lighting fixtures complete with all accessories and fixing arrangements
  - (ii) Lighting system equipment
    - Light control switches, lighting wires, conduits, DWC pipes and other similar items necessary to complete lighting system.
    - Lighting fixture supports, street lighting & post-top lantern poles and flood light with necessary fixing arrangements
    - Landscape Lighting, Bollard and Post-top lantern and Gate Lighting, Façade lighting, spike light, foot light, etc. as required

- Main Lighting distribution board, lighting panels, earthing for each light fixture.
- Foundation with minimum M20 grade design for streetlight, round shape post-top lantern and bollard light fitting.

#### **6.7.2 Design & Performance**

1. Carry out detailed lighting design for North Entrance Gate area to achieve required lux levels as per IS 3646 / NBC 2016. Target: 40-60 Lux average on road, 100-150 Lux at gate entrance, min. 300 Lux at security cabins / offices work plane.
2. Select type, wattage, mounting height, spacing, aiming of fixtures to meet lux levels and uniformity ratio  $>0.4$ . Submit Dialux/Relux lighting design report, SLD, fixture schedule for Client approval prior to procurement.
3. Supply, install, connect, test, commission all approved fixtures and fans.
4. Final selection from list below – Contractor need not use all types but must meet design intent with minimum energy consumption as per ECBC 2017.
5. Provide as-built drawings, photometric test report, warranty.

#### **6.7.3 CODES & STANDARDS**

1. IS 3646 – Code of Practice for Interior Illumination
2. IS 10322 – Luminaires – General Requirements & Tests, Parts 1 to 5
3. IS 16102 / IEC 62717, IEC 62722 – LED Luminaire Performance
4. ECBC 2017 – Energy Conservation Building Code
5. IS 374 – Ceiling Fans
6. IEC 60598, IEC 60529 – IP Rating
7. LM-79, LM-80 test reports required for LED

#### **6.7.4 EXTERNAL LIGHTING FIXTURES – TECHNICAL REQUIREMENTS**

Contractor shall select from below to meet lighting intent design and required lux level, Final selection of light fixture shall be as approved by the Client:

1. Street Light Pole Luminaire

- Type: LED Street Light, integrated or modular
- Wattage: 50W to 70W as per approved design
- Housing: Die-cast aluminium, IP66, IK08
- LED: LM80 certified, L70 >50,000 hrs at 40°C
- Optics: Road-specific, Type-II or Type-III distribution, anti-glare
- CCT: As approved by EIC
- CRI:  $\geq 80$
- Surge Protection: 10kV internal
- PF:  $>0.95$ , THD  $<10\%$
- Driver: Isolated, flicker-free, inbuilt
- Mounting: On 6-7m Octagonal GI pole with pole foundation and earthing

## 2. Bollard Light

- Type: Cylindrical Bollard, 900-1000mm height
- Wattage: 8-12W LED
- Body: SS316 or Powder coated die-cast aluminium
- Diffuser: Polycarbonate, UV stabilized, anti-glare
- IP Rating: IP65, IK08
- CCT: as per landscape design approved by EIC
- Mounting: On RCC foundation with base plate

## 3. Post Top Lantern – Round or as approved by EIC

- Type: Decorative Post Top Lantern
- Wattage: minimum 30W LED module
- Housing: Die-cast aluminium, powder coated
- Diffuser: Polycarbonate or PMMA, opal
- IP Rating: IP65

- CCT: As suggested by EIC
- Mounting: On 3.5-4m decorative pole with foundation, JB and required accessories

#### 4. Spike Light / Ground Burial Uplighter

- Type: Spike mount or Recessed ground uplighter
- Wattage: 5-12W LED as approved by EIC
- Body: SS316 or Marine grade aluminium
- IP Rating: IP67 for ground burial, IK10
- Beam Angle: 15° to 45° as per application
- CCT: 3000K for landscape, 4000K for façade or as approved by EIC

#### 5. Foot Light / Step Light

- Type: Recessed wall mounted
- Wattage: 3-5W LED
- Body: Die-cast aluminum, IP65
- CCT: 3000K or as approved by EIC
- Use: On walls, steps at gate

#### 6. LED Strip Light for Gate Structure

- Type: Linear LED Strip in aluminium profile with diffuser
- Wattage: 14.4W/m max
- Voltage: 24V DC
- IP Rating: IP66/65 silicone sleeve
- CCT: 4000K or as approved by EIC
- Profile: Extruded aluminum with end caps, mounting clips

#### 7. Downlight – Below Road Shade & Outside Cabin

- Type: Recessed or Surface mounted LED Downlight
- Wattage: Min. 30W
- Housing: Die-cast aluminium

- IP Rating: IP65
- CCT: 4000K or as approved by EIC
- CRI: >80

#### 8. Facade Lighting – Wall Washer / Linear Grazer

- Type: Linear LED Wall Washer or Point source Uplighter
- Wattage: 18-36W/m
- IP Rating: IP66
- Beam: Asymmetric wash or narrow spot as per facade
- CCT: 3000K or RGBW if approved or as suggested by EIC

#### 9. General Requirements for All External Fixtures

- Operating Temp: -10°C to +50°C
- Life: L70 >50,000 hrs
- Warranty/Guarantee: 3 years unconditional replacement guarantee
- LM-79 test report mandatory. LM-80 for LED chips.
- Luminaire shall have aluminium pressure die cast housing with powder coating.
  - PC Injection Moulded Diffuser shall be use for high light transmittivity, uniform illumination and reduced glare (Acrylic / any other material not acceptable).
  - LED Driver shall be external, Isolated type, separate Silicon Potted & BIS approved driver for ensuring better reliability and safety (Normal Circuit driver not acceptable without potting).
  - PF shall be >0.95 and THD shall be <10% for all lighting fixtures.

### **6.7.5 INTERNAL LIGHTING – SECURITY CABINS / OFFICES**

#### 1. LED Downlight 18W

- Type: Recessed or Surface mounted
- Housing: Aluminum powder coated
- Wattage: 18W ±10%



- IP Rating: IP20
- CCT: 4000K or as approved by EIC
- CRI: >80, UGR <19 for visual comfort
- PF: >0.95, THD <10%

## 2. LED Tube Light / Batten

- Type: 20W LED Tube in aluminum housing or 18W LED Batten
- Length: 4ft
- IP Rating: IP20
- CCT: 4000K or as approved by EIC
- Use: General illumination in cabin

## 3. General Requirements for Internal Fixtures

- Life: L70 >50,000 hrs
- Warranty/Guarantee: 3 years unconditional replacement guarantee
- LM-79 test report mandatory. LM-80 for LED.
- Luminaire shall have aluminium pressure die cast housing with powder coating.
  - PC Injection Moulded Diffuser shall be use for high light transmittivity, uniform illumination and reduced glare (Acrylic / any other material not acceptable).
  - LED Driver shall be external, Isolated type, separate Silicon Potted & BIS approved driver for ensuring better reliability and safety (Normal Circuit driver not acceptable without potting).
  - PF shall be >0.95 and THD shall be <10% for all lighting fixtures.

### 6.7.6 CEILING FAN – OFFICES/SECURITY CABINS

- Type: 1200mm sweep, 3 blades, ceiling mounted
- Motor: Energy efficient, copper winding, ball bearing
- Air Delivery: >210 CMM at high speed
- Power Consumption: <=50W at high speed
- Speed Control: Electronic regulator, 5 steps

- Finish: Powder coated
- BIS certified as per IS 374
- Make: Havells, Crompton, Usha, Orient
- Qty: Min. 3 Nos.

#### **6.7.7 INSTALLATION REQUIREMENTS**

1. Mount fixtures at height and spacing as per approved lighting design.
  2. External fixtures: Use heavy duty weatherproof hardware, ensure proper sealing, use brass cable glands.
3. Poles: Align vertically, aim luminaire as per photometric design.
  4. Wiring: 3Cx1.5/2.5sq.mm FR-LSH Cu cable in conduit/DWC pipe as applicable.
5. Label each circuit at DB with fixture type and location.

#### **6.7.8 TESTING & COMMISSIONING**

1. Visual inspection for damage, correct mounting, aiming.
2. Functional test for all circuits.
  3. Lux Level Test: Measure illuminance at North Entrance, road, cabin work plane using calibrated lux meter. Submit test report. Must achieve minimum 95% of design value.
4. 72-hour trial run.

#### **6.7.9 SUBMITTALS**

For Approval:

1. Lighting design report with Dialux output: plan view, iso-lux contours, calculation summary.
2. Fixture schedule with wattage, photometry, IP rating, etc.
3. TDS of all fixtures and fans.
4. LM-79, LM-80 reports for LED.

At Completion:

As-built lighting layout, lux test report, warranty certificates, etc.

Note: Light fixture items are indicative. Contractor shall supply as per approved lighting design. Lump sum EPC price includes all design, supply, installation, testing and commissioning.

- (a) The Luminaires shall be designed to facilitate easy maintenance, including cleaning.
- (b) Connections between different components shall be made in such a way that they will not work loose by small vibrations.
- (c) The Luminaires and accessories shall be designed to have low temperature rise. The temperature rise above the ambient temperature shall be as indicated in the relevant Standards.
- (d) Each luminaire shall have a terminal block suitable for loop-in, loop-out and T- off connection by 250/400V, 1 core, PVC insulated copper/aluminium conductor wires upto 4 sq.mm in size. In outdoor areas the termination at the luminaire shall be suitable for 1100 V, PVC insulated, copper/aluminium conductor, armoured cables of sizes upto 6 sq.mm conductors. Terminals shall be of stud or clamp type. The internal wiring should be completed by means of standard copper wire of minimum 1 sq.mm size and terminated on the terminal block. Terminal blocks shall be mounted with minimum two fixing screws.
- (e) Mounting facility and conduit knock-outs for the luminaries shall be provided.
- (f) The fixtures provided shall be energy efficient and shall be consuming less power.

#### **6.7.10 Lighting System Equipments**

##### **6.7.10.1 Light Control Switches**

- Light control switches of ratings and types, i.e. decorative/industrial shall be supplied as required. The switches shall be suitable for use on 240 V, 1 Ph, 50 Hz supply.
- Switches shall be of flush type for mounting behind an insulated plate or incorporated with a switch plate for mounting flush with the surface of wall or switch box/suitable enclosure. The switch box/enclosure may be recessed into or mounted on a wall as per the requirement of project layouts.
- The size of enclosure boxes shall be chosen to accommodate the number of switches to be installed at the particular location. The enclosures shall be 18 gauge sheet steel galvanised.

The enclosure box shall be covered with perspex/insulating cover. An enclosure intended for surface mounting shall not have holes or gaps in its sides other than those expressly provided for cable entry.

#### 6.7.10.2 Receptacle Units

- Receptacle units shall consist of socket outlet with associated switch and plug. The socket outlet and switch or MCB shall be flush mounted within galvanised 18 gauge steel enclosure with insulation cover. The box may be recessed into or mounted on a wall as per requirements of project layouts.
- The receptacle units shall be suitable for 240 V, 1 ph - N, 50 Hz/415 V, 3 Ph - N, 50 Hz supply as required.
- Single phase receptacles shall be associated with a switch/MCB of same current rating and the receptacle shall become live only when the associated switch/MCB is in “ON” position.
- Three phase receptacles shall be associated with a TPN switch housed in the same enclosure. The receptacle shall become live only when the associated switch is in “ON” position.
- The plugs shall be provided with cord grips to prevent strain and damage to conductors/wires at connection and entry points.

#### 6.7.10.3 Lighting Wires

- (a) The wires for wiring in lighting fixture shall be minimum 250/440 V, 1/C, PVC insulated, unarmored with stranded copper conductors.
- (b) The minimum area of conductors shall be 1.5 sq.mm. for light fittings and 5A Receptacles and 4.0 sq.mm for receptacles rated 15 A and above.
- (c) The wires shall be coded white for phase/positive of D.C. and black for neutral/negative of D.C.

#### 6.7.10.4 Conduits

- (a) Rigid heavy duty steel/non-metallic conduits and their associated fittings as required shall

conform to applicable standards. The minimum size of conduit shall be 20 mm for surface installation and 25 mm for concealed installation.

- (b) Steel conduits shall be seamed by welding and hot dip galvanized. They shall be supplied in standard lengths of 5 m.
- (c) Supply of conduits shall include all associated fittings like couplers, bends and tees as required for lighting system installation work.

#### 6.7.10.5 Outdoor Weatherproof Junction Boxes

- (a) Junction boxes with terminals shall be supplied for branching and terminating lighting cables when required for outdoor areas
- (b) The junction boxes shall be dust and vermin proof and shall be fabricated from 16-gauge sheet steel and shall be complete with removable cover plate with gaskets, two earthing terminals each with nut, bolt and washer. Boxes shall be additionally weatherproof.
- (c) The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable/conduit entry knock outs, terminal blocks, HRC fuses as required.
- (d) The terminal blocks, with specified number of terminals, shall be mounted securely on brackets welded to the back sheet of the box. The terminals shall be 600 V, grade, one piece construction complete with terminals, insulation barriers, galvanized nuts, bolts and washers and provided with identification strips of PVC. The terminals shall be made of copper alloy and shall be of box clamp type.
- (e) The boxes shall be painted with one shop coat of Red oxide zinc chromate primer followed by a finishing coat of paint.

#### 6.7.10.6 Automatic Timer Circuit

- (a) External Light fixtures shall be provided with automatic timer circuits including timer and contactors as suggested by EIC.

- (b) Applicable Standards

Time switch should conform to IEC 60730-11.

- (c) Technical Particulars

- (i) Time switch should be digital type.

- (ii) Time switch should have minimum switching time of 1 Sec.
- (iii) Time switch should have astronomical function i.e. switching time should vary as per sunrise and sunset time.
- (iv) Time switch should have easy programming.
- (v) Time switch should have running reserve of at least 6 years.
- (vi) Time switch should have high accuracy.
- (vii) Time switch should have option of manual switching.
- (viii) Time switch should have functions like hour counter, holiday function, offset function.

(d) Contactor

The power contactors used in the switchboard shall be of, air break, single throw, triple pole, electromagnetic type. Contactors shall be suitable for uninterrupted duty and rated for Class AC3 duty in accordance with the latest edition of IS 13947.

Operating coils of all contactors shall be suitable for operation on 240 V, single phase, 50 Hz supply. Contactors shall be provided with at least two pairs of NO and NC auxiliary contacts. Contactors shall not drop out at voltages down to 70 % of coil rated voltage.

## **6.8 TECHNICAL SPECIFICATIONS FOR INTERNAL WIRING**

### **SCOPE OF WORK**

This section covers, definition of point wiring, system of wiring and design, supply, installation, connection, testing and commissioning of point wiring for light points, ceiling fan points, exhaust fan points, convenience socket outlet points, power socket outlet points, Computer socket points, bell outlet points etc. including fixing of light fixtures, ceiling fan, exhaust fan, wall fan, bell etc. Scope covers complete design, material supply, installation, testing and commissioning of wiring system for North Entrance at GIFT City. Contractor shall submit the design, SLD, wiring layout, etc. before starting the execution work for approval of the Client.

### **CODES & STANDARDS**

The following standards and rules shall be applicable:

| <b>S</b> | <b>Item</b>  | <b>Relevant IS</b>  | <b>Relevant IEC</b> |
|----------|--|---------------------|---------------------|
| <b>1</b> | Code of practice for electrical wiring installation (System voltage not exceeding 650 V) | IS: 732             |                     |
| <b>2</b> | Code of practice for fire safety of buildings (General) Electrical installation.         | IS: 1646            |                     |
| <b>3</b> | Rigid steel conduits for electrical wiring.  | IS: 9537 (Part - 2) |                     |
| <b>4</b> | Fittings for rigid steel conduits for electrical wiring.                                 | IS: 2667            |                     |

|  |   |   |                        |  |
|--|---|---|------------------------|--|
|  | 5 | Flexible steel<br>conduits for<br>Electrical<br>wiring.                           | IS: 3480               |  |
|  | 6 | Accessories for<br>rigid steel<br>conduit for<br>electrical<br>wiring.            | IS: 3837               |  |
|  | 7 | PVC insulated<br>cables.  | IS: 694                |  |
|  | 8 | Rigid non-metallic<br>conduits for<br>electrical<br>wiring.                       | IS: 9537 (Part -<br>3) |  |
|  | 9 | Flexible (Pliable)<br>non-metallic<br>conduits for<br>electrical<br>installation. | IS: 6946               |  |
|  | 1 | 3 pin plugs and<br>sockets.   | IS: 1293               |  |
|  | 1 | Specifications of<br>conduits for<br>electrical<br>installation.                  | IS: 8130               |  |



|                                      |  |  |          |  |
|--------------------------------------|--|--|----------|--|
|                                      | 1  | Switches for domestic purpose.   | IS: 3854 |  |
|                                      | 1  | Fittings for rigid non-metallic conduits.  | IS: 3419 |  |
|                                      | 1  | Guide for electrical layout in residential buildings Indian electricity act and rules. | IS: 4648 |  |
| <b><u>TECHNICAL REQUIREMENTS</u></b> |  |  |          |  |
| <b>POINT WIRING</b>                  |  |  |          |  |
|                                      | A point shall consist of the branch wiring from the distribution board together with a switch as required, including the ceiling rose or pendant holder or swan holder, or ceiling fan box or socket or suitable termination. A point shall include, in addition, the earth continuity conductor/wire from the distribution board to the earth pin/stud of the outlet/switch box and to the outlet points. |  |          |  |
|                                      | Supply, installation, fixing of conduits with necessary accessories, junction/pull/inspection/switch boxes and outlet boxes included in scope of works.  |  |          |  |
|                                      | Supplying and drawing of wires of required size including earth continuity wire. There shall be no joints in point wiring. Separate neutral and earth wire shall be installed for every circuit; no tapping or joints shall allow.   |  |          |  |
|                                      | Supply, installation and connection of flush type modular switches, sockets, cover plates, switch plates, and fixing fan regulator etc.  |  |          |  |
|                                      | The point shall be complete with the branch wiring from the distribution board to the outlet point, through switchboard, conduit with accessories, junction, pull, inspection boxes, control switch, socket, outlet boxes, ceiling roses, button/swan holder, connector etc.   |  |          |  |

|  |  |
|--|--|
|  | <b>SYSTEM OF WIRING</b>  |
|  | <p>Unless otherwise mentioned on the approved drawings, the system of point wiring shall be as follows:</p> <p>The system of wiring shall consist of single core, FRLSZH insulated, 1100-volt grade, copper conductor wires/cables laid through concealed PVC/ open surface metal conduits as directed &amp; wherever required, conduits shall be concealed in walls and slabs or open as per approved drawing and EIC suggested.</p>  |
|  | <b>GENERAL</b>   |
|  | <p>Prior to laying of conduits, the contractor shall submit for approval, the shop drawing for conduit layout indicating the route of the conduits, number and size of the conduits, location of junction/inspection/pull/outlet boxes, size and location of switch boxes, number and size of wires pulled through each conduit and all other necessary relevant details. Only after the drawings are approved, the contractor shall proceed with the work of laying of conduits.</p>  |
|  | <b>MATERIAL</b>  |
|  | <p><b>PVC Conduit</b></p> <p>All non-metallic PVC conduits shall conform to IS: 9537 (Part - 3 ). The conduit shall be plane and of type as specified in IS: 9537 and shall be used with the corresponding accessories (Refer IS: 3419 specifications for fittings for rigid non-metallic conduits). PVC conduits shall be rigid unplasticised, heavy gauge having 2.0 mm. wall thickness upto 20 mm diameter conduit and 2.5 mm. wall thickness for all sizes above 20 mm. diameter</p>   |
|  | <p><b>M.S. CONDUIT</b></p> <p>Conduits shall conform to IS: 9537 (Part - 2), finished with galvanized surface. No steel conduit less than 20 mm. in diameter shall be used. Conduits shall be solid drawn of lap welded type, with minimum wall thickness for conduits having 20 mm and above diameter.</p> <p>The conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of manufacturers</p> <p>The conduit accessories such bends, coupling etc. shall be conforming to the relevant Indian Standard specification</p> |
|  | <p><b>BOXES</b></p> <ol style="list-style-type: none"> <li>1. All the boxes for switches, sockets and other receptacles, junction boxes, pull boxes and outlet boxes shall be fabricated from 2.0 mm. thick mild sheet painted with two coats of red-oxide and then two coats of enamel paints as called for. Color of the paints shall be as approved by the client. The boxes shall have smooth external and internal finished surface.</li> </ol>   |



|             |                       |
|-------------|-----------------------|
| Three phase | Red, Yellow, Blue     |
| Neutral     | Black                 |
| Earth       | Green or Green/Yellow |

7. Means of identifying the manufacturer shall be provided throughout the length of cable

8. Unless otherwise specified in the drawings the size of the cables used for internal wiring shall be as follows:

- In case of circuit wiring for lights, exhaust fans, ceiling fans, bell, convenience socket outlet points (P+N+E):

|           |                                     |
|-----------|-------------------------------------|
| 2.5sq.mm. | From D.B. to switch boards.         |
| 1.5sq.mm. | From switch boards to outlet points |

- In case of power socket outlet circuit having not more than two 15 A power outlet (P+N+E):

|           |  |
|-----------|--|
| 4.0sq.mm. | From D.B. to first power outlet                |
| 2.5sq.mm. | From first power outlet to second power outlet |

- In case of power socket outlet circuit having single 15 A power outlet (like water heater) (P+N+E):

|           |                            |
|-----------|----------------------------|
| 4.0sq.mm. | From D.B. to power outlet. |
|-----------|----------------------------|

- In case of 15 A. power outlet for window Air conditioner or other likewise appliances (P+N+E):

|           |                            |
|-----------|----------------------------|
| 4.0sq.mm. | From D.B. to power outlet. |
|-----------|----------------------------|

|  | <p>The earth continuity conductor shall be similar to circuit cables and shall be drawn through conduit along with other circuit cables. The size of the earth continuity conductor shall be as follows:</p> <p><b><u>MINIMUM SIZE OF EARTH CONTINUITY CONDUCTOR NOT FORMING PART OF THE SAME CABLE AS THE ASSOCIATE CIRCUIT CONDUCTOR</u></b></p> <table border="1"> <tr> <th>Nominal cross-section area of largest associated copper circuit conductor in sq.mm</th><th>Nominal cross-sectional area of earth continuity conductor in sq.mm.</th></tr> <tr> <td>1.5</td><td>1.5</td></tr> <tr> <td>2.5</td><td>2.5</td></tr> <tr> <td>4.0</td><td>4.0</td></tr> </table> <p>Separate circuit shall run for each water heater, kitchen equipment, window air conditioner, and similar outlets at location as shown on drawing</p> | Nominal cross-section area of largest associated copper circuit conductor in sq.mm | Nominal cross-sectional area of earth continuity conductor in sq.mm. | 1.5 | 1.5 | 2.5 | 2.5 | 4.0 | 4.0 |
|--|--|--|--|-----|-----|-----|-----|-----|-----|
| Nominal cross-section area of largest associated copper circuit conductor in sq.mm | Nominal cross-sectional area of earth continuity conductor in sq.mm.   |  |  |     |     |     |     |     |     |
| 1.5  | 1.5  |  |  |     |     |     |     |     |     |
| 2.5  | 2.5  |  |  |     |     |     |     |     |     |
| 4.0  | 4.0  |  |  |     |     |     |     |     |     |
|  | <p><b>SWITCHES</b></p> <ol style="list-style-type: none"> <li>Switches shall conform to IS: 3854, IS: 1293 and IS: 4615. The switches shall be single pole, single or two way as shown on the drawings or as specified. They shall be of moulded type rated for 250 volt, and of full 5/15 A capacity. They shall be provided with insulated dollies and covers</li> <li>The switches shall be rocker operated with a quiet operating mechanism with bounce free snap action mechanism enclosed in an arc resistant chamber.</li> <li>The switches shall have pure silver and silver cadmium contacts.</li> <li>The switches shall be flush modular type.</li> <li>The make of the switches shall be as indicated in the make of material or as suggested and approved by the client.</li> <li>The switches installed in outdoor areas shall be industrial, metal-clad type, and shall be provided in weatherproof enclosures, complete with weatherproof gasketed covers.</li> </ol>  |  |  |     |     |     |     |     |     |
|  | <p><b>SOCKETS</b></p> <ol style="list-style-type: none"> <li>The sockets shall conform to IS: 1293. Each socket shall be provided with control switch of appropriate rating. The sockets shall be moulded type, rated for 250 volts, and either of full 5 A or 15 A capacity or universal socket, as mentioned on the drawings.</li> </ol>   |  |  |     |     |     |     |     |     |

|  |  |
|--|--|
|  | <ol style="list-style-type: none"> <li>2. Sockets shall be of three pin type or five pin universal socket, the third in being connected to earth continuity conductor.</li> <li>3. The socket shall be flush modular type.</li> <li>4. The sockets installed in machine room, plant room or wet/damp area shall be metal clad weatherproof type.</li> <li>5. The finishing and make of all the sockets shall be same as switch.</li> <li>6. The socket shall have fully sprung contacts and solid brass shrouded</li> <li>7. Terminals to ensure positive electrical connections.</li> <li>8. The sockets shall be provided with automatic shutters, which open only when earth pin of the plug inserts in the socket.</li> <li>9. The socket shall be provided with three pin plug top suitable to the socket and of the same make as socket where required.</li> </ol> |
|  | <b><u>INSPECTION AND TESTING</u></b>   |
|  | <b>INSULATION RESISTANCE TEST</b>  |
|  | The insulation resistance shall be measured by applying 500-volt megger with all fuses in places, circuit breaker and all switches closed  |
|  | The insulation resistance in megohms of an installation, measured shall not be less than 50 megohms divided by the number of points on the circuit   |
|  | <p>The insulation resistance shall be measured between:</p> <ol style="list-style-type: none"> <li>1. EARTH TO PHASE</li> <li>2. EARTH TO NEUTRAL</li> <li>3. PHASE TO NEURAL</li> <li>4. PHASE TO PHASE</li> </ol>  |
|  | <b>EARTH CONTINUITY PATH</b>   |
|  | The earth continuity conductors shall be tested for electrical continuity and the electrical resistance of the same along with the earthing lead but excluding any added resistance or earth leakage circuit-breaker, measured from the connection, with the earth electrode to any point in the earth continuity conductor in the completed installation and shall not exceed one ohm   |
|  | <b>POLARITY OF SINGLE POLE SWITCHES</b>  |

|  |  |
|--|--|
|  | A test shall be made to verify that every no-linked, single pole switch is connected to one of the phase of the supply system  |
|  | <b>COMPLETION CERTIFICATES</b>   |
|  | All the above tests shall be carried out in presence of client and the results shall be recorded in prescribed forms. Any default during the testing shall be immediately rectified and that section of the installation shall be retested. The completed test result form shall be submitted to the client for approval.                            |
|  | On completion of an electric installation, testing and commissioning a certificate shall be furnished by the contractor, countersigned by the certified supervisor of contractor under whose direct supervision the installation was carried out. This certificate shall be in a prescribed form as required by the local electric supply authority. |
|  | <b><u>INSTALLATION OF THE SYSTEM</u></b>   |
|  | <b>CONCEALED INSTALLATION WITH RIGID PVC CONDUIT</b>   |
|  | All the rigid PVC conduit used for concealed installation shall be as per IS ; 9537 and its accessories shall be as per IS: 3419 (Small Wire Ropes).   |
|  | Whenever necessary bends or diversion may be achieved by bending the conduits with the help of bending spring. No other method of bending is allowed   |
|  | Conduit pipes shall be joined with the help of plain coupler fixed at the end with the help of vinyl solvent cement. No other method of joining is permissible   |
|  | All other methods, no wires through conduit, bunching, etc. Shall be as specified in the concealed installation  |
|  | Prior to fixing the conduits, the complete route shall be marked on site for the approval of consultant  |
|  | <b>CONCEALED WIRING SYSTEM WITH RIGID PVC CONDUIT</b>  |
|  | The rigid PVC conduits shall be used for concealed wiring system. The conduits shall be concealed in the concrete slab, floor, walls, beams, columns, etc.   |

|  | <b>FIXING OF CONDUIT</b>  |
|--|---|
|  | <ol style="list-style-type: none"> <li>1. Conduits embedded in concrete shall be installed in the frame work before pouring concrete. The conduits shall be installed above the bottom reinforcing bars, and shall provide positive wire fastening of the conduit to the reinforcing rods at an interval of not more than one meter, but on either side of couplers or bends or putlet/pull/junction boxes or similar fittings, proper hold fast shall be fixed at a distance of 30 cm from the center of such fittings. Conduits embedded in the wall shall be fixed inside the chase . The chase in the wall shall be neatly made and be fixed in the manner desired. In the case of building under construction, chase shall be provided in the wall at the time of their construction and shall be filled up neatly with cement mortar 1:4 after erection of conduit and brought to the original finish of the wall. Cutting of horizontal chases in walls is prohibited. The conduits shall be fixed inside the chase by means of staples or by means of saddles not more than 60 cm apart.</li> <li>2. Conduits shall be so arranged as to facilitate easy drawing of wires through them. Entire conduit layout shall be done in such a way as to avoid additional junction boxes other than light points. The wiring shall be done in a looping manner. All the looping shall be done in either switch boxes or outlet boxes. Looping in junction or pull boxes are strictly not allowed. Where conduits cross building expansion joints, adequate expansion fittings or other approved devices shall be used to take care of any relative movement</li> <li>3. Conduits shall be installed in such a way that the junction, derivation and pull boxes shall always be accessible for repairs and maintenance work. The location of junction/pull boxes shall be marked on the shop drawings and approved by the client.</li> <li>4. A separation of 200 mm shall be maintained between electrical conduits and hot water lines in the building.</li> <li>5. No run of conduit shall exceed ten mtr. between adjacent draw in points nor shall it contain more than two right angle bends, or other derivation from the straight line</li> <li>6. Caution shall be exercised in using the PVC conduits in location where ambient temperature is 50 degree cel. or above. Use of PVC conduits in places where ambient temperature is mote than 60 deg. cel. Is prohibited. The entire conduit system including boxes shall be thoroughly cleaned after completion of installations and before drawing of wires. Conduit system shall be erect and straight as far as possible. Traps where water may accumulate from condensation are to be avoided and if unavoidable, suitable provision for draining the water shall be made</li> </ol> <ol style="list-style-type: none"> <li>1. All jointing method shall be subject to the approval of the client</li> <li>2. Separate conduits shall be provided for the following system. <ul style="list-style-type: none"> <li>• 15 A power outlets.</li> <li>• 5 A outlets and lighting system.</li> </ul> </li> </ol> |



|  |  |
|--|--|
|  | <ul style="list-style-type: none"> <li>• Extra Low voltage system.</li> <li>• Telephone/intercom system.</li> <li>• C.C.T.V. system</li> <li>• Sound system</li> <li>• Computer data cabling system</li> <li>• Equipment wiring</li> </ul>   |
|  | <b>CONDUIT JOINT</b>   |
|  | <ol style="list-style-type: none"> <li>1. Conduits shall be joined by means of plain couplers vinyl and/or solvent cement. Where there are long runs of straight conduit, inspection type couplers shall be provided at intervals , as approved by the client</li> <li>2. The conduits shall be thoroughly cleaned before making the joints</li> <li>3. In case of plain coupler joints, proper jointing material like vinyl solvent cement (gray in color) or any material as recommended by the manufacturer shall be used.</li> </ol> |
|  | <b>BENDS IN CONDUIT</b>  |
|  | Wherever necessary, bends or diversions may be achieved by bending the conduits or by employing normal bends. No bends shall have radius less than 2.5 times outside dia. of the conduit.  |
|  | Heat may be used to soften the PVC conduit for bending, but while applying heat to conduit, the conduit shall be filled with sand to avoid any damage to the conduit   |
|  | <b>OUTLETS</b>   |
|  | All the outlets for fittings, switches etc. shall be boxes of substantial construction.  |
|  | In order to minimize condensation or sweating inside the conduits, all outlets of conduit system shall be properly drained and ventilated, but in such a manner as to prevent the entry of insects , etc.  |

|                            | Fixing between conduit and boxes, outlet boxes, switch boxes and the like must be provided with entry spouts and smooth PVC bushes.  |    |               |    |                            |                       |  |  |  |                       |  |  |  |  |    |    |               |   |     |   |    |     |    |
|----------------------------|--|----|---------------|----|----------------------------|-----------------------|--|--|--|-----------------------|--|--|--|--|----|----|---------------|---|-----|---|----|-----|----|
|                            | Joints between conduit and any type of boxes shall be affected by means of conduit couplers in to each of which shall be coupled smooth PVC bush from inside the box. In any case all the joints shall be fully water tight.   |    |               |    |                            |                       |  |  |  |                       |  |  |  |  |    |    |               |   |     |   |    |     |    |
|                            | <b>BUNCHING OF CABLES</b>  |    |               |    |                            |                       |  |  |  |                       |  |  |  |  |    |    |               |   |     |   |    |     |    |
|                            | Cables of AC supply of different phase shall be bunched in separate conduits   |    |               |    |                            |                       |  |  |  |                       |  |  |  |  |    |    |               |   |     |   |    |     |    |
|                            | <p>The number of insulated wires/ cables that may be drawn into the conduits shall be as per the following table. In this table, the space factor does not exceed 40%. However, in any case conduits having lesser than 19 mm dia. shall not be used.</p> <p><b>MAXIMUM PERMISSIBLE NUMBER OF 1100 VOLT GRADE SINGLE CORE CABLES THAT MAY BE DRAWN IN TO RIGID PVC CONDUITS.</b></p> <table border="1"> <thead> <tr> <th rowspan="2">CABLE<br/>SIZE IN<br/>MM SQ.</th><th colspan="4">SIZE OF CONDUITS (MM)</th></tr> <tr> <th colspan="4">MAXIMUM NO. OF CABLES</th></tr> </thead> <tbody> <tr> <td></td><td>25</td><td>32</td><td>38/<br/>4<br/>0</td><td>5</td></tr> <tr> <td>1.5</td><td>8</td><td>15</td><td>---</td><td>--</td></tr> </tbody> </table> |    |               |    | CABLE<br>SIZE IN<br>MM SQ. | SIZE OF CONDUITS (MM) |  |  |  | MAXIMUM NO. OF CABLES |  |  |  |  | 25 | 32 | 38/<br>4<br>0 | 5 | 1.5 | 8 | 15 | --- | -- |
| CABLE<br>SIZE IN<br>MM SQ. | SIZE OF CONDUITS (MM)  |    |               |    |                            |                       |  |  |  |                       |  |  |  |  |    |    |               |   |     |   |    |     |    |
|                            | MAXIMUM NO. OF CABLES  |    |               |    |                            |                       |  |  |  |                       |  |  |  |  |    |    |               |   |     |   |    |     |    |
|                            | 25   | 32 | 38/<br>4<br>0 | 5  |                            |                       |  |  |  |                       |  |  |  |  |    |    |               |   |     |   |    |     |    |
| 1.5                        | 8  | 15 | ---           | -- |                            |                       |  |  |  |                       |  |  |  |  |    |    |               |   |     |   |    |     |    |

|  |  |     |   |    |     |    |  |
|--|--|-----|---|----|-----|----|--|
|  |  | 2.5 | 6 | 10 | --- | -- |  |
|  |  | 4.0 | 4 | 8  | 12  | -- |  |
|  | <b>WIRING WITH RIGID STEEL CONDUIT</b>   |     |   |    |     |    |  |
|  | All conduits and it's accessories shall be of threaded type and under no circumstances pin grip type or clamp type accessories be used   |     |   |    |     |    |  |
|  | <b>FIXING OF RIGID STEEL CONDUIT</b>   |     |   |    |     |    |  |
|  | Conduit pipes shall be fixed by heavy gauge spacer bar saddles. The saddles shall be of 3 mm x 19 mm galvanized mild steel flat, properly treated and securely fixed to support by means of nuts and bolts raw bolts, brass machine screws, as mentioned, at an internal of not more than one meter but on either side of couplers, or bends, or junction/pull/outlet boxes or similar fittings, saddles shall be fixed at a distance of 30 cm from the centre of such fittings. |     |   |    |     |    |  |
|  | Draw boxes shall be located at convenient location for easy drawing of wires   |     |   |    |     |    |  |
|  | Every mains and sub mains shall run in independent conduits with an independent earth wire of specified capacity along the entire length of conduit  |     |   |    |     |    |  |
|  | The conduits to be installed shall be of ample cross section area to facilitate the drawing of wires. The diameter of the conduit shall be selected as per table specified in these specifications. But in no case it shall be less than 25 mm diameter  |     |   |    |     |    |  |
|  | Entire conduit layout shall be done such as to avoid additional junctions boxes other than for outlet points. Conduits shall be free from sharp edge and burrs. Conduits shall be laid in a neat and organized manner as directed and approved by the client. Conduit runs shall be planned so as not to conflict with any other services pipe, lines/duct.  |     |   |    |     |    |  |
|  | The entire conduit system shall be electrically and mechanically continuous and shall be bonded, together by means of approved type earthing clamp   |     |   |    |     |    |  |

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|  | and earthed through a bare copper conductor of 14 SWG to the earthing terminals on the nearest distribution board.  |
|  | If required, connection between PVC and steel conduits shall be through a junction box. Direct connection between PVC and steel conduits are not allowed  |
|  | Where exposed conduits are suspended from the structure, they shall be clamped firmly and rigidly to hangers of design to be approved by client. Where hangers are to be anchored to reinforced concrete, appropriate inserts and necessary devices for their fixing shall be left in position at the time of concreting, making holes and opening in the concrete will generally not be allowed. In case, it is unavoidable, prior permission of the client shall be obtained  |
|  | <b>RIGID STEEL CONDUIT JOINTS</b>   |
|  | Conduit pipes shall be joined by means of screwed couplers and screwed accessories, as per IS: 2667   |
|  | The threads shall be free from grease or oil  |
|  | In long distanced straight runs of conduit, inspection type couplers two way junction boxes at reasonable intervals shall be provided or running threads with couplers and lock nuts shall be provided. The bare threaded portion shall be treated with anti-corrosive paints. Threads on conduit pipes in all cases shall be between 11mm to 27mm long, sufficient to accommodate pipes to full threaded portion of couplers or accessories. Cut ends of conduit pipes shall have no sharp edges nor any burrs left, to avoid damage to the insulation of conductors while pulling them through such pipes |
|  | Brass female bushes shall be used in each conduit termination in a switch box, outlet box, electrical panel or any other box  |
|  | Conduit shall be secured in each outlet box switch box, electrical panel or any other box by means of one brass hexagonal lock nut and bush, outside and inside the box   |
|  | At each building, expansion joints approved oil tight double wire wound flexible steel conduit or any other approved method shall be used. This shall be united on both sides with the rigid conduits by suitable union   |
|  | Conduits installed in the plant room for mechanical equipment shall be properly clamped with the mechanical supports, but in no case, it shall be fixed with the body of the equipment  |

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|  | <p>The connection of conduit to the mechanical equipment shall be through oil tight double wire wound flexible steel conduit. In any case the length of the flexible conduit shall not exceed one meter. The flexible conduit shall be properly clamped with the body of the equipment. They shall not in any case be clamped with any cover or any removable parts of the equipment</p>   |
|  | <p><b>BENDS IN RIGID STEEL CONDUIT</b></p>   |
|  | <p>All necessary bends in the system including diversion shall be done by bending pipes or by inserting suitable solid or circular inspection type normal box or similar fittings. Conduit fittings shall be avoided as far as possible on conduit system exposed to weather, where necessary, solid type fittings shall be used. Radius of such bends in conduit pipes shall be not less than 75 mm. No length of conduit shall have more than the equivalent of four quarter bends from outlet, the bends at the outlets not being counted</p> |
|  | <p><b>PROTECTION AGAINST DAMPNESS</b></p>  |
|  | <p>In order to minimize condensation or sweating inside the conduit, all outlets of conduit system shall be properly drained and ventilated, but in such a manner as to prevent the entry of insects, as far as possible.</p>  |
|  | <p><b>PROTECTION OF CONDUIT AGAINST RUST</b></p>   |
|  | <p>The outer surface of the conduits including bends, junction boxes, etc., forming part of the conduit system shall be adequately protected against rust, particularly when such system is exposed to weather. In all cases, no bare/threaded portion of conduit pipe shall be allowed unless such bare threaded portion is treated with anti-corrosive coating or covered with approved plastic compound</p>   |
|  | <p><b>BUNCHING OF CABLES</b></p>   |
|  | <p>Unless otherwise specified, insulated conductors of different phases shall be bunched in separate conduit.</p>  |

|                      |  |    |     |     |  |                      |                       |  |  |  |  |                       |  |  |  |  |    |    |    |    |     |    |    |     |     |     |   |    |     |     |     |   |    |     |     |
|----------------------|--|----|-----|-----|--|----------------------|-----------------------|--|--|--|--|-----------------------|--|--|--|--|----|----|----|----|-----|----|----|-----|-----|-----|---|----|-----|-----|-----|---|----|-----|-----|
|                      | Wires carrying current shall be so bunched in the conduit that the out going and return wires are drawn into the same conduit. Wires originating from two different phases shall not be run in the same conduit  |    |     |     |  |                      |                       |  |  |  |  |                       |  |  |  |  |    |    |    |    |     |    |    |     |     |     |   |    |     |     |     |   |    |     |     |
|                      | <p>The number of insulated wires/cables that be drawn into the conduits shall be as per the following table.</p> <p>MAXIMUM PERMISSIBLE NUMBER OF 1100 VOLTS GRADE SINGLE CORE CABLE THAT CAN BE DRAWN INTO RIGID STEEL CONDUITS.</p> <table><tr><td>CABLE SIZE IN MM SQ.</td><td colspan="4">SIZE OF CONDUITS (MM)</td></tr><tr><td></td><td colspan="4">MAXIMUM NO. OF CABLES</td></tr><tr><td></td><td>25</td><td>32</td><td>38</td><td>51</td></tr><tr><td>1.5</td><td>10</td><td>14</td><td>---</td><td>---</td></tr><tr><td>2.5</td><td>8</td><td>12</td><td>---</td><td>---</td></tr><tr><td>4.0</td><td>6</td><td>10</td><td>---</td><td>---</td></tr></table> |    |     |     |  | CABLE SIZE IN MM SQ. | SIZE OF CONDUITS (MM) |  |  |  |  | MAXIMUM NO. OF CABLES |  |  |  |  | 25 | 32 | 38 | 51 | 1.5 | 10 | 14 | --- | --- | 2.5 | 8 | 12 | --- | --- | 4.0 | 6 | 10 | --- | --- |
| CABLE SIZE IN MM SQ. | SIZE OF CONDUITS (MM)  |    |     |     |  |                      |                       |  |  |  |  |                       |  |  |  |  |    |    |    |    |     |    |    |     |     |     |   |    |     |     |     |   |    |     |     |
|                      | MAXIMUM NO. OF CABLES  |    |     |     |  |                      |                       |  |  |  |  |                       |  |  |  |  |    |    |    |    |     |    |    |     |     |     |   |    |     |     |     |   |    |     |     |
|                      | 25   | 32 | 38  | 51  |  |                      |                       |  |  |  |  |                       |  |  |  |  |    |    |    |    |     |    |    |     |     |     |   |    |     |     |     |   |    |     |     |
| 1.5                  | 10   | 14 | --- | --- |  |                      |                       |  |  |  |  |                       |  |  |  |  |    |    |    |    |     |    |    |     |     |     |   |    |     |     |     |   |    |     |     |
| 2.5                  | 8  | 12 | --- | --- |  |                      |                       |  |  |  |  |                       |  |  |  |  |    |    |    |    |     |    |    |     |     |     |   |    |     |     |     |   |    |     |     |
| 4.0                  | 6  | 10 | --- | --- |  |                      |                       |  |  |  |  |                       |  |  |  |  |    |    |    |    |     |    |    |     |     |     |   |    |     |     |     |   |    |     |     |
|                      | <b>SWITCH AND SOCKET</b>   |    |     |     |  |                      |                       |  |  |  |  |                       |  |  |  |  |    |    |    |    |     |    |    |     |     |     |   |    |     |     |     |   |    |     |     |
|                      | Switches shall be installed at 900 mm above finished floor level unless otherwise indicated on the drawings.   |    |     |     |  |                      |                       |  |  |  |  |                       |  |  |  |  |    |    |    |    |     |    |    |     |     |     |   |    |     |     |     |   |    |     |     |
|                      | The switch controlling the light point or fan shall be connected on to the phase wire of the circuit and neutral shall be continuous, having no fuse or switch installed in the line except at the D.B. All fan regulators shall be fixed inside   |    |     |     |  |                      |                       |  |  |  |  |                       |  |  |  |  |    |    |    |    |     |    |    |     |     |     |   |    |     |     |     |   |    |     |     |

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|  | the switch boxes on adjustable flat M.S. strips/plates with tapped holes and brass machine screws, leaving ample space at the back and side for accommodating wires  |
|  | The cover plates to the switch box shall be fixed by means of sunk head brass cadmium screws   |
|  | Where two or more switches and fan regulators are installed together, they shall be provided with one gang cover plate with knockouts to accommodate required number of switches, sockets and regulators   |
|  | The switch controlling the socket outlet shall be on the phase wire of the circuit. The third pin of the socket shall be connected to the earth continuity conductor of the circuit  |
|  | The switch boxes, installed back-to-back in the same wall shall be offset from each other, 150 mm horizontally, to preclude noise transmission   |
|  | <b>DRAWING OF INSULATED CONDUCTORS</b>   |
|  | The drawing and joining of copper conductor or wires shall be executed with due regard to the following precautions. While drawing insulated wires into the conduits, care shall be taken to avoid scratches and kinks which may cause breakage of conductors. There shall be no sharp bends   |
|  | Insulation shall be shaved off for a length of 15 mm at the end of wire like sharpening of a pencil and it shall not be removed by cutting it square or ringing  |
|  | FRLSZH insulated copper conductor wire ends before connection shall be properly soldered (at least 15 mm length) with soldering flux/copper solder, for copper conductor. Strands of wires shall not be cut for connecting to the terminals. All strands of wires shall be soldered at the terminals. All strands of wires shall be soldered at the end before connection. The connecting brass-screws shall have flat ends. All looped joints shall be soldered and connected through terminals block/connectors. The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less. Conductors having nominal cross section exceeding 4 sq. mm shall always be provided with crimping type cable sockets. At all bolted terminals, brass flat washer of large area and approved steel spring washers shall be used. Brass nuts and bolts shall be used for all connections |
|  | Only certified wire men and cable jointers shall be employed to do joining work  |
|  | For all internal wiring FRLSZH insulated wires of 1100 volts grade shall be used. The sub-circuit wiring for point shall be carried out in looping system  |

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|  | and no joint shall be allowed in the length of the conductors. No wire shall be drawn in to any conduit, until all work of any nature that may cause injury to wire is completed. Care shall be taken in pulling the wires so that no damage occurs to the insulation of the wire. Before the wires are drawn into the conduits the conduits shall be thoroughly cleaned of moisture, dust, and dirt or any other obstruction by forcing compressed air through the conduits |
|  | <b>JOINTS</b>  |
|  | The wiring shall be by looping back system, and hence all joints shall be made at main switches, distribution boards, socket outlets, lighting outlets and switch boxes only. No joints shall be made inside conduits and junction boxes.  |
|  | Contractors shall be continuous from outlet to outlet. For joints where unavoidable, due to any specified reasons, prior permission in writing shall be obtained from the client before making such connections. Joints by twisting conductors are prohibited.   |
|  | <b>LOAD BALANCING</b>  |
|  | Balancing of circuit in three phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.  |
|  | <b>EARTHING</b>  |
|  | All earthing systems shall be in accordance with IS: 3043 - 1985 code of practice for earthing.  |

## 6.9 TECHNICAL SPECIFICATIONS FOR FIRE EXTINGUISHER



This section covers Design, Supply, Installation, Testing & Commissioning of portable fire extinguishers for North Entrance Gate, Security Cabins-Offices in accordance with NBC 2016 Part 4 and IS 2190.

### **6.9.1 Scope**

1. Carry out fire risk assessment and determine type, quantity, and location of extinguishers as per IS 2190 and NBC 2016 for “Mercantile/Office” occupancy. Submit plan location of fire extinguisher for Client approval.
2. Supply, install, test, commission portable extinguishers with cabinets/signage.
3. Provide initial filling, inspection tag, and training to Client’s staff.
4. Include maintenance during DLP.
5. Provide test certificate, warranty, etc.

### **6.9.2 CODES & STANDARDS**

1. IS 2190:2010 – Selection, Installation & Maintenance of Portable Fire Extinguishers
2. IS 15683:2018 – Portable Fire Extinguishers – Specification for Dry Powder Type
3. IS 13849:2018 – Portable Fire Extinguishers – Specification for CO2 Type
4. NBC 2016, Part 4 – Fire & Life Safety
5. IS 15683 – BIS certification mandatory

### **6.9.3 TYPES & TECHNICAL REQUIREMENTS**

Contractor shall supply as per approved risk assessment. Minimum types required:

1. ABC Dry Powder Extinguisher – Primary Type
  - Capacity: 6 kg
  - Type: Stored pressure, cartridge type not accepted
  - Extinguishing Media: ABC Mono Ammonium Phosphate Powder, min 90% purity
  - Body: Seamless MS, epoxy powder coated, red color RAL 3000
  - Operating Pressure: 15 bar  $\pm$  1 bar at 27°C
  - Discharge Time: Min 15 seconds
  - Throw: Min 4 meters

- Operating Temp: -5°C to +55°C
- Certification: BIS as per IS 15683, ISI marked
- Accessories: Pressure gauge, safety pin with seal, discharge hose 600mm min, wall mounting bracket
  - Warranty: 5 years on body, 2 years on charge
- 2. CO2 Extinguisher – For Electrical Panel/Server Rack location
- Capacity: 3 kg or 4.5 kg
- Type: Stored pressure, steel cylinder
- Extinguishing Media: CO2 gas, 99.5% purity
- Discharge Time: Min 8 seconds for 3kg
- Horn: Die-cast aluminum, discharge horn
- Certification: BIS as per IS 13849
- Accessories: Safety pin with seal, wall bracket, etc.

#### **6.9.4 QUANTITY & LOCATION – INDICATIVE**

Contractor to finalize based on travel distance  $\leq 15\text{m}$  as per IS 2190. Indicative minimum:

1. Cabin / Office – 1 No. 6kg ABC near entrance of each office/cabin, mounted at 1.2m height to handle
  2. Electrical room/Server Area – 1 No. 6kg ABC + 1 No. 3kg CO2 near electrical panel
- Total minimum: 4 Nos. 6kg ABC + 1 No. 3kg CO2.

#### **6.9.5 INSTALLATION REQUIREMENTS**

1. Mounting Height: Top of extinguisher not more than 1.5m from FFL.
2. Signage: Wall signboard 200x300mm above extinguisher: “FIRE EXTINGUISHER”
3. Install after painting work complete, before handover.
4. Mount on wall using MS bracket supplied with extinguisher. Fix with 2 Nos. 8mm anchor bolts.
5. Ensure extinguisher is easily accessible, not obstructed by door or furniture.
6. Keep away from direct sunlight and heat sources.
7. For outdoor location, provide weatherproof cabinet IP55 min.

#### **6.9.6 TESTING & COMMISSIONING**

1. Visual inspection: Body, gauge, seal, label, ISI mark.
2. Pressure test certificate from manufacturer for each extinguisher.
3. Hydrostatic test certificate for cylinder, valid for 5 years.
4. Functional check of safety pin and seal.
5. Submit test certificates and commissioning report signed by Contractor.

#### **6.9.7 MAINTENANCE & SUBMITTALS**

1. Contractor to provide maintenance during DLP: quarterly inspection, refill if discharged.

Submittal For Approval:

1. Fire extinguisher layout drawing showing location.
2. TDS of extinguisher, BIS certificate, hydro test certificate.
3. Signage sample.
4. At Completion: As-built layout, commissioning report, warranty certificates.

### 6.10 APPROVED MAKE OF ELECTRICAL COMPONENT/EQUIPMENT

| Sl. No. | Item   | Sub-Vendor's Name  |
|---------|--|--|
| 1       | 1.1kV Cables / Wires   | FINOLEX / UNIVERSAL / KEI / HAVELLS / POLYCAB / R R KABEL  |
| 2       | LUGS / BIMETALLIC LUGS / DOUBLE COMPRESSION CABLE GLAND WITH EARTHING LINK | Dowells/ HMI / Comet   |
| 3       | LT Panel / Switchboard   | ADVANCE PANELS AND SWITCHGEARS / ACTIVE ENGINEERS / SHIVSHAKTI ENGINEERS / SOHAM ELEC INFRA / SUN AUTOMAT CONTROLS |
| 4       | MCBDB / DISTRIBUTION BOARDS  | ABB / SIEMENS / SCHNEIDER / LK / LEGRAND   |
| 5       | LT Switchgear - Air circuit breaker, MCCB, MCB, MPCB, ELCB, Isolator / ATS | SIEMENS / SCHNEIDER / LK / LEGRAND / ABB   |
| 6       | PANEL BUSBAR   | Hindalco / Vedanta   |
| 7       | Timer  | Lauritz Knudsen – GIC / ABB / Siemens / Legrand  |
| 8       | MODULAR SWITCHES, SOCKETS, SWITCH BOXES & OTHER ACCESSORIES                | Legrand / Anchor Roma Urban / Honeywell  |
| 9       | Cable Trays  | Indiana/NEM/Reliance/OBO   |
| 10      | DWC PIPE   | REX / NOBLE / ASTRAL / Supreme   |

|    |   |  |
|----|---|--|
| 11 | PVC CONDUITS, CASING-CAPING, PVC TRUNKING AND ACCESSORIES | Precision / RMCON / Polycab / Nihir                |
| 12 | Metal CONDUITS AND ACCESSORIES (GI / MS)                  | BEC / RMCON / BHARAT / AKG                         |
| 13 | METAL FLOOR TRUNKING / Raceway / JB                       | LEGRAND / HONEYWELL                                |
| 14 | INTERNAL LIGHT FIXTURE                                    | BAJAJ / PHILIPS / OSRAM / HAVELLS / WIPRO / ACON   |
| 15 | EXTERNAL LIGHT FIXTURE                                    | CASTALDI / PHILIPS / ACON / HAVELLS                |
| 16 | FACADE LIGHTING   | COLOR KINETICS / ACON / IGUZZINI / ERCO / SCHREDER |
| 17 | CEILING FAN / EXHAUST FAN                                 | HAVELLS / CG / BAJAJ                               |
| 18 | ELECTRIC GEYSER   | HAVELLS / CG / BAJAJ / AO SMITH                    |
| 19 | POLE  | Philips / ACON / FABRICATED / BAJAJ                |
| 20 | UPS SYSTEM  | NUMERIC / EMERSON / APC / FUJI                     |
| 21 | EARTHING SYSTEM   | JEF / SOHAM / Cape                                 |
| 22 | LIGHTNING PROTECTION                                      | ABB / JEF / Cape                                   |
| 23 | IP JUNCTION BOX   | HENSEL / HAGER / SCAME / OBO                       |
| 24 | FIRE Extinguisher   | CEASEFIRE / KANEX / MINIMAX / HONEYWELL            |

## **7. TECHNICAL SPECIFICATIONS FOR EQUIPMENTS OF HVAC**

### **2.1. Air Cooled DX - Hi-wall type Split Unit**

The unit shall consist of an outdoor unit (air-cooled condensing unit) and an indoor unit (evaporating unit) - 3 star and an electronic remote-control unit.

#### **a) Outdoor Unit:**

The outdoor unit shall house the compressor, condenser with fan, in a sheet metal cabinet.

The cabinet shall be pre-treated and powder coated for long life in outdoor installation, and shall have acoustic lining for noise reduction. The condenser coil shall be made from copper tubes and aluminum fins firmly bonded. The Condenser fan shall be propeller type with water proof, design for low noise. The compressor shall be hermetically sealed scroll type, suitable for single phase 230V + 6%, AC, 50 Hz power supply, with built-in overload protection, mounted on vibration isolator rubber mounts.

#### **b) Indoor Unit:**

The indoor unit (Evaporator Unit) shall have a plastic molded body, housing the finned cooling coil made of 6.5mm Dia. copper tubes and aluminum fins, capillary tube for expansion, drain pan, silent centrifugal fan with single phase motor, automatic swinging vanes etc.

#### **c) Electronic Control Unit:**

A cordless remote electronic control unit having the functions of temperature setting, ON-OFF for fan & compressor, speed control of evaporator fan, shall be provided along with the indoor unit.

#### **d) Drain Piping**

The drain piping shall be made of rigid UPVC pipes of 6 Kg/cm<sup>2</sup> class. The piping shall be supported by clamping continuously below the pipe. The piping shall be insulated with 9 mm thick closed cell nitrile rubber sleeves. U trap shall be provided in the drain connection of each IDU.

#### **e) Refrigeration pipe:**

Closed cell, Elastomeric Nitrile Rubber tubing insulation of Minimum 13 mm thickness with fire performance to Class ‘O’ as per BS 476 Part 6:1989 shall be used for insulation of Refrigerant lines. Thermal conductivity of insulation shall not exceed 0.038 W/mK at an average temperature of 30 deg C. Insulation shall have all joints suitably bonded and shall be protected, with woven GRP Mat finished with coloured epoxy paint to withstand outside ambient conditions and UV radiation when exposed to atmosphere. The product shall have temperature range of -40 to 105 deg C.

#### 8. LIST OF APPROVED MAKES FOR HVAC

| Sr. No. | Material                              | Make                       |
|---------|---------------------------------------|----------------------------|
| 1       | Hi-wall split units                   | Daikin/Hitachi/Mitsubishi  |
| 2       | Elastomeric-Nitrile rubber insulation | Armaflex / K-flex / A-flex |
| 3       | Electrical Cables                     | Polycab/Havells            |
| 4       | Refrigerant Copper Pipe               | Rajco/Mandev/Maxflow       |
| 5       | Drainpipe                             | Prince /Astral/Supreme     |
| 6       | Control Cables                        | Polycab/Havells            |

## **9.0 Technical Specifications for Plumbing, Sanitary & Water Cooler**

### **1.SCOPE OF WORK**

This section covers Design, Supply, Installation, Testing & Commissioning of complete internal plumbing, sanitary, water storage, water heating, and drinking water system for Office/Security Cabin.

### **2.Contractors/Bidders Responsibility**

1. Carry out hydraulic calculations, pipe sizing, water demand calculation, drainage gradient design. Submit for Client/PMC approval.
2. Supply, install, test, commission complete system including pipes, fittings, valves, sanitary ware, water cooler, geyser, storage tanks, Arrangement for water lifting up to the storage tank, etc. Necessary wiring and piping work for gyser and water cooler included in scope of work.
3. Scope includes connection to GIFT supply main water line to site required location. STP/Septic tank line connection.
4. Provide as-built drawings, test reports, O&M manual, warranty.

### **3. Important Note on Plumbing Work**

Architecture drawing currently does not show toilets. This specification includes attached toilet-bathroom for Offices/security cabin as provisional scope. If architecture excludes it, Contractor to exclude toilet-washroom related items but retain water cooler, its require water supply and piping provision in scope.

### **4. CODES & STANDARDS**

1. IS 2065 – Code of Practice for Water Supply in Buildings
2. IS 1172 – Basic Requirements for Water Supply, Drainage & Sanitation
3. IS 2527 – CPVC Pipes for Hot & Cold Water
4. IS 4985 – HDPE Pipes for Water Supply
5. IS 13592 – SWR PVC Pipes for Drainage



6. IS 2556 – Sanitary Appliances

7. NBC 2016, Part 9 – Plumbing Services

## 5. WATER DEMAND & STORAGE

- Water Demand Calculation – It shall be in Contractor Scope
- Basis: 45 liters/person/day for office + 15 liters for toilet flushing as per NBC.
- Indicative load: 9-10 persons
- Contractor to calculate and submit for approval.

## 6. Water Storage Arrangement

1. Overhead Tank: 500 Liters capacity HDPE tank, 3-Layer, UV stabilized, IS 12701, for office. Mounted on high MS frame on roof.
2. Inlet: 25mm HDPE pipe from GIFT supply line connection with 25mm Brass Float Valve in tank.
3. Outlet: 20mm CPVC downtake to toilets + 15mm to water cooler + 15mm to geyser.
4. Overflow & Washout: 25mm PVC overflow to outside up to Ground level, 25mm drain plug.

## 7. WATER SUPPLY PIPING

### 7.1 Cold Water Distribution

- Main Inlet: 25mm HDPE PN6 pipe from supply tapping point to each office.
- Internal Distribution: CPVC SDR-11 pipes as per IS 2527.
- Geyser inlet: 20mm CPVC
- Cold water to Wash Basin, Cold to WC flush tank, Water Cooler: 15mm CPVC
  - Fittings: CPVC solvent weld fittings of same make.
  - Valves: 15mm Brass Ball Valve at entry to each fixture for isolation.

## 7.2 Hot Water – Geyser

- Geyser: 3-6 Liter, ISI marked, 5-Star BEE rated, vertical mounting, glass-lined inner tank, 5-year warranty. Make: Racold, Bajaj, Havells.
  - Location: In toilet, wall mounted.
  - Connection: 15mm CPVC hot water outlet to bath tap. Cold inlet from 20mm CPVC.
  - Safety: Pressure relief valve, thermostat, thermal cutout.
  - Power: Fed from 20A socket on normal DB, not UPS.

## 8. SANITARY WARE & CP FITTINGS

If toilet is considered, provide as per below:

### 8.1 Sanitary Appliances

1. European WC – EWC: Vitreous China, S-trap, flush cistern 3/6L, white.
2. Wash Basin: Pedestal type, Vitreous China, min. 550mm wide, with bottle trap and waste coupling.
3. Urinal: Half-stall type Vitreous China with auto flushing cistern, if urinal required. Otherwise omit.

### 8.2 CP Fittings – Brass, Chrome Plated

1. Pillar Tap for Basin: Single lever, 15mm.
2. Bib Tap for Geyser inlet: 15mm long body.
3. Angle Valve: 15mm, for WC & Basin connection.
4. Waste Coupling + Bottle Trap for Basin: 32mm, CP brass.
5. CP Brass Shower & Health Faucet.

### 8.3 Accessories

- Toilet Paper Holder, Soap Dish & Soap Dispenser – SS304.
- Mirror 600x450mm with wooden frame.

## 9.DRAINAGE & WASTE SYSTEM

### 9.1 Soil & Waste Pipes

- WC Waste: 110mm SWR PVC pipe, IS 13592, Type B.
- Wash Basin, T&P Discharge: 75mm SWR PVC.
- Vent Pipe: 75mm SWR PVC taken up to 1m above roof, with cowl.
- Fittings: SWR fittings with EPDM rubber ring.

### 9.2 Drainage Layout

- Gradient: 1:50 for 110mm, 1:60 for 75mm.
- Floor Trap: 100mm CP brass grating in toilet.
- Final Disposal: Connect to Employer's existing STP line. If not available, provide 1000 Liter RCC Septic Tank + Soak Pit for office as per IS 2470.

## 10. WATER COOLER – DRINKING WATER

1. Type: Water Cooler, 40 LPH cooling capacity with required RO plant.
2. Features: SS304 storage tank, compressor cooling, hot + cold + normal, ISI marked.
3. Location: In Gate office/ security cabin or common space.
4. Connection: 15mm CPVC cold water inlet with 5-micron filter + 0.5-micron carbon filter.  
Drain to floor trap.
5. Power: 230V, 500W max, from Normal DB, not UPS.
6. Make: Blue Star, Voltas, Usha.

## 10. INSTALLATION REQUIREMENTS

1. Conceal CPVC pipes in wall chase, cover with mesh before plaster. Exposed pipes in GI clamps at 1m spacing.
  2. Pressure test cold water line at 6 kg/cm<sup>2</sup> for 2 hours, hot water at 4 kg/cm<sup>2</sup>.  
No leakage permitted.
  3. Sanitary fixtures to be fixed level, plumb, with proper rubber gaskets.
  4. Maintain 25mm clearance between hot & cold pipes.
  5. Provide isolation valve for toilet and for water cooler.

## 11. TESTING & COMMISSIONING

1. Hydraulic test for water supply: 1.5 times working pressure for 2 hours.
2. Submit test reports, commissioning certificate.

## 12. SUBMITTALS

For Approval:

- Hydraulic calculation, pipe sizing, water demand calculation
- Layout showing pipe routing, tank, geyser, cooler location
- TDS of pipes, fittings, sanitary ware, geyser, cooler

At Completion: As-built drawings, test reports, O&M manuals, warranty cards.

## 13. Approved Make list

| Sr. No. | Material       | Make                          |
|---------|----------------|-------------------------------|
| 1       | ALL<br>SANITAR | SLOAN/EURONICS/DOLPHY/GEBERIT |

| Sr. No. | Material  | Make                                  |
|---------|---|---------------------------------------|
|         | Y<br>FITTINGS   |                                       |
| 2       | ALL BATH &<br>CP<br>FITTINGS                                      | SLOAN/EURONICS/DOLPHY/GEBERIT         |
| 3       | CONCEALED<br>FLUSHIN<br>G<br>CISTERN                              | GEBERIT / EURONICS / DOLPHY /<br>TOTO |
| 4       | CONCEALED<br>FLUSH<br>VALVE                                       | SLOAN/EURONICS/DOLPHY/JAQUAR          |
| 5       | SHOWER<br>DRAINS/<br>FLOOR<br>DRAINS                              | GEBERIT/EURONICS/DOLPHY/JAQUAR        |
| 6       | SOAP<br>DISPENSE<br>R   | SLOAN / TOTO / EURONICS / DOLPHY      |
| 7       | UPVC PIPE,<br>BALL<br>VALES &<br>FITTINGS<br>(SCH 40 &<br>SCH 80) | SUPREME / ASTRAL / ASHIRVAD           |

| Sr. No. | Material  | Make                        |
|---------|---|-----------------------------|
| 8       | HOT WATER<br>SUPPLY<br>PIPE<br>CPVC<br>(SDR 13.5 /<br>SDR 11) | SUPREME / ASTRAL / ASHIRVAD |
| 9       | SOIL, WASTE,<br>VENT<br>RAIN<br>PIPELINE<br>UPVC<br>SWR       | SUPREME / ASTRAL / ASHIRVAD |
| 1       | SOVENT /<br>ADV<br>SYSTEM<br>(P.A.P.A)                        | GEBERIT / ASTRAL / ASHIRVAD |
| 1       | BALL<br>VALVES -<br>BRASS /<br>SS                             | SANT / HONEYWELL / GEBERIT  |
| 1       | NRV, PRV,<br>AIR<br>RELEASE<br>VALVE,<br>CHECK<br>VALVES,     | SANT / HONEYWELL / GEBERIT  |

| Sr. No. | Material                  | Make                                   |
|---------|---------------------------|--|
|         | FLOT<br>VALVE             |  |
| 1       | RO PLANT                  | IONEXCHANGE/THERMAX/AQUAGUARD/KE<br>NT |
| 1       | WATER<br>COOLER<br>SYSTEM | VOLTAS / BLUE STAR / USHA              |
| 1       | WATER<br>STORAGE<br>TANKS | SUPEREM / ASHIRVAD / ASTRAL            |



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