

RFP No. HML / INFRA / 01 / 2021

**REQUEST FOR PROPOSAL (RFP)
FOR SELECTION OF
DESIGN & BUILD CONTRACTOR
FOR DEVELOPMENT OF PHYSICAL INFRASTRUCTURE AND
CONSTRUCTION OF ADMINISTRATIVE BLOCK AT
MEDIPARK IN CHENGALPATTU DISTRICT, TAMIL NADU**

**VOLUME IV
SCHEDULE OF WORKS**

**SCHEDULE 6
ADMINISTRATIVE BLOCK**



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SCHEDULE 6: ADMINISTRATIVE BLOCK**1. Architectural and Civil Works****1.1 Authority Requirements**

An Administrative Building block is to be constructed by the Contractor close to the Main entrance of the park. The intent design drawings enclosed in this Schedule are indicative, and the Contractor can propose minor modifications to the design/ drawings provided, based on the formwork technology that they intend to propose and implement for the Administrative building of Medipark project. Additionally, external development works like site grading & levelling, Compound walls (sides & rear), Front compound wall with MS gates, Underground sump tank of capacity 10,000 Liters, Driveways and parking areas with precast RCC paver slab with PCC M10 grade concrete as base, Precast RCC kerb to edges of driveway & parking areas etc. are part of the requirements. Further, the Bidder's proposal should be depending upon mentioned components and specifications with respect to conditions set forth in SCC of Volume 3. The Contractor should see that the Authority should not be charged for any financial implications due to new form of technology being proposed.

The Contractor must conduct a Soil Investigation survey at the location where the Administrative building and other civil structures are proposed, and suitably consider the findings of the survey before designing and constructing of the structures.

A. Project Components

The Project Facilities to be provided as per enclosed drawings/ details after proper designing as per standards and execution of the same, shall include the following:

1. Administrative Building – 1 No.

Engineering and execution of Administrative building with all external development work like site leveling & grading, compound wall (all three sides), Front compound wall as per design with MS gates (at entry & exit) as per requirements, UG sump (capacity 10000 Ltrs.), External driveway and parking with interlock paver blocks & kerb stone at edges, Precast cover slab over storm water drain etc.

The Contractor has to design the administrative block for Ground plus 2 upper floors and execution of the building as per plan, cross section and elevation drawings enclosed and as per structural design/ drawings/ details, for Ground floor and part in First floor.

- Total site area (40.11m x 54.34m) – 2180.0 Sqm.
- Total Built-up Area (Ground Floor) – 566.0 Sqm.
- Total Built-up Area (Part in First Floor) – 47.0 Sqm.
- Total Carpet Area – 548.0 Sqm.
- Total Roof Area (RCC for GF and FF) – 613.0 Sqm.
- Height – 3.5m (floor to floor)

B. Specifications**1. Administrative Building – External Development Works**

- a. Clearing the site of light jungle/ scrub jungle

- b. Site leveling and grading including filling with available earth or with borrowed earth as per requirement including consolidation.
- c. Plain cement concrete of grade M-10 for bed concrete below precast RCC pavement slab – Driveways and Parking areas.
- d. Providing and fixing at or near ground level, factory made RCC pavement slab of M-30 grade cement concrete and of size 450x 450x 50mm, including setting in position in footpath to the required level, line and curvature, over a bed of 20 mm average thick cement mortar 1:5 (1 cement: 5 coarse sand), having joint thickness not more than 5mm except on curve, including filling of joints with same cement mortar and making grooves etc. Complete – Driveways and Parking areas.
- e. Providing and placing in position 100mm thick factory made machine batched & machine mixed precast RCC rectangular covers on drains of footpath of various sizes, of M-25 grade cement concrete for RCC work, including cost of centering, shuttering, reinforcement of 8mm dia. TMT bars of FE 500 grade @ maximum 100mm c/c on both ways, neat cement punning on finished surface, properly encased on all edges with 1.6mm thick, 100mm wide MS sheet duly painted over priming coat, reinforcement to be welded at edges with MS sheet and providing 2 nos. of 12mm dia. bar for hooks etc. including cost of cartage, all leads & lift, handling at site etc. all complete – Storm water drain in site front.
- f. Providing and laying at or near ground level, factory made kerb stone of M-25 grade cement concrete, in position to the required line, level and curvature, jointed with cement mortar 1:3 (1 cement: 3 coarse sand) including making joints with or without grooves (thickness of joints except at sharp curve shall not be more than 5mm) including making drainage opening wherever required complete etc. as per direction of Authority's Engineer – Driveways and Parking areas.

2. Administrative Building – Under Ground Sump

- a. To design & execute as per water storage requirement
- b. Earthwork excavation for UG sump, to required size and depth, in all types of soil/ soft rock/ hard rock including depositing excavated earth away from the excavation area with all lead & lift, trimming the bottom and sides, all as per standard practice and structural requirement.
- c. Plain cement concrete of grade M-10 for bed concrete with necessary form work.
- d. Filling to sides of footings/ foundations and inside plinth either with available earth or with borrowed earth as per requirement including consolidation.
- e. Machine batched and machine mixed design mix M-25 grade cement concrete for RCC works, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Authority's Engineer.

- f. Centering and shuttering including strutting, propping etc. and removal of form for
 - Foundations, footings, bases of columns, etc. for mass concrete
 - Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.
 - Suspended floors, roofs, landings, balconies and access platform
 - Lintels, Beams, Plinth beams, Girders, Bressumers and cantilevers
 - Columns, Pillars, Piers, Abutments, Posts and Struts
 - Weather shade, chajjas, corbels etc. including edges
- g. Reinforcement to all RCC works as per structural design/ drawings/ details using thermo mechanically treated bars of grade FE-500D or more
- h. 52 mm thick cement concrete flooring with concrete hardener topping, under layer 40 mm thick cement concrete 1:2:4 and top layer 12 mm thick cement hardener consisting of mix 1:2 (1 cement hardener mix : 2 graded stone aggregate 6 mm nominal size)
- i. Water proofing treatment on roofs of slabs by applying cement slurry mixed with water proofing cement compound consisting of applying a) after surface preparation, first layer of slurry of cement @ 0.488 kg/sqm mixed with water proofing cement compound @ 0.253 kg/sqm. b) laying second layer of Fibre glass cloth when the first layer is still green. Overlaps of joints of fibre cloth should not be less than 10 cm. c) third layer of 1.5 mm thickness consisting of slurry of cement @ 1.289 kg/sqm mixed with water proofing cement compound @ 0.670 kg/sqm and coarse sand @ 1.289 kg/sqm. This will be allowed to air cure for 4 hours followed by water curing for 48 hours. The entire treatment will be taken upto 30 cm on parapet wall and tucked into groove in parapet all around. d) fourth and final layer of brick tiling with cement mortar (which will be paid for separately).
- j. Providing gola 75x75 mm in cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 10 mm and down gauge), including finishing with cement mortar 1:3, as per standard design
- k. Watertight Manhole frame and cover (Medium type) of size 0.60m x 0.60m in RCC 1:11/2:3 with suitable reinforcement and 50 x 50 x 6mm MS angle fixed along edges and as directed by the TWAD Board Officers.
- l. All internal concrete/ masonry surfaces plastered with CM and finished with lime rendering/ cement rendering. All external concrete/ masonry surfaces plastered with CM and sponge finished.
- m. All cement mortar used for plastering, should be mixed with waterproofing compound in proportion recommended by the manufacturers.
- n. All external plastered surfaces finished with Premium Acrylic Smooth exterior paint with Silicone additives of required shade (Two or more coats) including priming coat of exterior primer.

3. Administrative Building – Compound Wall

- a. To design & execute as per typical cross section and elevation drawing enclosed.
- b. Earthwork excavation for column/ wall footings and foundations, to required size and depth, in all types of soil/ soft rock/ hard rock including depositing excavated earth away from the excavation

area with all lead & lift, trimming the bottom and sides, all as per standard practice and structural requirement.

- c. Plain cement concrete of grade M-10 for bed concrete with necessary form work.
- d. Wall foundation as per structural requirement to required width and depth using solid concrete blocks of 200mm width or as specified in CM 1:6.
- e. Filling to sides of footings/ foundations and inside plinth either with available earth or with borrowed earth as per requirement including consolidation.
- f. Solid concrete block masonry walls of 200mm thick upto 1.5m height above plinth.
- g. Plastering to masonry surfaces in CM and sponge finished including making putty/ grooves as per elevation etc.
- h. All cement mortar used for plastering, should be mixed with waterproofing compound in proportion recommended by the manufacturers.
- i. Ceramic glazed wall tiles 1st quality conforming to IS:15622 (thickness to be specified by the manufacturer), of approved make, in all colours, shades & of any size as approved by Engineer-in Charge, in skirting, risers of steps and dados, over 12mm (average) thick bed of cement mortar 1:3 (1 cement : 3 coarse sand) and jointing with grey cement slurry @ 3.3 kg/ sqm. including pointing the joints with white cement and matching pigments etc. complete.
- j. Steel work welded in built-up sections/ framed work, including cutting, hoisting and fixing in position including providing and applying a coat of approved steel primer using structural steel etc. as required in MS gates (Considering 45 Kg./ sqm.)
- k. All external plastered surfaces finished with Premium Acrylic Smooth exterior paint with Silicone additives of required shade (Two or more coats) including priming coat of exterior primer.
- l. All steel surfaces finished with synthetic enamel paint (two or more coats) of approved brand and manufacture of required colour over an under coat of suitable shade with ordinary paint of approved brand and manufacture including priming coat with approved steel primer.

4. ADMINISTRATIVE BUILDING – Civil Works

- a. To design the administrative block for Ground plus 2 upper floors.
- b. To execute as per plan, cross section and elevation drawing enclosed and as per structural design/ drawings/ details, for Ground floor and part in First floor.
- c. Earthwork excavation for column/ wall footings and foundations, to required size and depth, in all types of soil/ soft rock/ hard rock including depositing excavated earth away from the excavation area with all lead & lift, trimming the bottom and sides, all as per standard practice and structural requirement.

- d. Pre-constructional anti-termite treatment for excavated areas, inside plinth and around plinth.
- e. Plain cement concrete of grade M-10 for bed concrete with necessary form work.
- f. Wall foundation as per structural requirement to required width and depth using solid concrete blocks of 200mm width or as specified in CM 1:6.
- g. Filling to sides of footings/ foundations and inside plinth either with available earth or with borrowed earth as per requirement including consolidation and having 100mm thick PCC M10 bed concrete on top.
- h. Machine batched and machine mixed design mix M-25 grade cement concrete for RCC works, as per structural design/ drawings/ details, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Authority's Engineer.
- i. Centering and shuttering including strutting, propping etc. and removal of form for
 - Foundations, footings, bases of columns, etc. for mass concrete
 - Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.
 - Suspended floors, roofs, landings, balconies and access platform
 - Lintels, Beams, Plinth beams, Girders, Bressumers and cantilevers
 - Columns, Pillars, Piers, Abutments, Posts and Struts
 - Stairs (excluding landings) except spiral staircase
 - Weather shade, chajjas, corbels etc. including edges
- j. Reinforcement to all RCC works as per structural design/ drawings/ details using thermo mechanically treated bars of grade FE-500D or more
- k. Masonry work with solid concrete blocks of 200mm width or as specified, for walls, piers and architectural features, in CM 1:6 for super-structure using solid concrete blocks of approved quality, size and of grade D(3.5) blocks as per IS: 2185 (Part I) - 1979 including necessary scaffolding, raking of joints, finishing, curing etc., complete with all lead & lift for all materials & labour and as directed, at all heights & locations (with minimum compressive strength of blocks should be 35 kgs./ sqcm.).
- l. Flagging concrete around the building to a width of 600mm with PCC 1:3:6 concrete including finishing the top surface with 15mm thick cement plaster 1:4 and with a floating coat of neat cement.

5. Administrative Building – Finishing Works

- a. Flooring/ Skirting/ Dadoing – To be as per details provided in architectural drawings
 - i. 52 mm thick cement concrete flooring with concrete hardener topping, under layer 40 mm thick cement concrete 1:2:4 and top layer 12 mm thick cement hardener consisting of mix

- 1:2 (1 cement hardener mix : 2 graded stone aggregate 6 mm nominal size) – Office area, UPS room.
- ii. Polished granite stone flooring in required design and patterns, as per the architectural drawings, with 18mm thick stone slab over 20mm (average) thick base of cement mortar 1:4, laid and jointed with cement slurry and pointing with white cement slurry admixed with pigment of matching shade including rubbing, curing and polishing etc. – Waiting/ Reception/ Meeting rooms, Lobby, Staircase area, Staircase steps, Passage, Pantry, Surveillance Room, Store and Entrance steps & platform.
 - iii. Flamed finish granite stone flooring in required design and patterns, as per the architectural drawings, with 18mm thick stone slab over 20mm (average) thick base of cement mortar 1:4, laid and jointed with cement slurry and pointing with white cement slurry admixed with pigment of matching shade including rubbing, curing and polishing etc. – Toilets
 - iv. Ceramic glazed wall tiles, 1st quality, conforming to IS:15622 (thickness to be specified by the manufacturer), of approved make, in all colours, shades & of any size as approved by Engineer-in Charge, in skirting, risers of steps and dados, over 12mm (average) thick bed of cement mortar 1:3 and jointing with grey cement slurry @ 3.3 kg/ sqm. including pointing the joints with white cement and matching pigments etc. complete – Toilets dado (Height 2.25m)
- b. Doors/ Windows/ Ventilators - To be as per details provided in architectural drawings
- i. CRCA pressed steel box section 18 gauge or 1.25mm thick for door frames including providing holes and fixing wooden blocks for fixing furniture and fittings, with powder coated primer – Internal doors.
 - ii. Solid core flush shutters with commercial ply on both sides with teakwood lipping around (35mm thick) – Internal doors
 - iii. FRP door frames made out of FRP sheets of 3mm thick of overall size 65mmx 50mm with rebate, suitably reinforced using MS angle/ MS flats, cost of holdfasts and solid core FRP shutter panel of 5mm thick and hollow core frames of 3mm wall thickness for styles and rails etc. – Toilets
 - iv. UPVC (Un-plasticized polyvinyl chloride) windows of casement type (open) from the profile the size of outer frame 60x 58mm and shutter profile are reinforcement with GI/ 1mm 125GSM and 100% corrosion free, the profiles are multi-chambered sections with wall thick of 2mm. The EPDM rubber (black colour) covered with over all the edges of frame and shutter. The shutter will be provided with Espag multi power point locks and also it operates as handle. The corners and joints should be welded and cleaned. Radiations free pin headed plain or brown colour glass 4mm thick should be provided to the shutter and it should not allow leakage of water even at most ranging storms and should have key lockable action, security protective hinges, strong locking systems and as per size for arresting noise and energy loss. The connecting mechanism between sash and outer frame that enables opening of the window. The window should be fixed to the wall with 100% packing with screws and silicon packing all round the frames.
 - v. Supplying and fixing UPVC (Un-plasticized polyvinyl chloride) louvered ventilators of from the profile the size of outer frame 60x 58mm and shutter profile size of 60x 78mm, both profiles are reinforced with GI/ 1mm 125GSM and 100% corrosion free, the profiles are

- multi-chambered sections with wall thick of 2mm. The EPDM rubber (black colour) covered with over all the edges of frame and shutter. The corners and joints should be welded and cleaned. Radiations free pin headed plain or brown colour glass 4mm thick should be provided in the louvers. The window should be fixed to the wall with 100% packing with screws and silicon packing all-round the frames.
- vi. MS grills (weighing 15 kg./ sqm.) of required pattern in frames of windows etc. with MS flats, square or round bars etc.
 - vii. Double shutter glass door of 12mm thick frosted toughened glass of approved make. The door is fixed by using any approved make hardware fitting like patch fitting, pivot, floor machine, locking arrangements and suitable SS door rails with floral glass etching for 1/3 portion of the door area etc. complete – Main Entry doors.
 - viii. Pull and push type rolling shutter with ISI make of approved size and section using 18 gauge GI sheet. The shutter shall be painted with one coat of red oxide primer and the rate is inclusive of hood covers, transportation charges etc.
 - ix. Stainless steel handrails for staircase using 50mm dia. 304L grade stainless steel pipe of 1.60mm thick at required locations to a height of 900mm from finished floor level, welded to 38mm dia. stainless steel pipe post of 1.00mm thick as vertical at 900mm centre with 2 nos. of 25mm dia. intermediate horizontal stainless steel pipe of 1.60mm thick in between. The vertical pipe has to be welded to the 100x100x6mm MS base plate encased in the base concrete. The rate is inclusive of the charges for cutting, bending, welding, grinding, polishing, conveyance, electrical charges etc. complete.
- c. Integral cement-based water proofing treatment with average thickness of 120 mm and minimum thickness at khurra as 65 mm including preparation of surface as required for treatment of roofs, balconies, terraces etc.
 - d. Providing gola 75x75 mm in cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 10 mm and down gauge), including finishing with cement mortar 1:3, as per standard design.
 - e. Making khurras 45x45 cm with average minimum thickness of 5 cm cement concrete 1:2:4, over PVC sheet 1 m x1 m x 400 micron, finished with 12 mm cement plaster 1:3 and a coat of neat cement, rounding the edges and making and finishing the outlet complete.
 - f. All internal concrete/ masonry surfaces plastered with CM and finished with lime rendering/ cement rendering. All external concrete/ masonry surfaces plastered with CM and sponge finished.
 - g. All cement mortar used for plastering, should be mixed with waterproofing compound in proportion recommended by the manufacturers.
 - h. All internal plastered surfaces finished with distempering in two or more coats with 1st quality acrylic distemper (ready mixed) having VOC content less than 50 gms/ liter, of approved manufacture and of required shade & colour, over plaster of Paris putty of 2 mm thickness and one coat of water thinnable cement primer of approved brand and manufacture.
 - i. All external plastered surfaces finished with Premium Acrylic Smooth exterior paint with Silicone additives of required shade (Two or more coats) including priming coat of exterior primer.
 - j. All wood/ steel surfaces finished with synthetic enamel paint (two or more coats) of approved brand and manufacture of required colour over an under coat of suitable shade with ordinary paint of approved brand and manufacture including priming coat with approved steel primer.

6. Administrative Block – Interior works :

- a. Providing & fixing false ceiling at all height including providing & fixing of frame work made of special sections, power pressed from MS sheets and galvanized with zinc coating of 120 gms/ sqm (both side inclusive) as per IS: 277 and consisting of angle cleats of size 25mm wide x 1.6mm thick with flanges of 27mm and 37mm, at 1200mm centre to centre, one flange fixed fixed to the ceiling with dash fastener 12.5mm dia. x 50mm long with 6mm dia. bolts, other flange of cleat fixed to the angle hangers of 25x10x0.50mm of required length with nuts & bolts of required size and other end of angle hanger fixed with intermediate GI channels 45x14x0.9mm running at the spacing of 1200mm centre to centre, to which the ceiling section 0.5mm thick bottom wedge of 80mm with tapered flanges of 26mm each having lips of 10.5mm, at 450mm centre to centre, shall be fixed in a direction perpendicular to GI intermediate channel with connecting clips made out of 2.64mm dia. x 230mm long GI wire at every junction
- b. including fixing perimeter channels 0.5mm thick 27mm high having flanges of 20mm and 30mm long, the perimeter of ceiling fixed to wall/ partition with the help of rawl plugs at 450mm centre, with 25mm long dry wall screws at 230mm interval, including fixing of gypsum board to ceiling section and perimeter channel with the help of dry wall screws of size 3.5x 25mm at 230mm c/c, including jointing and finishing to a flush finish of tapered and square edges of the board with recommended jointing compound, jointing tapes, finishing with jointing compound in 3 layers covering upto 150mm on both sides of joint and two coats of primer suitable for board, all as per manufacturer's specification and also including the cost of making openings for light fittings, grills, diffusers, cutouts made with frame of perimeter channels suitably fixed, all complete as per drawings, specification and direction of the Engineer in Charge
- c. 12.5mm thick tapered edge gypsum plain board conforming to IS: 2095 (Part I) - 2011 (Board with BIS certification marks)
- d. 12.5mm thick tapered edge gypsum moisture resistant board
- e. Providing and fixing powder coated aluminium (minimum thickness of powder coating 50 micron) work for partitions with extruded built-up standard tubular sections/ appropriate Z sections and other sections of approved make conforming to IS: 733 and IS: 1285, fixing with dash fasteners of required dia. and size, including necessary filling up the gaps at junctions i.e., at top, bottom and sides with required EPDM rubber/ neoprene gasket etc. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle, aluminium snap beading for glazing/ panelling, CP brass/ stainless steel screws, all complete as per architectural drawings and the directions of Engineer in Charge (Glazing, panelling and dash fasteners to be paid for separately) - For fixed portion
- f. Providing and fixing glazing with float glass panes of 8mm thickness (weight not less than 20 kg./ sqm.) in aluminum partitions with EPDM rubber / neoprene gasket etc. complete as per the architectural drawings and the directions of Engineer in Charge (Cost of aluminium snap beading shall be paid in basic item)
- g. Filling the gap (upto 5mm depth and 5mm width) in between aluminium frame and adjacent RCC/ Brick/ Stone work by providing weather silicon sealant over baker rod of approved quality as per architectural drawings and the directions of Engineer in Charge complete
- h. Providing & fixing single shutter glass door of 12mm thick frosted toughened glass of approved make. The door is fixed by using any approved make hardware fitting like patch

- fitting, pivot, floor machine, locking arrangements and suitable SS door rails with floral glass etching for 1/3 portion of the door area etc. complete. The rate includes cost of all materials, labour, hire of tools & machineries as per specification.
- i. Providing and fixing cubicle workstations consisting of wings made out of 75mm thick MS CRCA powder coated, tile based system for main and return spine, top tile finish 8mm thick MDF covered with fabric of approved colour and one writing board (600mm wide) and one soft board (600mm wide) per workstation, bottom tile finish 9mm thick laminate tile of approved colour. Raceway - one middle raceway (600mm wide) below table top per workstation and continuous raceway at the the skirting level. Wire manager - ABS plastic grommet one number per table. Table top - 25mm thick PLPB with straight table top, End table 25mm thick PLPB with straight edge bound hardware, MS powder coated corne bracket, cantilever bracket, separator hook on bracket, L bracket and table joint plate, as per specifications, drawings and as directed by Engineer in charge - a) X type - 4 wings and of size 1500mm width x 1500mm depth x 1200mm height)
 - j. Providing and fixing cubicle workstations consisting of wings made out of 75mm thick MS CRCA powder coated, tile based system for main and return spine, top tile finish 8mm thick MDF covered with fabric of approved colour and one writing board (600mm wide) and one soft board (600mm wide) per workstation, bottom tile finish 9mm thick laminate tile of approved colour. Raceway - one middle raceway (600mm wide) below table top per workstation and continuous raceway at the the skirting level. Wire manager - ABS plastic grommet one number per table. Table top - 25mm thick PLPB with straight table top, End table 25mm thick PLPB with straight edge bound hardware, MS powder coated corne bracket, cantilever bracket, separator hook on bracket, L bracket and table joint plate, as per specifications, drawings and as directed by Engineer in charge - a) X type - 4 wings and of size 1500mm width x 1200mm depth x 1200mm height)
 - k. Providing and fixing 450mm width x 450mm depth x 685mm height, mobile pedestal unit - wooden with 18mm thick PLPB with edge bonded for body, two equal drawer and one filing drawer with centralized locking system, telescopic channels, castors, handles, lock etc. complete as per specifications, drawings and as directed by Engineer in charge
 - l. Providing and fixing free standing table for cabin without frames, consisting of 25mm thick PLPB table top, 25mm thick PLPB with edge bonded end table, 18mm thick PLPB with edge bonded modesty. Wire manager - ABS plastic grommet one number per table. Hardware - minifix assembly and screw leg, as per specifications, drawings and as directed by Engineer in charge - a) Main Table 1500mm wide x 750mm depth x 750mm height (edgebinding table top), Side table 900mm wide x 450mm depth x 750mm height.
 - m. Providing and fixing free standing table for cabin without frames, consisting of 25mm thick PLPB table top, 25mm thick PLPB with edge bonded end table, 18mm thick PLPB with edge bonded modesty. Wire manager - ABS plastic grommet one number per table. Hardware - minifix assembly and screw leg, as per specifications, drawings and as directed by Engineer in charge - a) Main Table 1500mm wide x 750mm depth x 750mm height (post formed table top), Side table 900mm wide x 450mm depth x 750mm height.
 - n. Providing and fixing meeting table consisting of 25mm thick PLPB table top edge bonded, 25mm thick PLPB with edge bonded end table, 18mm thick PLPB with edge bonded modesty. Hardware - minifix assembly and screw leg, as per specifications, drawings and as

- directed by Engineer in charge - a) 1500mm width x 900mm depth x 750mm height (6 seater)
- o. Providing and fixing meeting table consisting of 25mm thick PLPB table top edge bonded, 25mm thick PLPB with edge bonded end table, 18mm thick PLPB with edge bonded modesty. Hardware - minifix assembly and screw leg, as per specifications, drawings and as directed by Engineer in charge - a) 2400mm width x 1200mm depth x 750mm height (12 seater)
 - p. Providing and fixing conference table consisting of 25mm thick PLPB table top edge bonded, 25mm thick PLPB with edge bonded end table, 18mm thick PLPB with edge bonded modesty. Hardware - minifix assembly and screw leg, as per specifications, drawings and as directed by Engineer in charge - a) 4800mm width x 2400mm depth x 750mm height (20 seater), U shaped with a top width of 600mm
 - q. Providing and fixing wooden storage unit one side laminate finish, with 18mm PLY/ PLPB with edge bound for body, 18mm PLY/ PLPB with openable shutters and individual locking sytem for shutter, 9mm PLY with edge bound for rear portion with Hafele fitting hinges and locks, Hardware - minifix assembly and screw legs, handles and tower bolt complete as per specifications, drawings and as directed by Engineer in charge - a) 900mm width x 430mm depth x 750mm height
 - r. Providing and fixing wooden storage unit one side laminate finish, with 18mm PLY/ PLPB with edge bound for body, 18mm PLY/ PLPB with openable shutters and individual locking sytem for shutter, 9mm PLY with edge bound for rear portion with Hafele fitting hinges and locks, Hardware - minifix assembly and screw legs, handles and tower bolt complete as per specifications, drawings and as directed by Engineer in charge - a) 900mm width x 430mm depth x 1200mm height
 - s. Providing and fixing wooden storage unit one side laminate finish, with 18mm PLY/ PLPB with edge bound for body, 18mm PLY/ PLPB with openable shutters and individual locking sytem for shutter, 9mm PLY with edge bound for rear portion with Hafele fitting hinges and locks, Hardware - minifix assembly and screw legs, handles and tower bolt complete as per specifications, drawings and as directed by Engineer in charge - a) 900mm width x 430mm depth x 2100mm height
 - t. Providing and fixing 100mm wide venetian blinds of window fashion fabric of taiwan make, with 50mm thick powder coated channel with balance, imported, acrylic self alignable mechanism and equally placed spacers, imported tilting mechanism for easy tilting operation, with nylon imported thread and beadings, 100mm wide imported washable reusable fabric placed with top hanger and bottom with 100mm long bottom plate connected to nylon imported bottom link chain. The rate is inclusive of drilling holes for fixing channels to the wall, fixing threads and beadings and link chains, hardware fixtures etc., complete as per drawing, specifications.
 - u. **High Back Chair (2 numbers)**
The specification of the High Back Chair shall be of the same as mentioned below or equivalent. The size shall be not less than / equivalent as mentioned below
Backrest : The back is made up of combination of 12mm (7 layers) & 4mm (3 layers) thick hot pressed plywood and 37mm thick, 32 Density U foam upholstered with pure Leather. The back ply and foam is designed with contoured lumber support for achieving comfortable seating posture. High Back size 475x770mm. The same shall comply with BIFMA standards.

Seat : The seat is made up of 12mm thick (7 layers) hot pressed plywood and moulded seat foam upholstered with fabric. Seat Size 510mm (W) X490mm (D). The same shall comply with BIFMA standards. Seat foam to be made out of moulded Polyurethane foam.

Armrest : The armrests to be made of black integral skin polyurethane with 40-55 Shore Hardness and reinforced with 2mm thick M.S. insert. Arm pad size 248mm (L) x 92mm (W). The armrests are fitted to the seat with seat. Arm rest to be of fixed type. The same shall comply with BIFMA standards.

Mechanism : Conventional mechanism with one lever control for lock and seat height adjustment. Mechanism made out of MS Plate thickness is 3mm and seat is tilting angle is 3°~10°. and back tilting angle is 87°~106°. Also it has the back tension adjustment knob. The same shall comply with BIFMA standards.

Gas Lift : Gas lift pipe diameter 50mm and has an Height adjustment stroke of 120mm. Gas lift tested for 1, 00,000 Cycles as per ANSI / BIFMA X5.1. Meets DIN 4550 Class 3 and all applicable ANSI/BIFMA, EN performance standard.
Base: The base made up of pressure die casted in Aluminium fitted with 5Nos twin wheel castors. The base is 650mm pitch circle diameter. The base tested for static load of 1134Kg as per ANSI / BIFMA X 5.1.

Castors : The twin wheel castors are injection moulded in nylon and over moulded in polyurethane. Diameter of Castor 60 mm. The castors are tested for 1,00,000 Cycles as per ANSI / BIFMA X 5.1. The product to be BIFMA compliant.

The manufacturer to be a member of Indian Green Building Council (IGBC) under the category of Mfg. /Product Supplier. Product should have Ergonomic Certification from reputed third party agency. The same shall be comply with BIFMA standards.

- v. **Executive Chair (105 numbers)** shall be of the same as mentioned below or superior. The size shall be not less than / equivalent as mentioned below. **Backrest :** The back is made up of combination of 12mm (7 layers) & 4mm (3 layers) thick hot pressed plywood and 37mm thick, 32 Density U foam upholstered with Fabric of approved colour. The back ply and foam is designed with contoured lumber support for achieving comfortable seating posture. Back rest size to be of 700mm (H) X 550mm (W). The same shall comply with BIFMA standards. **Seat :** The seat is made up of 12mm thick (7 layers) hot pressed plywood and moulded seat foam upholstered with fabric of approved colour. Seat Size 510mm (W) X490mm (D). The same shall comply with BIFMA standards. **Armrest:** The armrests to be made of black integral skin polyurethane with 40-55 Shore Hardness and reinforced with 2mm thick M.S. insert. Arm pad size 248mm (L) x 92mm (W). The armrests are fitted to the seat with seat. Arm rest to be of fixed type. The same shall comply with BIFMA standards. **Mechanism:** Conventional mechanism with one lever control for lock and seat height adjustment. . Also it has the back tension adjustment knob. The same shall comply with BIFMA standards. **GasLift :** Gas lift pipe diameter 50mm and has an Height adjustment stroke of 120mm. The same shall comply with BIFMA standards. **Base:** The base made up of injection moulded in black glass filled nylon and fitted with 5Nos twin wheel castors. The base is 640mm pitch circle diameter. The same shall comply with BIFMA standards. **Castors:** The twin wheel castors are injection moulded in nylon and diameter of Castor 50 mm. The same shall comply with BIFMA standards. The manufacturer to be a member of Indian Green Building Council (IGBC) under the category of Mfg. /Product Supplier. Product should have Ergonomic

Certification from reputed third-party agency. The same shall be comply with BIFMA standards.

- w. Type of sofa shall be considered either Two-seater (1 no). or single seater (2 nos). The specification of the 2 seater sofa shall be of the same as mentioned below or equivalent. The size of 2 seater shall be not less than / equal to 1345mm x 835mm x 730mm. Single seater-Size not less than 860mmX900mmX730mmFrame construction Kiln seasoned mixed meranti solid tropical hard wood. SEATS Webbing 3" diagonal pattern webbing. Foam 7" Multilayered foams Having 4" of High Resilience-HD Foam and 3" of HD virgin PU Foam. BACKREST Webbing 2" elastic webbing Foam 18D PU foam Upholstery semi PU with layer of polyester polywadding of approved colour. Stitching Nylon Bonded thread Glue Sp4 from Pidilite. Legs Solid kiln seasoned and treated Solid wood with approved finish. The product to be BIFMA compliant. The manufacturer to be a member of Indian Green Building Council (IGBC) under the category of Mfg. /Product Supplier. The same shall comply with BIFMA standards.

x. 3 Seater Sofa (1 number):

The specification of the 3 seater sofa shall be of the same as mentioned below or equivalent. The size shall be as mentioned in the admin block building plan. Frame construction Kiln seasoned mixed meranti solid tropical hard wood. SEATS Webbing 3" diagonal pattern webbing. Foam 7" Multilayered foams Having 4" of High Resilience-HD Foam and 3" of HD virgin PU Foam. BACKREST Webbing 2" elastic webbing Foam 18D PU foam Upholstery semi PU with layer of polyester polywadding of approved colour. Stitching Nylon Bonded thread Glue Sp4 from Pidilite. Legs Solid kiln seasoned and treated Solid wood with approved finish. The manufacturer to be a member of Indian Green Building Council (IGBC) under the category of Mfg. /Product Supplier. The same shall comply with BIFMA standards.

7. List of Approved Makes of Materials

Civil		
S.No	Item	Vendor
1	Fine sand & Coarse Sand	1st quality
2	Cement (43/ 53 Grade)	ACC, Birla Super, Ultra-tech Ramco, Bharti, Coromandel
3	Stone aggregate	1st quality
4	White cement	Birla, JK
5	Tor Steel	Tata, TISCO, JSW
6	M.S. Section	Tata, SAIL, Jindal
7	Reinforcement Steel	TISCO, IISCO, SAIL, JSW
8	Structural Steel	TISCO, IISCO, SAIL, JSW
9	Ready Mix Concrete	ACC, Ultratech, RMC
10	AAC Block	JK Lakshmi, Builtech
11	Brick	1st class
12	Plaster of Paris	Gypsum India, Supreme, Sakarni

Civil		
S.No	Item	Vendor
13	Gyp Plaster	Gypsum India, Buildon
14	Anti-termite Treatment	Hicare, PCI
15	Water Proofing Compound	Dr. Fixit, FOSROC, Ardex, BASF, Laticrete
16	Admixtures and Epoxy Flooring	Dr. Fixit, FOSROC, Ardex, BASF, Laticrete
17	Concrete blocks	Approved Sample having minimum compressive strength 35 Kg./ Sqcm
18	Putty	Shall be Goldsize Putty by Shalimar Paints Ltd.or Equivalent
19	Expansion Bolts for fixing	Hilti, Fischer, IRW
20	Anchor Fastner	Hilti, Canon, Fischer, IRW
21	Welding Electrodes	Advani or approved equivalent make

Adhesives		
S.No	Item	Make
1	For carpentry works	Pidilite
2	For rubber-based applications	Pidilite SR-998 grade
3	For stone, metal etc. applications	Ardex Endura, Araldite, Kerakol, Pidilite, Laticrete
4	Epoxy Grout	Ardex Endura, Laticrete, Kerakol, Pidilite
5	Sealing Component	Dow Corning, GE Bayer Silicone Ltd., Pidilite
6	Rubber Insulation	Armaflex, Videoflex
7	Silicone sealants	Wacker, Dow Corning, GE, Laticrete

Paints		
S.No	Item	Make
1	Anti - termite paint	Nosil Mudguard (Castor) Nithol
2	Matt melamine	Asian, Berger, Goodlass Nerolac, Shalimar
3	Auto coat paint	Asian, Berger, Shalimar, ICI Dulux
4	Plastic Acrylic emulsion paint	Asian, Berger, Shalimar
5	Velvet touch Plastic Emulsion paint	Asian, Berger, Shalimar, ICI Dulux
6	Decorative Plastic paint	Asian, Berger, Shalimar, ICI Dulux
7	Distemper	Berger, Asian, Shalimar
8	Putty white cement based	Birla White, JK White

Paints		
S.No	Item	Make
9	Putty acrylic based	Asian, Berger, RJ London
10	Primer	Asian, Berger, Shalimar, ICI Dulux
11	Textured paint	Spectrum, Heritage, SKK, Renovo, Asian, Berger, Pidilite
12	Fire Retardant Paint	Viper
13	White washing lime	Nerolac, Asian
14	Concrete micro topping	Convow, Ardex, BASF, Pidilite
15	Autocoat Paint	AkzoNobel (Dulux), Asian
16	PU Paint	Dulux
17	Epoxy Paint	Ardex Endura, Laticrete
18	Stencilling marking	Ardex Endura
19	Damp Proofing Membrane	Ardex
20	Texture internal application	Armour coat, Cameleo, Novafine
21	Powder coating	MRF, Berger, Akzonbel
22	Dry Distemper	Asian, Berger, Shalimar, ICI Dulux

Partition / Wood		
S.No	Item	Make
1.	Commercial blockboard	Merino Tuffply & Tuffboard (BWR grade Phenol Bonded), Greenply, Duro, Archid
2.	Fibre Cement Board and Heavy-Duty Board	Everest, V-Next, Ramco
3.	Aluminum Sections	Jindal, Hindalco, Bhoruka
4.	Imported Anodized Aluminum Sections	Alloy, Jeb, Dorma, Kubik
5.	SS Railing/Grill	Kich, Lynx, Ozone
6.	Commercial plywood	Merino, Greenply, Somani, Duro, Archid
7.	Vinyl Curtain	Rola Shade
8.	Roller Blinds	Mac, Vista, D-Décor
9.	Transition Profile & Corner Guard	Optimus, Bottomline, ORE Enterprise
10.	Slotted Angle Racks	Harmony, Godrej,
11.	Sink	Nirali, Hindware, Cera
12.	Fabric	Response, Colorays, Atmosphere, Maspar, Muslin,
13.		Season's, Jagdish Store, Yamini, Cocoon
14.	Leatherlite	Response, D-Décor
15.	Turf Flooring	Unitex, Tarkett

Partition / Wood

S.No	Item	Make
16.	Cushion Form	Dunlop, Kurlon
17.	GRG Ceiling Tile	Universal Building Product or Equivalent
18.	Acoustic Panels	Decosonic (Universal Building product), Navair
19.	Trap Door	Knauf, Novapan, Rehau
20.	Acrylic Solid Surfaces	LG, Hanex, Dupont, Tranquil, Dunes
21.	Glass	Modi Float, Saint Gobain, Asahi
22.	G.I Sections	USG Boral, Saint Gobain, Knauf
23.	Anodised Aluminium modular partitions	Alloy, Dorma, Kubik
24.	Glasswool	Rockwool, U.P Twiga
25.	Teak board ply	Greenply, Merino, Archid, Action Tessa
26.	Indian/ Imported veneer	Archid, Greenply, Century
27.	Gypsum Partition	Gypsum (India) Limited, USG Boral, Knauf
28.	Flush door shutter	Merino, Greenply, Duro, Action Tessa, Somani
29.	Hard wood	Teak, Mirindi, Saal, Oak or Equivalent (all First Class Seasoned)
30.	Golden maple	(First class seasoned) free from knots, termite & glue
31.	Laminates	Merino, Green, Archid, Century, Sonear, Woodstock, Rotolam
32.	Acoustical Panel	Ecophon, Armstrong, Nittobo, Universal Building Product, Anutone, Tranquil, Hilpoint
33.	Laminate particle board	Novopan, Archid, Merino, Action Tessa
34.	Exterior & Interior Grade MDF/HDF board	GreenPanelmax, Action Tessa, Merino
35.	Soft board	Sitatex, Jolly, Cellotex
36.	Extruded aluminum section	Hindalco, Indal (Indian Aluminium Co. Ltd.)
37.	Fire Retardant/Pest Control	Viper
38.	Anchor Fasteners	Hilti, Canon
39.	Fire-proof shutters (Steel)	Shakti Met, Adhunik, Signum, Global, MPP
40.	Fire-proof shutters (Wooden)	Pacific, Navair, Promat, Global
41.	Whiteboards	Elcon, Whitemark
42.	Toilet Cubical	Besco Merino, Greenply
43.	Clear Glass	Saint Gobain, Asahi, Gold plus
44.	Sandblasted & Decorative Glass	Art & Glass, Design & Art

False Ceiling

S.No	Item	Make
1	Gypsum board	Gypsum India, USG Boral
2	Ceiling tile	Armstrong, Saint Gobain, OWA
3	Metal Perforated/Metal Baffle Ceiling Aluminum Baffle	LD, Ceiflo, Chanakya Technologies

Flooring

S.No	Item	Make
1	Ceramic tile	NITCO, Johnson, Somany, Kajaria, RAK
2	Vitrified Tiles	NITCO, Johnson, Somany, Kajaria, RAK
3	Anti-static Vinyl Tiles	Armstrong, Ego, Tarkett
4	Porcelain Tile	Kajaria, Nitco, Somany, RAK, Johnson
5	Sport Vinyl Flooring	Tarkett, Forbo, Gesflor
6	Tile adhesive	Adrex Endura. Fosroc, Pidilite, Laticrete
7	False Floor	Unitile, Metal Matrix, Unifloor
8	Laminated wooden flooring	Green Floormax, SquareFoot, Prego, Ego, Action Tessa
9	Hardwood Flooring	SquareFoot, Prego, Ego, Floor Tex
10	Brick Tile	Pioneer, Sarada
11	Italian marble	As per approved sample
12	Granite	As per approved sample
13	Waterproofing compound	Cico No 1, STP, Fosroc, Ardex Endura, Dr. Fixit, Pidilite, TapeCrete

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Hardware

S.No	Item	Make
1	Galvanized steel door frame	Size 125 x 60mm and Approved Sample
2	Flush Door Shutters	Both sides commercial ply veneered and 35mm thick and Approved Sample
3	UPVC Windows/ Ventilators	Powder Coated finish and Approved Sample
4	Hardware fixtures for Doors (Administrative Building)	Stainless Steel finish and Approved Sample
5	Hardware fixtures for Doors (Security/ Pump room)	MS oxidized finish and Approved Sample
6	Stainless Steel hinges	Ozone, GEZE, Hafele, Hettich, Dorma
7	Multi purpose locks / nitch latch	Hettich, Geze, Dorma

Hardware		
S.No	Item	Make
8	Key board tray / CPU	Hettich, Hafele
9	Mortice lock handles	Ozone, GEZE
10	SS Handles/ Drawer	Hettich, Kich, Hafele
11	Storage fittings	
12	Mortice lock six lever	Ozone, GEZE
13	Stainless Steel patch fittings / handles	Ozone, GEZE
14	Sliding folding mechanism for door	Ozone, GEZE, Hettich, Hafele
15	Anchor Dash fastener	Hilti, Fischer
16	Door stopper	Ozone, GEZE
17	Screws	GKW, Nettlefold (Oxidized & IS1365)
18	Fabric Curtain and Tracks	D-Décor
19	Blinds	D-Décor, Vista, Phfier
20	PVC Spacers & Corner Guards	Arpithe exports, Catex Specialities Building
21	Aluminium Corner Guards	Bottom line, Gradus

Furnishers		
S.No	Item	Make
1	Upholstery	Vimal, Jagdish, Maspac, Muslin, Response, D-Décor
2	Carpet	Mohawk, Belgotex, Interface, Miliken
3	Modular Furniture	Godrej, Talin, Morarch, Feugo, Feather lite
4	Executive Chairs (105 chairs)	Godrej, Featherlite, Monarch, Eurotech, Klug Furniture
5	High Back chairs (CEO chair - 2 chairs)	Godrej, Featherlite, Monarch, Eurotech, Klug Furniture, Herman miller
5	Loose Furniture 3 seater sofa – 1 2 seater sofa – 1 Pantry chairs - 20	Multiseats, Godrej, Featherlite, MMA, Monarch
6	Floor Mat	3m/Gradus
7	Compactor	Godrej/Pan/Svil Automation

HVAC		
S.No	Item	Make
1	VRV/VRF system with capsule AC units	Daikin, Toshiba, Mitsubishi, Voltas, Hitachi
2	Copper Pipe	Metube, Manvdev, Rajco, Maxflow, Indigo metal alloy

HVAC		
S.No	Item	Make
3	Insulation Tubes	Aflex, Armacell, Supreme, Kflex
4	Cable/Wire	Polycab, Finolex, Havells, KEI
5	PVC Pipe	Supreme, Polypack, Finolex, Prakash
6	MCB	ABB, Legrand, L&T, Havells
7	PVC Conduit	AKG, Kalinga, BEC, Precision, Shivam, Anchor
8	Duct Dampers	Carryair, Ravistar, Raviarcon, Nangia
9	PIBC Control Valve with Actuator, Motor & Thermostat	Danfoss, Siemens, Oventrop
Miscellaneous		
S.No	Item	Make
1	Stainless Steel 304/316 Grade	Salem steel, Stellora
2	Glass Signage/film	3M, Avery
3	Glass upto 12 mm thickness	Modi float, Saint Gobain, Asahi
4	Mirror	Modi float, Saint Gobain, Asahi
5	Partition Insulation	Rockwool
6	Sun control film	3M, Garware polyster ltd.
7	Annealed Glass, Reflective glass	Saint Gobain, AIS
8	Glass Toughening Manufacturer	Fuso, Forms, Citiglass
9	One LED Overhead Projector (7000 lumens)	Benq, Epson, Panasonic
10	EPABX system (30 users)	Panasonic, Syntel, NEC
11	One Coffee vending machine	Café Coffe day, Leo, Gemini

1.2 Design Brief Reports (DBR)

A: ARCHITECTURAL DESIGN BRIEF REPORT

1. Introduction

The Medipark is designed over a 330-acre property in which 230-240 acres is developable. An Administration Block is designed and is to be constructed to support the Medipark in all its daily activity, marketing, financing, maintenance of the park. This specification of the Administration block explains the works to be executed by the Contractor. These are only indicative, and the contractor shall be responsible for the functional stability and adequacy and specifications of the design.

The Administrative Block should be so designed such that it should have possibility of future expansion at the rear, and on the floors above. It has to be designed for three levels including the ground level. There needs to be a separate entrance for the ground level which will house the main administrative area. Access to the floors above will be separate and have provisions for two lifts and a staircase. The first floor will have space for regulatory offices. The Administrative block in the ground floor, will contain a reception, waiting area and space for three meeting rooms at the entrance lobby. The office within will have space for 25-30 workstations with five cabins, one for the CEO of the park. A separate meeting room for 15 people shall be provided. Space for documentation and filing will be separate. For internal meeting a separate meeting room will be provided within the main office work area.

Services will be common. Toilet for gents and ladies and handicap will be provided at each floor. Separate room for pantry services will be provided. The pantry services can double up as a lunchroom for the staff. A surveillance room shall be provided for control of the building and the park in general.

2. The Design

- a. Should be suitable based on the soil investigation survey conducted at the location of construction
- b. Should conform to environmental and energy efficiency norms. Administrative block should be modern in description and character. It should give a message of simplicity and elegance. It should have a global image and appearance.
- c. Conforming to the climate response is a must while designing the facility
- d. The design should in context to the site and its surroundings
- e. The design should use materials consistent with the government policies on environmental and sustainability

- f. Compliance and Environmental and Energy efficiency norms should be complaint to at least 3-star GRIHA rating
- g. Signage inside and outside should be clear enabling visitors, service users and staff and emergency services to easily locate the required directions
- h. The design of the facility shall keep the health and safety of the occupants. It should also consider the requirements of the physically handicapped people.
- i. All materials procured should be to the satisfaction of the Authority engineer before being brought to the site and executed.
- j. All water supply / sanitary fixtures and fittings shall be of approved make conforming to IS codes
- k. The design should provide for underground sump and overhead water tank
- l. The planning of the building should include landscape within the building and outside to increase comfort of the occupants. The site should have provisions for car parking and two where parking and parking dedicated to handicapped persons.

3. Following standards need to be applied:

- The National Building Code – 2016
- The National Electrical Code – 2020
- The Indian Electricity Act 2003 and amendments
- Local Municipal authority for water and sewer connections, electricity connections
- Requirements of the Pollution Control Board, Environment clearances, and other relevant authorities wherever applicable.
- The Contractor shall organise all inspections and obtain the NOCs within the time for completion
- The contractor shall submit the relevant drawings like completion drawings, and other statutory documentary requirements of local bodies in copies as per requirement to obtain the above at their own cost.

B: STRUCTURAL DESIGN BRIEF REPORT

1. Structure

The Administration block consists of (G+2) Floors with Length - 25.8m, Width - 27.5m Height - 12m. Conventional reinforced concrete column/ beam frame structure has been considered as the basic structural system for the building. Analysis and detailed design have been carried out in accordance with relevant BIS codes as described in the following paragraphs

2. Loading and Other Considerations

The building shall be designed for the following loads:

- **Dead Load**

Self-Weight (slab) – $t \times 25 \text{ KN/m}^2$

Superimposed Dead Load – Wall thickness $\times 20 \text{ kn/m}^2$

Floor Finishes – 1.5 KN/m^2

- **Imposed Load**

Live Load – 4.0 KN/m^2

- **Wind Load**

Basic wind speed at Chennai is 50 m/s . Design wind pressure is calculated in accordance with clause-5 of IS:875 (Part-3).

$V_b = 50 \text{ m/sec}$.

Risk coefficient = $k_1 = 1.00$ (Design life of the structure = 50 years)

Terrain, height and structure size factor = $k_2 = 0.97$

Topography factor = $k_3 = 1.0$

Importance Factor for Cyclonic region $k_4 = 1.0$

Design wind speed = $V_z = V_b \times k_1 \times k_2 \times k_3 \times k_4 = 48.50 \text{ m/sec}$

Design wind pressure = $0.6 V_z^2 = 1411.35 \text{ N/m}^2$ (height 12 m)

- **Seismic Load**

The seismic force shall be calculated in accordance with IS:1893 (Part-I). Chennai comes under seismic zone –III. Accordingly, the following parameters are considered in calculating seismic load.

Response Reduction Factor $R : 3.0$

Soil Type : Medium

Importance factor $I : 1.5$

Seismic zone factor $Z : 0.16$

- **Load Combination considered for Design**

Load combination considered is as per Clause 36.4.1 of IS:456-2000

i)	DL+LL	DL=DEAD LOAD
ii)	$1.5 (DL + LL)$	LL=LIVE LOAD
iii)	$1.5 (DL + EQX)$	EQX=SEISMIC LOAD IN X-AXIS
iv)	$1.5 (DL - EQX)$	EQZ=SEISMIC LOAD IN Z-AXIS
v)	$1.5 (DL + EQZ)$	WL X=WIND LOAD IN X-AXIS
vi)	$1.5 (DL - EQZ)$	WL Z=WIND LOAD IN Z-AXIS
vii)	$(0.9 DL + 1.5 EQX)$	
viii)	$(0.9 DL - 1.5 EQX)$	
ix)	$(0.9 DL + 1.5 EQZ)$	
x)	$1.2 (DL+LL-EQX)$	
xi)	$1.2 (DL+LL+EQZ)$	
xii)	$1.2 (DL+LL-EQZ)$	

- xiii) 1.5 (DL+WLX)
- xiv) 1.5 (DL-WLX)
- xv) 1.5 (DL+WLZ)
- xvi) 1.5 (DL-WLZ)
- xvii) (0.9 DL+1.5 WLX)
- xviii) (0.9 DL-1.5 WLX)
- xix) (0.9DL+1.5WLZ)
- xx) 1.2 (DL + LL - WLX)
- xxi) 1.2 (DL + LL + WLZ)
- xxii) 1.2 (DL + LL - WLZ)

The most critical of the above combinations has been considered for design.

3. Structural Analysis

- Analysis for Dead Load, Imposed Load and lateral load due to wind.
- Building frames have been analyzed as three-dimensional space frame structure using software.
- Seismic Analysis
- The building is in seismic zone-III. This analysis has been carried out using software by 3-D model with columns fixed at foundation.

4. Structural Design

All the structural elements have been designed as per limit state method as given in IS:456-2000. Slab and beam elements have been checked for limit state of serviceability such as deflection and cracking as outlined in IS:456-2000. However, foundations are designed by working stress method.

5. Soil Report

Soil consists of medium dense soils with SBC – 250 KN/m²

6. Foundation System

Foundation system shall be consist of isolated footing. Founding level will be 1.5m from the natural ground level as per Soil report.

7. Construction Materials

Controlled concrete shall be used for all reinforced concrete structures as follows:

- Concrete Grade – M-25 grade concrete
- Reinforcement – High yield strength deformed TMT bars of grade Fe 500 conforming to IS:1786-1985

8. Cover

Minimum clear cover to all main reinforcement shall be as follows:

- For Foundation : 50 mm
- For Columns : 40 mm

For beams : 30 mm
For slabs : 20 mm

9. Reference Codes

- IS 456-2000 – Plain and reinforced concrete- code of practice
- IS 1893 (Part I)-2016 – Criteria for earthquake resistant design of structures.
- IS 875 (Part I)-1987 edition 3.1 (1997-12) – Code of practice for design loads (other than earthquake) for buildings and structures- Dead loads
- IS 875 (Part-II)-1987-(reaffirmed 1997) – Code of practice for design loads (other than earthquake) for buildings and structures - Imposed loads
- IS 875 – (Part – III) – 2015 - Code of practice for design loads (other than earthquake) for buildings and structures.- Wind loads
- IS 875 – (Part – V) -1987- reaffirmed 1997) Code of practice for design loads (other than earthquake) for buildings and structures.- special loads and load combinations.
- IS 13920 – 2016 - Ductile detailing of reinforced concrete structures subjected to seismic forces- code of practice

1.3 Technical Specifications – Civil Works

A. Excavation, Filling and Metaling

1. General

This item refers to the clearing of site for construction of start, setting out of works, profiles, etc., excavation and filling of all open foundations, wet or dry, for the column and wall footings, trenches, pavements, inspection pits and basements, plinths, areas for levelling, drainage lines, water supply lines etc.

2. Clearing the Site and Setting Out of Works

The site on which the structure is to be built, as shown on the plan and the area required for setting out and other operations, shall be cleared of all obstructions, loose stones, materials and rubbish of all kinds, stumps, brush wood, shrubs and other growth, roots being entirely grubbed up without extra cost. The materials obtained will be the property of the Authority and the materials pronounced useful by the Authority's Engineer shall be conveyed and properly stacked as directed by the Authority's Engineer. All holes or hallow, whether originally existing or produced by the removal of loose stones or brushwood, shall be carefully filled up with earth, well rammed and levelled off up to the level of already filled or existing ground as directed.

Trees on the site shall not be cut unless authorized by the Authority's Engineer, shall not be damaged during construction. The above work of cleaning the site shall be reckoned to be included in the rate paid for various items and no extra shall be paid.

The contractor shall be responsible for the true and proper setting out of the works. He shall be responsible for proper maintenance of all reference pillars, benchmarks, stakes and other evidences existing in the field required in connection with the setting out of works, at his own

cost, till physical completion of all the items of the work or prior to that if agreed to by the Authority's Engineer.

The lines and levels of all structures shall be carefully set out and frequently checked, care being taken to ensure that correct gradients and levels are obtained everywhere. No earthwork or structural works shall be commenced until the centre line has been referenced.

All such benchmarks, reference pillars etc., established by the contractor shall be subject to check and approval of the Authority's Engineer or his authorized representative at all times and the contractor shall ensure safeguarding all survey monuments, benchmarks, beacons etc. Any variations noticed in the work as a result of improper establishment or maintenance of these shall be at the risk and expenses of the contractor.

3. Classification of soil for excavation purposes

All materials encountered in the excavation shall be classified as under:

- a. Soils shall include sand, gravel, clay, silt and other similar soft or loose materials and all materials of earthy or sandy nature, small size stone or gravel, soft and hard murrum, stiff clay etc., which can be ploughed or excavated by ordinary spade, pick, shovel etc., without restoring to barring, wedging and or blasting.
- b. Soft laterite shall include all rocks such as slate, shale, laterite, conglomerates, all decomposed and weathered rock, highly fissured rock, old masonry, concrete foundation and pavements, which can be removed by barring, wedges, etc., but not by ordinary spade, pick, shovel etc.
- c. Hard laterite rock shall include all rock occurring in masses and boulders larger than 0.3 cum in volume which in the opinion of the Authority's Engineer can be best be removed by blasting but on account of restriction to blasting at this site will have to be removed by cold chisels or wedges, line drilling or jack hammer.

The decision of the Authority's Engineer regarding the classification of soil and rock shall be final and binding.

4. Excavation

- a. Excavation shall include careful removal of all materials or whatever nature and whether dry or wet, necessary for the construction of work, exactly in accordance with lines, levels, grades and curves shown on the plans or as directed by the Authority's Engineer. It shall be taken to exact widths and levels of the lowest step of foundation/footing and the sides shall be left to plumb where the nature of the soil permits it. Any shoring, strutting and timbering or cutting of extra widths of trenches required for providing working space shall be done by the contractor, the same shall be deemed to have been included in the quoted rate. The contractor shall notify the Authority's Engineer before starting excavation and take cross section levels jointly with the Authority's Engineer before the ground is disturbed.

- b. The bottom of the foundation shall be levelled both longitudinally and transversally or stepped as directed. Should any of the excavation be carried down to a level below the specified level, the contractor shall fill in such extra excavation at his own cost with M100 concrete, well rammed into position until it is brought up to the proper level, filling with excavation material not being permitted for this purpose.
- c. Where such extra excavation is necessary due to removal of loose boulders, the extra excavation and concrete for filling shall also be responsibility of Contractor. The corners of the excavated pits shall be made true and square and all loose debris shall be removed to the satisfaction of the Authority's Engineer. Before any foundation concrete is placed, the Authority's Engineer shall inspect the foundation trenches. If any loose patches or pockets come to light on inspection, these shall be dug out as directed and filled and rammed with M100 concrete. Just before laying the foundation concrete all bottom of trenches shall be lightly watered and thoroughly rammed.
- d. The contractor shall provide suitable drainage arrangements, to prevent surface water from any source entering the foundation pits, at his own cost.
- e. Any obstacle encountered during excavation shall be reported immediately to the Authority's Engineer and shall be dealt with as instructed by him. Removal of buried piping or cables shall not be done without prior permission of the Authority's Engineer and the contractor shall take all measures to protect such lines. Cost of such protective measures and deemed to be included in the rates for various items of excavation. No blasting shall be permitted for excavation of foundation even in rocky formation without the prior permission of the Authority's Engineer.
- f. The contractor shall not undertake any concreting in foundation until the excavation pits is approved by the Authority's Engineer.

g. Excavation Below Ground Water Table

For all foundations below ground water table, excavation shall be done first just up to ground water level and further excavation to founding level shall be done just before concreting. As soon as founding strata is reached, lean concrete mud mat shall be placed and concreting of foundation shall be carried out with minimum loss of time. During entire operation, excavation shall be kept dry by dewatering. CONTRACTOR shall programme his work to ensure that the above procedure is strictly followed.

h. Backfilling Near Structures

Backfill shall not be dropped directly upon or against structure/facility where there is a danger of displacement damage. Trucks or heavy equipment for depositing compacting backfill shall not be used within 1.5 m building of walls, piers or other facilities which may damage by their, weights, or operation or method compaction. The method of depositing and compact backfill shall be approved by ENGINEER.

i. Excavation in Hard Rock Scope

This specification covers general requirements of excavation in all types of hard rock as classified in specification "Earth work in grading, Excavation, Backfilling".

Unless otherwise stated herein, IS Specification "IS-4081: Safety code for Blasting and related Drilling operations" shall be followed. After removal of overburden, if any, excavation shall be continued in rock to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by ENGINEER. As far as possible all blasting shall be completed prior to commencement of construction. At all stage of excavation, precautions shall be taken to preserve the rock below and beyond the lines specified for the excavation, in the soundest possible condition. The quantity and strength of explosive used, shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by ENGINEER, shall be taken during the blasting operations and care shall be taken so that no damage is caused to the adjoining buildings or structures as a result of blasting operations. In case of damage to permanent or temporary structures, CONTRACTOR shall repair the same at his cost to the satisfaction of ENGINEER. As excavation approaches its final lines and levels, the depth of holes and amount of explosives used shall be progressively and suitably reduced. In this section wherever blasting is referred, it means only controlled blasting.

Specific of ENGINEER will have to be taken by CONTRACTOR for blasting rock and he shall also obtain a valid Blasting License from the authorities concerned. If permission for blasting is refused by ENGINEER, the rock shall be removed by wedging, barring, heating and quenching or other approved means. All loose or loosened rock in the sides shall be removed by barring, wedging etc. The unit rates for excavation in hard rock shall include the cost of all these operations.

CONTRACTOR shall obtain necessary license for storage of explosives, fuses and detonators issued to him from authorized stores, from the authorities dealing with explosives. The fees, if any, required for obtaining such license shall be borne by CONTRACTOR. CONTRACTOR shall have to make necessary storage facilities for the explosives, etc., as per rules of local, State and Central Government authorities and statutory bodies/ regulations. Explosives shall be kept dry. and shall not be exposed to direct rays of Sun or to be stored in the vicinity of fire, stoves, steam pipes or heated metal etc. No explosive shall be brought near the work in excess of quantity required for a particular amount of firing to be done; and surplus left after filling the holes shall be removed to the place of storage, A portable magazine of approved design should be provided by the CONTRACTOR at his cost. and the same shall be as far as possible away from the area to be blasted. Engineer's prior approval shall be taken for the location proposed for the portable magazine.

In no case shall blasting be allowed closer than 30 m to any structure or to locations where concrete has been placed. In the latter case the concrete must be at least 7 days old.

For blasting operations, the following points shall be observed.

- i) CONTRACTOR shall employ a competent and experienced supervisor' and' licensed blaster in-charge of each set of operation/ who shall be held personally responsible to ensure that all safety regulations are carried out.
- ii) Before any blasting is carried out, CONTRACTOR shall intimate ENGINEER and obtain his approval in writing in resorting to such operations. He shall intimate the hours of firing charges, the nature of explosives to be used and precautions taken for ensuring safety.
- iii) CONTRACTOR shall ensure that all workmen and the personnel at site are excluded from an area within 200 m radius from the firing point, at least 15 minutes before firing time by sounding warning whistle. The area shall also be \given warning by sounding a distinguishing whistle.
- iv) The Blasting of rock near any existing buildings, equipment or any other property shall be done under cover and. CONTRACTOR has to make all such necessary muffling arrangements. Covering may preferably be done by M.S. plates with adequate dead weight over them. Blasting shall be' done with small charges only and where directed by ENGINEER, a trench shall have to be cut by chiseling prior to the blasting operation separating the area under blasting from the existing structures.
- v) The firing shall be supervised by a Supervisor and not more than 6 (six) holes at a time shall be set off successively. If the blasts do not tally with the number fired, the misfired holes shall be carefully located after half an hour and when located, shall be exploded by drilling a fresh hole along the misfired hole (but not nearer than 600 mm from it) and by exploding a new charge.
- vi) A wooden tamping rod with a flat end shall be used to push cartridges home and metal rod or hammer shall not be permitted. The charges shall be placed firmly into the hole and not rammed or pounded. After a hole is filled to the required depth, the balance of the hole shall be filled with stemming which may consist of sand or dust or similar inert material.
- vii) CONTRACTOR shall preferably detonate the explosives electrically.
- viii)The explosive shall be exploded by means of primer which shall be fired by detonating a fuse instantaneous detonator (F.I.D) or other approved cables. The detonators with F.I.D. shall be connected by special nippers.
- ix) In dry weather and normal dry excavation, ordinary low explosive gunpowder may be used. In damp rock, high explosive like gelatin with detonator and fuse wire may be

used. Under water or for excavation in rock with substantial accumulated seepage electric detonation shall be used.

- x) Holes for charging explosives shall be drilled with pneumatic drills. The drilling pattern being so planned that rock pieces after blasting will be suitable for handling without secondary blasting.
- xi) When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level. Any rock excavation beyond and over break limit of 75mm shall be filled up as instructed by ENGINEER, with concrete of strength not less than M 10. The cost of filling such excess depth shall be borne by CONTRACTOR and the excavation carried out beyond limit specified above will not be paid for. Stepping in rock excavation shall be done by hand trimming.
- xii) CONTRACTOR shall be responsible for any accident to workmen, public or Authority's, property due to blasting operations. CONTRACTOR shall also be responsible for strict observance of rules, laid by Inspector of Explosives, or any other Authority duly constituted under the State and / or Union Government.

5. Shoring

- a. Any shoring, strutting and timbering required for protecting the sides of excavation and for ensuring the safety of workmen and equipment, shall not be paid for separately. The contractor shall be responsible for the design of the shoring which shall however be strong enough to resist side thrust and prevent slips, slow and damage to adjacent works and property. It shall be removed as directed after all the items of work, which it is required are completed.
- b. Shoring shall include all labour, materials, erection of the poling boards, wales, ballies etc., keeping in position as required and dismantling and receiving the same after the work is over, as directed.

6. Dewatering

The rate quoted for excavation shall include bailing or pumping out all water which may accumulate in the excavation during the progress of the work either from seepage, rain or any other cause and diverting surface if any, by bund or other means. The bunds shall be removed after their purpose is served. Pumping out water from any foundation enclosure, basements or trenches shall be done generally in such a manner as to preclude the possibility of any damage to the foundation trenches, concrete or masonry or any adjacent structure. The excavation shall be kept free from water:

- During inspection and measurement,
- When placing of concrete or masonry is in progress and until they have come above the natural water level,
- Till the Authority's Engineer considers that the concrete or mortar have set and hardened sufficiently and

- During back filling and consolidating

7. Protection and Safety

Foundation pits and similar excavation, road blockades, obstruction etc. shall be adequately fenced and marked at night with red lights and a watchman keep in-charge to avoid accidents. Adequate protective measures shall be taken to see that the foundation excavation does not affect or damage adjoining structures. All required measures shall be taken by the contractor, at his own cost to ensure safety of the excavation, the people working in or near the excavation and people and property in the vicinity. He shall be entirely responsible for any injury to life and a damage to property caused by his negligence or accident due to his constructional operations.

8. Stacking of Excavated Materials

All materials excavated from the foundation, of whatever kind they may be, shall be placed at a distance of more than 1.5m from the edge of the foundation or as directed by the Authority's Engineer. All excavated material will remain the property of the Authority. Rate for excavation shall include the cost of sorting out of useful materials and stacking them separately or transporting them as directed. Material suitable for filling or other use shall be stacked in convenient places. Materials not useful in any way shall be disposed-off. The Authority's Engineer shall be the final authority as to what is useful material. The site shall be left clean of all debris at the completion of the work. Notwithstanding the above, it may be noted that in this particular work, as there is no space to stack the excavated earth at site, the contractor has to convey the earth excavated to a place selected by him and arrange to stack there temporarily. The useful earth (which would be decided by the Authority's Engineer) shall be brought back for refilling and the balance if any shall be disposed of by the contractor. All the expenses incurred in the above operation of transportation of earth to and fro will be borne by the contractor and the rates built into the item No. (1) will be inclusive of all the above operations.

9. Back Filling around Foundations in Trenches and Plinth

- Back filling material shall be as approved by the Authority's Engineer or as specified in drawing.
- Back filling for excavations in trenches around foundation and elsewhere shall consist of one of the following materials as the Authority's Engineer may direct in each location.
 - Selected earth from excavated soil heap
 - Selected earth brought from borrow area
 - Sand filling
 - Lean concrete filling
- Filling shall be done after the concrete or masonry in the foundation has fully set and its curing completed. It shall be done in such a manner as not to cause undue thrust on any part of the structure.
- Back filling around completed foundations shall be done to the lines and levels shown on the drawings, including any trimming of the surfaces, as may be necessary. This will be

done with selected and approved earth from excavation or otherwise with borrowed materials as directed by the Authority's Engineer. Where sufficient suitable material is not available from the excavation, The Authority's Engineer may direct to import suitable earth from different sources. The refilling shall be done in horizontal layers of thickness not exceeding 15cms from pocket with careful watering, ramming and rolling etc., to obtain necessary level of compaction.

- e. The contractor shall not fill in and around any work, until it has been approved by the Authority's Engineer
- f. Back filling around liquid retaining structures and piping shall be done only after testing of structures against leakage is done and approval of Authority's Engineer is taken

10. Metalling

- a. Graded coarse aggregate layer below floor, pavements and plinth protection
 - Graded coarse aggregate layer of thickness as shown on the drawing shall be provided after the structural foundations and plinth constructions have been built and the filling in the plinth has been watered and thoroughly consolidated. Excavation for cable ducts, pits, trenches and pockets other than those for structural foundations and plinth shall be made only after the graded coarse aggregate layer is laid and consolidated
 - **Materials:** The aggregate to be of the quality as specified for concrete elsewhere. The sizes to be used are 50mm to 40mm, 40mm to 25mm and 25mm to 20mm.
 - **Construction Procedure:** The bed on which the graded coarse aggregate layer is to be laid shall be cleared of all loose materials levelled, watered and compacted and got approved by the Authority's Engineer before laying the aggregate layer.
- b. The metal shall be mixed thoroughly in a proportion of 2 parts of 50mm metals, to 1 part each of 40mm and 25mm. The mixing shall be done before laying the same at site. It shall be laid in 2 layers of 10cm thickness and each layer shall be consolidated to a thickness of 7.5cm by an 8T to 10T capacity roller. At places which have no access for mechanical rollers, hand rollers after obtaining permission from Authority's Engineer. While laying, rolling and consolidating, precautions shall be taken to ensure that no damage occurs to the masonry or any other portion of the structure. But special care shall be taken for compaction near masonry and concrete structures. Proper manual and vibratory tamping equipment shall be employed for satisfactory compaction in such area. Weak spots if any shall be rectified at contractor's own cost. After the graded coarse aggregate has been thoroughly consolidated, murrum to completely fill the interstices shall be sprayed gradually over the surface and dry rolling shall be done with murrum for each layer. Finally, the surface shall be finished with a layer of murrum moistened and rolled over so

as to provide an even surface. The maximum thickness of the finished murrum layer shall not exceed 12mm. The quoted rate shall include the cost of murrum layer also.

11. Disposal of Excavated Earth

Surplus earth and soil, which are rejected for back filling shall be removed from construction area to the area demarcated by the Authority's Engineer. The materials shall be conveyed by suitable means including trucks, if necessary and disposed-off as directed by the Authority's Engineer, loading and unloading incidental to this transportation shall be included in the quoted rate.

12. Back Filling

Back filling shall be done by extracting suitable approved earth from excavated soil, carriage up to directed locations, placing, watering, compacting in layers, trimming and dressing, finished surface and disposal of surplus material. Back filling may also be done with other borrowed materials approved by Authority Engineer.

13. Metalling

Graded coarse aggregate layer shall include for consolidating the layers and surface finishing with murrum layer not more than 12 mm thick and all other incidental work required to complete the item as per specifications.

14. Disposal

Quantity generated due to voids in back filled volume of earth shall be removed by the contractor. The Authority's Engineer may also direct the contractor to remove surplus earth, concrete debris or any other waste material from site to the areas of disposal

B. Concrete Works

1. General Scope

This specification covers the general requirements for concrete to be used on jobs using on-site production facilities including requirements in regard to the quality handling, storage of ingredients, proportioning, batching, mixing and testing of concrete and also requirements in regard to the quality, storage, bending and fixing of reinforcement. This also covers the transportation of concrete from the mixer to the place of final deposit and the placing, curing, protecting, repairing and finishing of concrete.

2. Relevant Codes and Specifications

The following specifications, standards and codes are made a part of this specifications. All standards, specifications, codes of practice referred herein shall be the latest editions including all applicable official amendments and revisions. In case of discrepancy between this specification and those referred to herein, this specification shall govern.

- **IS Code for Materials**

- IS: 269 – Specification for ordinary, rapid hardening and low heat and Portland cement.
- IS: 455 – Specification for Portland blast furnace slag cement.
- IS: 1489 – Specification for Portland pozzolana cement.

- IS: 4031 – Method of Physical tests for Portland cement.
 - IS: 650 – Specification for standard sand for testing of cement.
 - IS: 383 – Specification for coarse and fine aggregates from natural sources for concrete.
 - IS: 516 – Method of test for strength of concrete.
 - IS: 1199 – Method of sampling and analysis of concrete.
 - IS: 432 – Specification for mild steel and medium (Part I & II) tensile steel bars and hard drawn steel wire for concrete reinforcement.
 - IS: 1139 – Specification for hot rolled mild steel and medium tensile steel deformed bars for concrete reinforcement.
 - IS: 1566 – Specification for plain hard drawn steel wire fabric for concrete reinforcement.
 - IS: 1786 – Specification for high tensile steel bars for concrete reinforcement.
 - IS: 2090 – Specification for high tensile steel bars used in pre-stressed concrete.
 - IS: 4990 – Specification for plywood for concrete shuttering work.
 - IS: 2645 – Specification for integral cement water proofing compound.
 - IS: 6925 & IS: 903 – Specifications for admixtures.
 - IS: 8112 – Specification for 43 grade cement.
- **IS Code for Equipment**
 - IS: 1791 – Specification for batch type concrete mixer.
 - IS: 2438 – Specification for Roller Pan mixer.
 - IS: 2505 – Specification for concrete vibrators immersion type.
 - IS: 2506 – Specification for screed board concrete vibrator.
 - IS: 2514 – Specification for concrete vibrating tables.
 - IS: 3366 – Specification for pan vibrators.
 - IS: 4656 – Specification for form vibrators for concrete.
 - IS: 2722 – Specification for portable swing weigh batchers for concrete (single and double buckets types).
 - IS: 2750 – Specification for steel scaffolding.
- **Code of Practice for Concreting Works**
 - IS: 456 – Code of practice for plain and reinforced concrete.
 - IS: 1343 – Code of practice for pre-stressed concrete.
 - IS: 3370 – Code of practice for concrete structures (Parts I to IV) for storage of liquids.
 - IS: 3935 – Code of practice for composite construction.
 - IS: 3201 – Criteria for design and construction of precast concrete trusses.
 - IS: 2204 – Code of practice for construction of reinforced concrete shell roof.
 - IS: 2210 – Criteria for the design of RC shell structures and folded plates.
 - IS: 2751 – Code of practice for welding of mild steel bars used for reinforced concrete construction.
 - IS: 2502 – Code of practice for bending and fixing of bars for concrete reinforcement.
 - IS: 3414 – Code of practice for design and installation of joints in buildings.
 - IS: 3558 – Code of practice for use of immersion vibrators for consolidating concrete.
 - IS: 4014 – Code of practice for steel tubular scaffolding (Part I & II)
 - IS: 2571 – Code of practice for laying in-situ cement concrete flooring.

- IS: 10262 – Code of practice for mix design.
- SP: 23 – Handbook for concrete mix design.

- **Code of Practice for Measurement**

- IS: 1200 – Method of measurement of building works.
- IS: 3385 – Code of practice for measurement of civil engineering works.

- **Code of Practice for Construction Safety**

- IS: 3696 – Safety code for scaffolding and ladders (Part I & II).

3. Materials

All materials shall be obtained from sources approved by the Authority. The agreed source or quality of any material shall not be changed during the course of the contract except with the approval of the Authority's Engineer.

When requested by the Authority's Engineer, the Contractor shall provide a certificate from the manufacturer, for each and every delivery of material, showing the source, quantity delivered and confirming that the material has been tested and conforms to the required Indian Standard.

- **Testing of Concrete Materials**

Prior to the commencement of concrete work, the Contractor shall get all cement, aggregates and water tested in the laboratories approved by the Authority's Engineer and shall keep approved samples in the site office for inspection of the Authority's Engineer at any time of the concreting operation.

During construction also, the materials shall be sampled and tested as often as deemed necessary. Samples shall be taken and tested in accordance with the latest revisions of relevant Indian Standard Specifications and the cost thereto shall be borne by the Contractor.

- **Cement**

The cement used throughout the work shall be to the approval of the Authority's Engineer. A certificate shall be obtained from the manufacturers and produced for each delivery of cement and in case of Ordinary Portland Cement it shall comply with the requirements of IS: 269 and IS: 8112. The Contractor shall store the cement in sheds to be provided by him for this purpose at site. The Cement shall be delivered to the site in bags sealed with the manufacturer's seal and different types of cement shall be stored separately. The storage sheds with watertight walls and roof, shall be maintained in a perfectly dry and well-ventilated condition, 30 cm above ground level and the cement shall be stored as per instructions issued in the booklet of the Associated Cement Company. It shall be turned over from the bottom as and when required by the Architects. Any cement which has been deteriorated, caked or which has been damaged due to any reason whatsoever shall not be used. No cement shall be used for the works that has been stored at site for more than three months unless it is retested. Test samples of cement may be drawn from each consignment as delivered and tested by the Contractor. Should the result of such test show that any sample does not comply with the specified requirement, the whole

consignment from which the sample was taken, shall be rejected and forthwith removed entirely from the site and replaced with cement of satisfactory quality.

- **Sand**

Sand to be used for concrete shall be well graded mixture from coarse to fine grains, comply with the requirements of IS: 383 and IS: 515. It shall be clean, hard and free from salt, earth, clay and other impurities. Fine sand of uniform size or silt shall not be used. It shall comply with sieve analysis in accordance with IS: 2386 (Part I and II). Unless initially clean, all sand shall be thoroughly and carefully cleaned by screening and washing in fresh and clean water. The screened and washed sand shall not contain more than 8% by volume of clay, dust and silt immediately after allowing it to settle for 3 hours in water.

FM of sand shall neither be less than 2.2 nor more than 3.2.

Field tests shall be carried out regularly to ensure the suitability of sand.

Sample loads shall be available at site for the inspection of the Authority's Engineer and if approved by them all sand in the work shall be of similar quality.

In case of sand containing moisture the proportions of concrete materials shall be adjusted to give the correct mixture.

- **Coarse Aggregate**

The coarse aggregate for the reinforced concrete work shall consist of crushed gravel, black trap, granite or other stone to the approval of the Authority's Engineer and shall be free from dust. If considered necessary, the aggregate shall be washed specially until an approved cleanliness is obtained. The use of laminated stone, flat or flaky material will not be permitted. The combined coarse aggregate shall in all respects be so graded as to allow 95% to 100% by weight to pass a 20mm IS sieve; 25% to 55% by weight to pass a 10mm IS sieve and 0% to 10% by weight to pass a 5mm IS sieve. The aggregates of different sizes shall be stored in separate stacks in clean state and free from all dirt.

The coarse aggregate where absorption of water after 24 hours immersion is more than 5% by weight shall not be used.

When required by the Authority's Engineer tests indicated in IS: 383 shall be carried out by Contractor at his cost to show the acceptability of the materials. Strong piles of aggregate shall have good drainage, preclude inclusion of foreign matter and preserve the gradation.

- **Water**

Water used for all purposes in this contract shall be free from oil, acid, vegetable matter, salts or dirt of any kind which will have adverse effect on cement or steel in the case of reinforced concrete. Whenever called for, the Contractor shall produce test results for water being used on work.

Average 28 days compressive strength of at least three 15 cm concrete cubes prepared with water proposed to be used shall not be less than 90% of the average strength of three similar concrete cubes prepared with distilled water. Sea water shall not be used.

- **Admixtures**

Plasticisers may be used in the concrete work to achieve better workability. Admixtures or cements containing additives (such as accelerators, retarders, water proofing agents etc.) shall not be used unless specified or otherwise directed or approved by the Authority's Engineer.

- **Steel Reinforcement**

The following types of reinforcement shall be used.

- Mild steel round bars conforming to IS: 432 (Part-I)
- Hot-rolled deformed bars conforming to IS: 1139
- Cold-twisted bars conforming to IS: 1786

The contractor shall produce a test certificate of the manufacturer for each consignment.

Bars upto 25 mm diameter shall stand bending cold to an angle 180 Deg. round a diameter equal to that of the test piece without fracture of the outside skin of the bent portion. If independent tests are considered necessary, they shall be carried out to IS: 223. No bar shall be (+/-) 2.50% over or under the areas specified. Immediately before deposition of the concrete, reinforcement shall be well cleaned and made perfectly free from dirt, loose, rust, scales, paint, oil wash, grease or any other coatings which may destroy or reduce bond.

4. Fabrication and Placement of Reinforcement

All steel reinforcement shall be fabricated and fixed in accordance with IS: 2502. Bars shall be firmly bound together with annealed steel wire not thinner than 16 SWG at sufficient intersections to ensure that the network of rods will retain its original form and the mesh will be so temporarily supported as to retain its correct position in the formwork during the process of depositing the concrete. An adequate number of MS chairs and spacer bars shall be used in order to ensure accurate positioning of reinforcement. All splices and lengths of overlaps in reinforcement shall be strictly in accordance with the drawings. The overlaps shall be staggered, and their positions shall be approved by the Authority's Engineer. No welding of reinforcement is permitted unless approved by the Authority's Engineer in writing. The ends of wire ties must not project towards the face of the concrete, and all ends shall be cut off or bent inwards so that there is no risk of rust staining the surface of concrete. Off cuts of binding wire must be removed from the inside of forms after the steel fixing operations are over.

Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original positions, care shall be taken to ensure that at no time is the radius of the bend less than 4 bar diameters for deformed bars. Care shall also be taken when bending back bars, to ensure that the concrete around the bar is not damaged.

Where reinforcing bars are lapped with dowels provided in concrete work:

If the lap length to provide in concrete work is less than the minimum lap length specified on the drawings for development of full strength of the connection, bars shall be spliced by welding. Such welding shall conform in all respects to the provisions given in Appendix 'A' of SP: 34 (S&T)-1987, Handbook on concrete reinforcement and detailing, Bureau of Indian Standards.

5. Spacer Blocks

To maintain the specified amount of concrete cover to the reinforcement, small precast concrete blocks of grade similar to that of concrete to be placed shall be used.

- At each end of reinforcing bar, not less than 25mm, nor less than twice the diameter of bar.
- For a longitudinal reinforcing bar in a beam, not less than 25mm, nor less than the diameter of the bar.
- For a longitudinal reinforcing bar in a column, not less than 40mm nor less than the diameter of the bar.
- For tensile, compressive, shear or other reinforcement in a slab, not less than 15mm, nor less than the diameter of the bar.
- For vertical or horizontal reinforcement in concrete walls not less than 15mm nor less than the diameter of the bar.
- For reinforcement in footings, pile caps and raft foundations not less than 50mm.

6. Prevention of Rust Staining

Reinforcement left projecting above a concrete surface shall be cement washed if exposed in such a way that rust staining of concrete surfaces is likely. Any rust staining of exposed surfaces shall be cleaned immediately.

7. Storage and Handling of Reinforcement

Reinforcement shall be stacked off the ground in clean conditions and protected from contamination and excessive rusting. The reinforcement shall be clean and free from oil, grease, loose rust, loose mill scale, salt and chemical contaminants at the time of fixing in position and concreting.

8. Proportion for Concrete

The Contractor shall design concrete mixes to produce concrete of the required strengths. The contractor must submit full designs of the mixes for approval of the Authority's Engineer and trial mixes will be prepared by the contractor in the presence of the Authority's Engineer, having workability, strength, minimum cement content and finish as criteria.

Concrete surfaces, which are to be finished with cement rendering shall be thoroughly hacked with approved hand tools immediately after removal of formwork so as to bring about adequate bond between the concrete and cement rendering.

Notwithstanding the acceptance of any mix design and series of trial mixes, variations may be made to the proportions when considered necessary by the Authority's Engineer. Such variations

may be made to nominal mixes if used, but variations of this nature will not be allowed to affect the unit price of concrete.

For both Nominal as well as Design Mix concrete, the quantity of cement shall be determined by weight. Where standard bags of cement are used, their weight shall be checked at frequent intervals and any loss in weight due to leakage etc. shall be made good.

In the case of Nominal Mix Concrete, aggregates shall be measured by volume, cement by weight and mixing water in graduated liter cans. In the case of controlled concrete all aggregates and cement shall be measured by weight in approved weigh batching equipment. Mixing water shall be measured in graduated liter cans.

While calculating the amount of mixing water, the moisture content of the aggregate shall be taken into account. The grades of concrete shall be in accordance with Table below. The cement content of the mixes specified shall not exceed the minimum content specified in para 2.20 by more than 5%.

Grade of Concrete	Minimum Compressive strength N/ mm ²		
	At 7 days	At 28 days	Remarks
M 15	10	15	--
M 20	13.5	20	--
M 25	17	25	--
M 30	20	30	--
M 40	28	40	--

The above specified compressive strengths shall be for the use of ordinary Portland Cement in concrete. When rapid hardening Portland Cement is used, the 28 days compressive strength requirements specified in Table shall be met at 7 days.

In order to get a relatively quicker idea of the quality of concrete, compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength tests and it shall not be less than 67% of the 28 days Cube Strength. In all cases 28 days compressive strength shall alone be the criterion for acceptance or rejection of the concrete.

Design mix concrete is preferred to Nominal mix. If Design mix concrete cannot be used for any reason on the work for grades of M20 or lower, nominal mixes may be used with the permission of the Authority's Engineer.

If Nominal mix concrete does not yield the specified strength, such concrete shall be classified as belonging to the appropriate lower grade. Nominal mix concrete proportion for a given grade shall not, nowhere, be placed in higher grade on the ground that the test strengths are higher than the minimum specified. As long as the quality of the materials does not change, a mix design earlier in use may be considered for later work.

The proportion of fine aggregate to coarse aggregate in Nominal mix is generally 1:2 but subject to an upper limit of 1:1-1/2 and lower limit 1:2-1/2 depending upon the nature of aggregates. The cement content of the mix for any nominal mix shall be proportionately increased if the quantity of water in a mix has to be increased to overcome the difficulties of placement and compaction so that water cement ratio is not exceeded.

To improve workability of concrete and cement, grout admixtures conforming to IS: 6925 and IS: 9103 could be permitted subject to the approval of Authority's Engineer. Admixtures generating hydrogen, nitrogen etc. should not be used. Nothing extra will however be paid for the same.

9. Mixing of Concrete and Placing by Pumping / Pneumatic Placers

Mixing of concrete shall continue until there is a uniform distribution of material and the concrete is uniform in colour and consistency and shall be for at least two minutes.

Mixers and weigh batches shall be maintained in first class condition throughout the contract and any mixer or plant which is faulty shall not be used. The drums on all mixers shall revolve at the speed recommended by the manufacturer. A mixer of any type which has been out of use for more than 20 minutes shall be thoroughly cleaned out before any fresh concrete is mixed. The subsequent 1st batch shall have additional cement to allow for sticking in the drum. All equipment shall be maintained in a clean, serviceable condition and their accuracy periodically checked. All controlled mix of concrete shall be from RMC plants, which are duly approved.

Concrete may be conveyed and placed by mechanically operated equipment like pumps or pneumatic placers only with the written permission of the Authority's Engineer.

10. Compressive Strength

The Contractor shall keep on site minimum six standard 15 cm test cube moulds and ancillary equipment for preparing test cubes. Before the Contractor commences any concrete construction, he shall make six cubes of mix concrete with the cement, sand, aggregate and water which he proposes using on the contract and shall have them tested at a Laboratory approved by Authority's Engineer. Three cubes shall be tested at 7 days and three cubes at 28 days after casting and curing but shall not be limited to six cubes but additional cubes have to be cast as per IS: 456-2000, for 7 days strength and 28 days strength separately. In all cases the cubes shall give the minimum compressive strength for Preliminary Tests specified above. No concrete construction shall be commenced until Preliminary Tests on the six cubes referred above have been completed and result show the concrete to have the minimum compressive strength.

As construction proceeds samples from fresh concrete shall be taken as per IS: 1199 and cubes shall be made, cured and tested in accordance with IS: 516. Three test specimen shall be made for each samples for testing at 28 days. Additional cubes may be required for various purposes as to determine the strength of concrete at 7 days or at the time of striking formwork, or to determine the duration of curing, or to check the testing error. The test strength of the sample shall be the average of the strength of three specimens. The individual variation should not be more than (+/-) 15 percent of the average. If more the results of the sample are invalid, any part

of the work from which the cubes fail to give the required minimum compressive strength shall be dealt with the Contractor as directed by the Authority's Engineer and at the expenses of the Contractor.

11. Design Mix Concrete

All designs mix concrete shall be designed on the basis of preliminary tests. The contractor shall make trial mixes using samples of aggregates and cement, typical of those to be used in the works. If possible, the concreting plant and the methods of transporting and depositing the concrete to be employed in the work shall be used to working conditions with the trial mixes.

All these preliminary tests approvals etc. shall be got done well in advance by the contractor before any concreting is contemplated. Failure on the part of the contractor to do so and the consequent delay in the completion of the works will not entitle him for any compensation whatsoever, either financially or by way of extension of time.

Based upon the successful preliminary crushing and workability tests, the contractor shall submit mix design proposals to the Authority's Engineer who will have the right to reject any trial mix not deemed satisfactory. The design mix shall be done for the Ready-mix concrete of all the grades, as well as of the batching mixing separately through a certified agency. The Design is to be got approved by the authority before execution.

It shall be the ultimate responsibility of the contractor for selection of the trial mix to the complete satisfaction of the Authority's Engineer.

12. Cement Content, Water Cement Ratio and Workability

From durability consideration, strict control on the cement content and water ratio and in the process of concrete making, laying, compaction and curing must be exercised, the aim being to achieve a dense and impermeable concrete.

The following limit in respect of cement content and water cement ratios shall be maintained:

Structural Member	Min. cement content in kg/ m³ (for 20mm nominal size of aggregate)	Maximum water cement ratio
a) PCC members		0.45
b) RCC members	(As per IS: 456)	0.40
c) PSC members		0.40

The cement content shall be as low as possible but not less than the quantities as specified above.

The concrete is also liable to be rejected or repaired as per the instructions of the Authority's Engineers/ Authority's Engineer, if it is porous or honeycombed, its placing has been interrupted without providing a construction joint or the reinforcement has been disproportionately

displaced.

The Contractor shall keep a daily record showing the date when each portion of concrete is poured in slab, beam, column etc., curing period, removal of formwork and test cube results at 7 days and 28 days period.

13. Tests & Standards of Acceptance

- **Slump Test**

The Contractor shall keep at the site of the works for the constant use of the Authority's Engineer, a standard slump test mould and shall provide facilities throughout the construction for tests to be made as and when the Authority's Engineers may require. The slump cannot be definitely stated until tests have been made using the materials adopted for the work, but it is anticipated, that the slump of between 25mm to 50mm will be required.

The Contractor at his own expense shall establish a field laboratory to carry out all preliminary tests, work tests and also to work out grading and proportioning of aggregates in order to obtain and maintain uniform quality of work. A 150 mm cube testing machine shall be installed by the contractor at his own expense to ascertain the strength of concrete from time to time. The contractor shall supply all materials, labour and testing machines for preparing and testing sample as required by the Authority's Engineer. The concrete shall also be got tested in an independent laboratory approved by the Authority's Engineer at the discretion of the Authority's Engineer or his authorised representative at no extra cost.

- **Defective Concrete**

Any concrete which gives results below the results specified in relevant paras or becomes severely damaged due to cracking or shows excessive honey-combing and exposure of reinforcement or exhibits any fault which in the opinion of the Authority's Engineer, seriously impairs its function, may be declared defective concrete. Such concrete shall be cut out and removed from the site by contractor at his own expense to the satisfaction of the Authority's Engineer. Alternatively, the contractor shall carry out at his own expense, whatever other remedy the Authority's Engineer may reasonably require having regard to all the circumstances.

- **Tests**

In case of doubt regarding grade of concrete used, either due to poor workmanship or bases on results of cube crushing strength, test of concrete on the basis of any or all of the following shall be carried out. The Authority's Engineer shall be the final authority for interpreting the results of all these tests and the contractor shall carry out these tests at his own expenses without any additional cost to the authority.

- **Core test**

The points from which cores are to be taken and the number and size of cores required

shall be the discretion of the Authority's Engineer. Core shall be prepared and tested as described in relevant code. Concrete in the member represented by a core test shall be considered acceptable if the average equivalent strength of 85% of the cube strength of the grade of concrete specified for the corresponding age and no individual core has a strength less than 75%.

In case the strength of individual core is found unsatisfactory and below the specified stipulation, approval is to be obtained from the Authority's Engineer after submitting necessary proofs in writing on safety and stability of the structure. Decision on acceptance/rejection to this effect given by the Authority's Engineer shall be final binding on the contractor.

Other non-destructive test e.g. rebound hammer test, ultrasonic test - as directed by the Authority's Engineer.

14. Transporting Placing and Compaction of Concrete

The concrete shall be transported maintaining required workability in a manner such as to avoid the segregation of the constituent materials, and loss of any of the ingredients. It shall be deposited as nearly as practicable in its final position to avoid re-handling. It shall be placed and compacted before setting commences and should not be subsequently disturbed. Methods of pouring should be such as to preclude segregation, and to avoid displacement of reinforcement and movement of formwork.

The concrete should be thoroughly compacted and fully worked around the reinforcement, around embedded fixtures and into the corner of the formwork without formation of honey combing, pinholes or surface irregularities and any other defects whatsoever. The use of mechanical vibrators having capacity of producing vibrations at a rate not less than 5000 cycles per minute is recommended. Over vibration or vibration of very wet concrete is harmful and should be avoided; under vibration is also harmful. In addition to mechanical vibration, sufficient hand tools must be used to ensure full consolidation around reinforcement and at edges and corners.

The deposition of concrete shall be carried out as continuously as possible to reduce to a minimum joints between new concrete which has set. Where construction joints are necessary, they shall be formed at right angles to the axis of the member concerned by the insertion of rigid stopping off form, against which concrete can be properly rammed. Concrete shall not be dropped from a height of more than 1.0 M. No unset concrete shall be brought into contact with unset concrete containing cement of different type. Special permission and instructions shall be obtained when concrete has to be deposited under water. Under water concreting shall be done with the help of tremi pipeline only. Concrete shall contain 10% more cement than that required for the specific mix placed in dry condition.

Accumulation of set concrete on the reinforcement shall be avoided. Before fresh concrete is deposited upon or against any concrete which has already hardened, the surface of hardened

concrete shall be well roughened if necessary, by chipping and all laitance removed. The surface shall then be swept clean with wire brushes, thoroughly wetted and covered with a thin layer of cement mortar.

Care should be taken such that there is no cold joints while laying concrete.

Use of Vibrators:

Immersion vibrator shall be inserted vertically at points not more than 450mm apart and withdrawn when air bubble cease to come to the surface. Immersion vibrator shall be withdrawn slowly.

The immersion vibrator shall penetrate the layer being placed and also penetrate the layer below while the under layer is still plastic to ensure good bond and homogeneity between the two layers and prevent the formation of cold joints.

The use of surface vibrators will not be permitted under normal conditions. However, for thin slabs, such as highways, runways and similar constructions, surface vibration by specially designed vibrators may be permitted upon approval of Authority's Engineer.

15. Protection of Concrete

Newly placed concrete shall be protected by approved means from rain, sun and drying winds. Concrete placed below the ground shall be protected from falling earth during and after placing. Approved means shall be taken to protect immature concrete from damage by debris, excessive loading, vibration, abrasion, deleterious ground water, mixing with earth or other materials that may impair the strength and durability of concrete.

16. Working in Extreme Weather

During windy weather efficient protection is to be provided to prevent the cement from being blown away during the process of apportioning and mixing. During wet weather the concrete shall be adequately protected as soon as it is in position. No concreting shall be carried out during period of continuous heavy rain unless it is completely covered during mixing, transporting and placing. In extreme hot weather, concreting shall be restricted to mornings and evenings. Time between mixing and placing of concrete shall be kept to the minimum and formwork shall be cooled by sprinkling with water before it starts drying out.

17. Construction Joints

The minimum number of joints should be used, and their constructions should be simple. They should be either horizontal or vertical because concreting sloping surfaces are usually unsatisfactory.

Where concrete is placed in vertical members e.g. walls columns and the like, the lifts of concrete shall finish or in sloping members at right angles to the axis of the members, the joint line matching the features of the finished work. Concreting shall be carried out continuously up to the construction joints.

Laitance, both on the horizontal and vertical surfaces of the concrete, should be removed before fresh concrete is adhesion and sand wet blasted. Various methods for removal can be used. But they should not dislodge the coarse aggregate particles. Concrete may be brushed with a stiff brush soon after casting while the concrete is still fresh, and while it has only slightly stiffened.

If the concrete has partially hardened, it may be treated by wire brushing or with a high-pressure water jet, followed by drying with an air jet, immediately before the new concrete is placed.

Fully hardened concrete should be treated with mechanical hand tools or grit blasting, taking care not to split or crack aggregate particles. The best time for treating the joints is a matter of judgement because it depends on the rate of setting and hardening (which is itself dependent on the temperature of the concrete) before further concrete is cast the surface should be thoroughly cleaned to remove debris and accumulated rubbish, one effective method being by air jet.

Where there is likely to be a delay before placing the next concrete lift protruding reinforcement should be protected before the next lift is placed, rust, loose mortar, or other contamination should be removed from the bars and where conditions are particularly aggressive and there has been a substantial delay between lifts, the concrete should be cut back to expose the bars for a length of about 50 mm to ensure that contaminated concrete is removed.

In all cases, when construction joints are made, it is essential to ensure that the joint surface is not contaminated with release agents, dust, or curing membrane and that the reinforcement is fixed firmly in position at the correct cover.

Concrete in beams shall be placed throughout without a joint but if the provision of a joint is unavoidable the joint shall be vertical within the middle third of the span unless otherwise shown on drawings. Where a beam intersects a girder, the joints in the girder shall offset a distance equal to twice the width of the beam and additional reinforcement provided for shear the joints shall be vertical throughout the full thickness of the concrete member a joint in a slab shall be vertical and parallel to the principal reinforcement where it is unavoidable at the right angles to the principal reinforcement the joint shall be vertical at the middle third of the span.

18. Concreting at Construction Joints

When the form work is fixed for the concreting work, it should be inspected to ensure that no leakage is seen from the fresh concrete.

The practice of first placing a layer of mortar or grout when concreting joints is not recommended. The old surface should be soaked with water, without leaking puddles immediately before starting concreting then the wet concrete should be thoroughly compacted against it.

When fresh concrete is cast against existing mature concrete or masonry, the older surface should be thoroughly cleaned and soaked to prevent the absorption of water from the new

concrete. Standing water should be removed shortly before the new concrete is placed and the new concrete should be thoroughly vibrated in the region of the joint. Chemical bonding agents shall be used with the approval of the Authority's Engineer at no extra cost.

The use of epoxy for bonding fresh concrete used for repairs will be permitted upon written approval of Authority's Engineer. Epoxies shall be applied in strict accordance with the instruction of the manufacturer.

19. Structural Joints

Expansion joints or other permanent structural joints shall be provided in position and of the form described in the drawings or elsewhere.

In no case shall the reinforcement, corner protecting angles or other fixed metal items, embedded or bonded into concrete, run continuously through an expansion joint. The placing of concrete on either side of the expansion joint shall be done separately after an interval of at least seven days.

20. Cutting into Concrete

No concrete shall be cut into, nor shall it be interfered with in any way, without the prior approval in writing of the Architect. Necessary holes shall be provided as required for plumbing work and for electrical pipes at the time of execution.

21. Curing of Concrete

Exposed surfaces of concrete shall be kept continuously in a damp or wet condition for at least fourteen days from the date of placing of concrete.

Approved curing compounds may be used in lieu of moist curing with the permission of the Architect. Such compounds shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set and care shall be taken so as the compound shall not affect the concrete. The surface shall be cleaned by using wire brushes before plastering without additional cost.

22. Inserts

The contractor shall fix all necessary steel plates, pipe holes, pockets, dowels etc. in the shuttering of concrete work, to enable subsequent fixing of supports, brackets, ceilings, precast members etc., as indicated in the drawings or as required by the Authority's Engineer of Work.

23. Finishing

Immediately on removal of forms, the RCC work shall be examined by the Authority's Engineer before any defects are made good.

- The work that has sagged or contains honey-combing to an extent detrimental to structural safety or architectural concept shall be rejected.

- Surface defect of a minor nature be accepted to acceptance of such work by the Authority's Engineer and the same shall be rectified in an approved manner.
 - Surface defects which require repair when form are removed usually consist of bulges due to the movement of forms, ridges at form joints, honey combed areas, damage resulting from the stripping of forms and bolt hole. Bulges and ridges are to be removed by careful chipping or tooling and the surface is then rubbed with a grinding stone, honey combed, and other defective areas must be chipped out, the edges being cut as straight as possible and perpendicularly to the surface or preferably slightly undercut to provide a key at the edge of the patch . bolt holes shall be closed by cement mortar to ensure through filling.
 - Shallow patches are first treated with a coat of thin grout composed of one part of cement and one part of sand and then filled with mortar similar to that used in the concrete. The mortar is placed in layers is given a scratch finish to secure bond with the succeeding layer. The last layer is finished to match the surroundings concrete by floating, rubbing or tolling on formed surfaces by pressing the form material against the patch while the mortar is still plastic. Bonding compound shall be used without any extra cost.
 - Large and deep patches require filling up with concrete held in place by forms. Such patches are to be reinforced and carefully dwelled to the hardened concrete.
 - The same amount of care to cure the material in the patches should be taken as with the whole structure. Curing must be started as soon as possible, after the patch is finished to prevent early drying. Damp hessian may be used but in some location, it may be difficult to hold it in place. A membrane curing in these cases will be most convenient.
 - On receiving approval of the Authority's Engineer, the exposed concrete surfaces of substructure and superstructure above well cap shall be finished with two coats of cement-based paint of approved shade and quality.

24. Pre-Cast Concrete

All aforesaid specifications for concrete shall apply to precast concrete in addition to the following variations.

The concrete in one precast piece shall be placed in one operation. No piece shall be removed from the mould or erected until sufficiently matured to ensure that no damage shall be done to the piece.

All details of jointing, inserts, anchors and bearing widths shall be as shown on the drawings.

All precast concrete members shall be clearly marked to indicate the top of the member and its location.

Units shall be stored, transported and placed with due care so that they will not be overstressed or damaged.

Precast units shall be adequately braced and supported during erection to ensure proper alignment and safety, and such bracings and supports shall be maintained until there are adequate permanent connections.

25. Plum Concrete Course

The unevenness in the founding strata shall be levelled using plum concrete. The pockets in the founding strata shall be filled with plain cement concrete of lean mix. Plums above 160mm and upto any reasonable size shall be embedded in the plain cement concrete layer upto a maximum limit of 20 percent by volume of plain concrete when specifically permitted by the Authority's Engineer. The plums shall be distributed evenly and shall be no closer than 150mm from the surface.

26. Levelling Course

It shall be plain cement concrete of leaner mix which shall be proportional as stipulated and placed in position conforming to line and level shown on the drawing and compacted by approved means and cured.

27. Supervision

Constant and strict supervision at all items of the construction is necessary during the progress of the work, including the proportioning and mixing of the concrete. Supervision is also of extreme importance to check the reinforcement and its placing before being covered.

28. Formwork

The Form work shall be designed for rigidity and durability, strength, water tightness, easy removal, surface finish required for concrete in contact with shuttering and economy.

Material used in form work shall be 12mm thick film faced shuttering plywood, steel props, steel plates, or specially designed and manufactured moulds out of plastic or reinforced fiber glass or steel.

Use shall depend upon its location, type of finish specified subject to acceptability by AUTHORITY'S ENGINEER. Form work designed with proposed material in use should be able to retain its shape, lines and dimensions shown in the drawings. It should safely carry the full load of concrete self-weight, reinforcement weight together with any live and impact load likely to occur during concreting.

Material used shall conform to relevant IS codes. It is the contractor's responsibility to entirely achieve the standard expected to the satisfaction of the Authority's Engineer.

29. Workmanship

Erection of form work may be from pre-molded, pre-fabricated, pre-assembled plates or forms reasonable enough to transport and erect at site to correct line and level as set out at site. Supports shall be firm and maintained in position by nails, cross bracings, tie rods, locking bolts and nuts. It shall be rigid and stiff so as to retain its shape during and after concreting.

Joints shall be watertight, and no cement slurry shall be allowed to slip through.

Pre-fabricated or site fabricated forms shall be assembled, so as to de-shutter without any jerk to the green concrete. For this double wedges shall be used. Wedges shall be nailed, the heads reasonably left out, allowing easy removal while de-shuttering.

Pre-fabricated or site fabricated forms shall be of sufficient thickness and with the required supporting runners in either direction. Supporting runners shall be standardized in size for easy replacement and universal use at site.

Props shall be of steel only. Size and vertically shall be approved by the AUTHORITY'S ENGINEER. Its spacing shall be as per design. It shall be vertical and to plumb. Base shall be a proper steel plate or timber plank, for equal distribution of load. The concreting of the upper floor shall be done only after 14 days of concreting of lower floor.

Beams and slabs shall have camber of 4mm per meter or as directed by the AUTHORITY'S ENGINEER.

All angles and corners shall be sharp and well defined in places where concrete edges are permanently exposed and require no further treatment, they shall be chamfered in a triangle of 25 x 25mm. Props of steel or timber shall be provided with adequate horizontal and cross-bracing. Steel props shall use steel pipes and steel couplers. If use of timber is permitted, planks of 100 x 25 mm shall be used and shall be secured by nailing them to timber props. No other material shall be permitted.

At the design and erection stage, the following additional points shall be considered and incorporated into the shutters.

- Openings for cleaning prior to start of concreting.
- Pouring points shall avoid high drops and provide easy access to vibrator needles.

Surfaces shall be treated with mould releasing oil or emulsion as approved by the AUTHORITY'S ENGINEER prior to reinforcement laying.

The following points shall be observed very carefully:

- Joints of moulds shall be watertight. It is easy to check from the bottom and make sure that no light is visible.

- Props shall be on solid base, plumbed, in one straight line and braced horizontally and cross.
- Tie bars in beams, walls and columns shall be at the correct place and fully tight.
- Wedges shall be fully secured and nailed with heads left out for easy removal.
- All saw dust, dirt, shavings and any other unwanted materials shall be cleaned and hosed out.
- Provisions shall be made for watching form work while concreting and any other platform needed for movement of workers without any disturbance of reinforcement.

Form work shall be erected in accordance with:

- IS: 3696 - Safety code of scaffolds and ladders.
- IS: 4014 - Code of practice for steel tubular scaffolding I and II. Part - 2 safety regulation for scaffolding.
- IS: 8989 - Safety code for erection of concrete framed structures.

30. Special Fair Faced Finish

Where special fair faced finish is specified, the contractor shall be responsible for producing a perfectly smooth surface to the concrete, free from projections or imperfections of any description. Arises must be clean, sharp and perfectly sound. The form work must be designed so that it can be erected and maintained perfectly plumb and all surfaces must be true planes free from winding or other deformities throughout. Tying wires through the concrete to hold the form work together will not be permitted and either exterior bracing or through bolts are to be employed. If the latter are used the bolts shall subsequently be removed and the holes plugged with cement mortar. The pattern of holes has to be to the approval of the Authority's Engineer. No part of any metal tie or spacer remaining permanently embedded in the concrete shall be nearer than 50mm to the finished surface of the concrete. Concrete faces must be protected at all times during and after construction against accidental damage or disfiguration and the contractor will be responsible for taking all necessary measures to ensure that the work is perfectly sound and free from blemishes, stains, etc. when finally handed over.

31. Removal of Formwork

Under normal circumstances and where Ordinary Portland Cement is used, forms shall be removed after expiry of the following periods. As per IS: 456-2000

- Walls, columns and vertical faces – 24 to 48 hours
- Slabs (props left under) – 7 days
- Beams soffits (props left under) – 7 days
- Removal of props under slabs
 - Spanning up to 4.5 M – 7 days
 - Spanning over 4.5 M – 14 days
- Removal of props under beams and arches
 - Spanning up to 6 M – 14 days
 - Spanning over 6 M – 21 days

For other cements, the stripping time shall be suitably modified in consultation with the

AUTHORITY'S ENGINEER.

Where the shape of elements is such that the form work has re-entrant angles, the form work shall be removed as soon as possible after the concrete has set, to avoid shrinkage or cracking that might occur due to the restraint imposed. For precast moulds, the stripping time shall be 24 hours. The mould may be lifted and stored in the yard within 24 hours to 48 hours as approved by the AUTHORITY'S ENGINEER.

- **Openings / Inserts**

All required openings and pockets shall be provided as detailed in the drawing. The contractor shall provide for the required material, labour, for fixing and supporting during concreting, in his quoted price. It is imperative that all openings and pockets shall be de-shuttered with care and all corners of openings shall be preserved. All openings/pockets shall be in a correct line and level. After concreting, the openings shall be secured against any accident by proper covering and guard-rail and warning notice, if any.

The contractor shall clean and grout the pocket at a later date with a non-shrinking compound added to the grout mix or non-shrinking cement shall be used. It shall be well-cured and protected to correct line and level till handing over.

Inserts are material such as timber, steel, plastic, dowels, bolts, locks, brackets, pipes etc. left in concrete partly or fully embedded to receive connection with foreign member at a later date. These may be fabricated by the contractor or provided by the Authority as received from specialist, manufacturer, etc. These shall be protected from weathering and damage in course of the construction. The cleaning required after concreting and any treatment such as oiling, greasing or covering with paint etc., shall be carried out by the contractor at his cost.

It is very important that the providing and fixing shall be carried out with the "utmost precision" and to the entire satisfaction of the Authority's Engineer. Any deviation from that as shown in the drawings or instructions shall be rectified by the contractor at his own cost and responsibility.

- **Preparation of Formwork Before Concreting**

- **Special provision**

Wherever the concreting in narrow members is required to be carried out within shutters of considerable depth, temporary openings in the sides of the shutters shall, if so, directed by the Authority's Engineer, be provided to facilitate the pouring and consolidation of the concrete. Small temporary openings shall be provided as necessary at the bottom of shutters of walls and deep beams to permit the expulsion of rubbish, etc.

- **Discoloration**

Formation of blotches and stains due to detachment of form work panel from the concrete when adjacent portion to the same lift is still adhering, shall not be allowed to occur, and for this purpose, all shutters shall be struck off at the same time.

C. Stone Masonry

1. Indian Standards

The following Indian Standards apply to this section.

- IS: 112 (Part-I) -1974 – Method of test for determination of strength properties of natural building stone Part-I – Compressive strength (first revision).
- IS: 1124 – 1974 – Method of test determination of water absorption, apparent specific gravity and porosity of natural building stones (first revision).
- IS: 1597 – 1967 – Code of practice for construction of stone masonry.
- IS: 1706 – 1972 – Method for determination of resistance to wear by abrasion of natural building stones (first revision)

2. Stone

The stone shall be of the type specified such as granite, trap, other igneous rock, sandstone, etc. and shall be obtained from the approved quarries as indicated.

Stone shall be hard, sound durable and free from weathering, decay and defects like cavities, crack flaw, sand holes, injurious veins, patches of loose or soft materials and other similar defects that may adversely affect its strength and appearance. As far as possible, stone shall be of uniform colour and texture. Generally, stone shall not contain Crypto Crystalline silica or chert, mica and other deleterious materials like iron oxide, organic impurities etc.

The compressive strength and water absorption of common type of stones are given in the table below:

Type of stones	Water absorption, percentage by weight max.	Compressive strength Kg/Sq. cm. Min.
Granite	0.50	1000
Basalt	0.50	400
Sandstone	2.50	300
Marble	0.40	500
Laterite stone	Not more than 12% by mass	35

- **Laterite Stone**

The laterite stone shall be compact in texture and mottled and streaked with various colors like brown, red & yellow. It shall not contain white clay lithomarge or appreciable number of sinuosity's, which are deep. The blocks should be obtained as far as possible from a good ferruginous laterite which hardens on exposure after it is quarried. The Laterite stone shall be machine cut and obtained from an approved quarry.

The specific gravity of laterite stone shall not be less than 2.5. The compressive strength of the blocks to be used in masonry work shall not be less than 35kg/ cm² in its dry condition. The water absorption after 24 hours of immersion in water shall not be more than 10%. Laterite stone shall be dressed soon after quarrying when it is soft enough to be cut with a pick and easy to make into rectangular blocks. After quarrying, the stones shall be allowed to season for some time before using in work.

- **Dimensions of Stones**

Unless otherwise indicated, the length of stone for stone masonry shall not exceed three times the height and the breadth on base shall not be greater than three-fourth the thickness of wall. Height of stone may be up to 30 cms. Minimum dimensions of stones for various types of masonry shall be as given below.

- Stone for random rubble masonry may be of any size and shape but shall be not less than 15 cms in any direction.
- Stones for squared rubble masonry shall be not less than 15 cms in length and width.
- Stones for block-in-course masonry shall be not less than 20 cms in breadth or height and length not less than twice the height.
- Stones for ashlar masonry shall be not less than 30 cms in breadth and height and length not less than twice the height.

3. Masonry Mortar

- **Cement**

Cement shall be of ordinary Portland cement, Portland blast furnace slag cement or pozzolona cement as specified.

- **Sand**

Unless otherwise indicated sand for masonry mortar shall consists of natural sand, crushed stone sand or crushed gravel sand or the combination of any of these conforming to IS: 2160–1980 - Specification for sand for masonry mortar. Sand shall be hard, durable, clean and free from adherent coating and shall not contain clay and impurities such as iron, pyrites, salt, coal, mica, Shale or similar laminated or other materials.

The maximum quantity of clay, fine silt and fine dust in sand shall not be more than 5% by mass. Organic impurities shall be below that the obtained by comparison with a standard solution.

- **Proportioning**

Mortar should be of the mix as indicated. The mix specified shall be proportioned by volume of cement to dry sand.

- **Preparation of Cement Mortar**

Mixing should be done preferably in mechanical mixer. If hand mixing, operation shall be carried

on a clean watertight platform. Cement and sand shall be mixed dry in the required proportion to obtain a Uniform colour. The required quantity of water shall then be added, and the mortar hoed back and forth for 5 to 10 minutes with addition of water to a workable consistency. In the case of mechanical mixing the mortar shall be mixed for at least three minutes after addition of water. Cement mortar should be freshly mixed for immediate use. Any mortar which has commenced to set shall be discarded and removed from the site.

4. Dress Stonework

The various dressing specified shall have the following meanings

- Rubble: Stones of irregular shapes and sizes as quarried, with irregular angles taken off.
- Self-faced surfaces: Surface of stone slabs used for roofing, flooring, lintels etc., as obtained from quarry.
- Squared Back Surface: Means the surface shall be dressed back at right angles to the face of stone.
- Chisel Drafted Margin: The dressing done with a drafting chisel in narrow strips of width generally 2 to 5 cms chisel drafted margin shall be punch dressed.
- Hammer Dressed Surfaces: A hammer dressed stone shall have no sharp and irregular corners and shall have a comparatively even surface so as to fit well in masonry. Hammer dressed stone is also known as hammer faced, quarry faced and rustic face. The bushing from the general wall face shall not be more than 40 mm on an exposed face and 20 mm on surfaces to be rendered.
- Punched Dressed Surfaces: A rough tooled surface is further dressed by means of a punch chisel to show series of parallel ridges. The depth of gap between the surface and a straight edge held against the surface shall not exceed 3 mm.
- Close Picked Surfaces: A punched stone is further dressed by means of a point chisel, so as to obtain a finer surface, ridges or chisel mark left over being very tiny. The depth of gap between the surface and a straight edge kept over the surface shall not exceed 1.5 mm.
- Polished Surfaces: Surfaces having a high gloss finish.

5. Types of Stone Masonry

- **Random Rubble Masonry**
 - **Un-coursed:** This type of masonry is constructed of stones as they come from the quarry. The mason selects stones of all shapes and sizes, more or less at random and places them in position to obtain a good bond, while restricting cutting of the stones to the removal of inconvenient corners with scabbling or spalling hammer.
 - **Brought to Courses:** This walling is similar to un-coursed random rubble except that the work is roughly levelled up to courses at intervals varying from 30 cm to 60 cm in height according to the locality and the type of stone used.
- **Polygonal Rubble Masonry**

Stone with no pronounced stratification is roughly hammer dressed or pitched into irregular

polygonal shapes and bedded to show the face joints running irregularly in all directions.

- **Squared Rubble Masonry**

- **Un-coursed:** In this type, the stones are roughly squared as risers or jumpers and stretchers with varying heights and laid un-coursed.
- **Brought to Courses:** The stones are similar to those used for un-coursed rubble, but the work is levelled to courses of varying depth from 30 cm to 60 cm according to the locality and the type of stone used.
- **Coursed:** Coursed walling is built in courses which may vary in height from 15 to 30 cms but the stones in any one course are roughly squared to the same height.

- **Block in Course Masonry**

This is hammer faced, regular coursed masonry in large blocks.

- **Ashlar/ Plain Ashlar Masonry**

Stone blocks of the same height in each course are used and every stone is rough tooled on all beds and joints, full and true and faces dressed as indicated.

6. General Requirements for Stone Masonry construction

- All stone masonry shall be set out and built to the respective type dimensions, thickness and heights as indicated.
- All labours on stone shall normally be executed when it is freshly quarried.
- Stones shall be sufficiently wetted before laying to prevent absorption of water from mortar.
- The natural bed of the stratified stone shall be so laid that the pressure is always perpendicular to the strata. Stones in walling, steps, copings, sills etc., shall be placed with the grain or natural bed, horizontal.
- The courses shall be built perpendicular to the pressure which the masonry will bear. In case of battered walls, the beds of stones and the plane of course shall be at right angle to the batter.
- Vertical joints shall be staggered as far as possible. In the case of squared rubble coursed masonry block in course masonry and ashlar masonry, stones shall break joints, on the face for at least half the height of the course and the bond shall be carefully maintained throughout.
- Stones shall be laid on a full bed of mortar. All joints shall be properly flushed and packed.
- The walls and pillars shall be carried up truly plumb or to the specified batter.
- No part of the wall during its construction shall rise more than 1 meter above the general construction level to avoid unequal settlement. Where there is a break in masonry work, the masonry shall be raked back in sufficiently long steps for facilitating joining of old and new work. The stepping of the raking shall not be more than 30 degrees with the horizontal.

- At all angular junctions, the stones in each alternative course shall be well bonded into the respective course of the adjacent wall.

7. Protection

Care shall be taken during construction that the edges of jambs, sills, heads etc. or not damaged. In inclement weather new built work shall be suitably protected by covering with gunny bags or tarpaulin.

8. Curing

Masonry work shall be kept constantly moist on all the faces for a minimum period of seven days. Watering shall be done carefully so as not to disturb or wash out green mortar.

9. Bond Stones

Dressing of bond stones shall be done as for other stones. In coursed masonry full surface of the bed shall be dressed. In random rubble masonry, bond stones shall be hammer dressed on the face, beds and joints and made into a squared block.

10. Plain Cement Concrete Bond Stones

Plain Cement Concrete Bond Stones of mix 1:3:6 may be provided in lieu of stone bond stones, where indicated. The size and spacing of PCC bond stones shall be as specified for stone bond stones and shall be laid on the full section of the walling in one piece.

11. Brick Work

• Indian Standard Codes

The following Indian Standard codes apply to this section.

I.S. NO.	SUBJECT
IS:1077-1986	Specification for common burnt clay building Bricks.
IS:1905-1980	Code of practice for structural safety of building masonry wall (Second Revision)
IS:2116-1980	Specification of sand for masonry mortar (First Revision)
IS:5454-1978	Method of sampling of clay building Bricks (First Revision)
IS:2250	Code of practice for preparation and use of masonry cement.

12. Materials

• Cement

Cement shall be of ordinary Portland cement, Portland blast furnace slag cement or pozzolona cement as specified.

• Sand

Unless otherwise indicated sand for masonry mortar shall consists of natural sand, crushed stone sand or crushed gravel sand or the combination of any of these conforming to IS: 2160-

1980 specification for sand for masonry mortar. Sand shall be hard, durable, clean and free from adherent coating and shall not contain clay and impurities such as iron, pyrites, salt, coal, mica, shale or similar laminated or other materials.

The maximum quantity of clay, fine silt and fine dust in sand shall not be more than 5% by mass. Organic impurities shall be below that the obtained by comparison with a standard solution.

- **Common Burnt Clay Building Bricks**

Common burnt clay building bricks (hereinafter termed as “Bricks”) shall conform to the requirement laid down in IS: 1077-1986, specification for common burnt clay building bricks. The class of Bricks, based on minimum compressive strength, 35, 50, 75, 100 or 125 and their sub class A or B shall be indicated. Sub class A bricks shall have smooth rectangle faces with sharp corners and shall be uniform in colour.

- Dimensions - Size of Standard Bricks shall be as under

TYPE OF BRICKS	NOMINAL SIZE	ACTUAL SIZE
Modular Bricks	20x10x10 cms	19 x 9 x 9 cms
Old size Bricks (FPS)	9x4.5x3 inches OR 23 x 11.3 x 7.5 cms	9x 4 ³ / ₈ x 2 ³ / ₄ inch

- Tolerance:
The permissible to tolerance on the dimensions of the Bricks unless otherwise indicated, shall be + or – 3% for class A Bricks and + or – 8% sub class B Bricks.
- General Quality:
Bricks may be hand or machine moulded and shall be made from suitable soils. They shall be free from cracks, flaws and nodules of free line. Bricks of 7.5 cms, 10 cms thickness (height) shall be moulded with frog 1 to 2 cms deep on one of its flat surfaces.
- Compressive Strength:
The compressive strength of individual bricks shall not fall below the minimum average compressive strength specified for class of bricks by more than twenty percent.
- Water Absorption:
The average water absorption of Bricks, after immersion in cold water for 24 hours shall not be more than Twenty percent (for Bricks up to Class 125).
- Efflorescence:
The rating of Efflorescence of the Bricks shall not be more than moderate (for Bricks Class 125).

- Handling and Storage:
Bricks shall not be dumped at site; they shall be stacked in regular tiers on even ground as they are unloaded to minimize breakage and defacement of Bricks. Bricks stacked for facing and any particular purpose/ situation of use shall be stacked separately.

13. Masonry Mortars

- Proportioning: Mortar should be of the mix as indicated; the mix specified by volume in proportion of cement to dry sand.
- Preparation of Cement Mortar – Mixing should be done preferably in mechanical mixer. If hand mixing, operation shall be carried on a clean watertight platform. Cement and sand shall be mixed dry in the required proportion to obtain a uniform colour. The required quantity of water shall then be added, and the mortar hoed back and forth for 5 to 10 minutes with addition of water to a workable consistency. In the case of mechanical mixing the mortar shall be mixed for at least three minutes after addition of water. Cement mortar should be freshly mixed for immediate use. Any mortar which has commenced to set shall be discarded and removed from the site.

14. Setting Out

All Brick work shall be set out and built to the respective dimensions, thickness and height as indicated.

15. Scaffolding

Scaffolding shall be strong to withstand all dead, live and impact loads which are likely to come on that. Scaffolding shall provide to allow easy approach to every part of work, overhead work shall not be allowed. For exposed brick facing double scaffolding having two sets of vertical supports shall be provided. For brick work, which is to be plastered over, single scaffolding may be provided. In single scaffolding one end of put logs shall rest in the hole provided in the header course of brick masonry. Not more than one header for each put long shall be left out. Such hole shall not be allowed in the case of pillar or narrow masonry portions, between the openings, which are less than 1 M in width or are immediately under or near the structural member supported by the walls. The holes left shall be made good on removal of scaffolding to match with the face work/ surrounding area.

16. Soaking of Bricks

Bricks shall be soaked in water before use for a period for the water to just penetrate the whole depth of bricks. Alternatively, bricks can be soaked in stacks by profusely spraying with clean water on regular intervals for a period not less than six hours.

17. Laying

All loose materials, dirt and set lumps of materials which may be laying over the surface on which brick work is to be freshly started shall be removed with wire brush and surface wetted slightly. Brick shall be laid on a fully bed of mortar. When laying, the Brick shall be properly bedded and slightly pressed with handle of trowel, so that the mortar can get into all pores of the brick surface

to ensure proper adhesion. All the joints should be properly flushed and packed with mortar, so that no hollow space is left. Care shall be taken to see that the required quantity of water is added to the mortar at the mixing platform to obtain required consistency. Addition of water during laying of course shall not be permitted. In the case of walls two brick thick and over, the joints shall be grouted to every course in addition to bedding and flushing with mortar.

While using old size bricks, (FPS conventional bricks) top courses of plinth, parapet, steps and top of walls below roof slab or floor slab shall be laid on brick on edge, applicable in case of additional bricks unless directed otherwise. Care shall be taken that brick forming top courses and ends of wall are properly keyed into position.

Brick shall be laid frog up however, when the top course is exposed, brick shall be laid with frog down, care shall be taken to fill the frogs with before embedding the bricks in position.

All quoins shall accurately construct, and the height of course checked with storey rods as the work proceeds. Acute and abuts quoins shall be bonded. Where practicable, in the same way as square quoins, abuts quoins shall be formed with squint showing a three-quarter brick on one face and quarter brick on the other.

18. Bond

All brick work shall be built in English bond, unless otherwise indicated, half brick wall shall be built in stretcher bond. Header bond shall be used for walls curved on plan for better alignment. Header bond shall also be used in foundation footings; stretcher may be used when the thickness of wall renders uses of header impracticable. When the thickness of footings is uniform for the number of course, the top course of the footing shall be header. Half or cut bricks shall not be used except where necessary to complete the bond.

Overlap in stretcher bond is usually half brick and is obtained by commencing each alternate course with the half brick. The overlap of the header bond which is usually half the width of the brick is obtained by introducing three quarter brick, in each alternate course at quoins. In general, the cross joints in any course of brick work shall not be nearer than quarter of the brick length, from these in the course below or above it.

19. Uniformity

The Brick work shall be built, in uniform layers, corners and other advance work shall be raked back. No part of the wall during its construction shall rise more than one meter above the general construction level, to avoid unequal settlement. Part of wall left at different levels shall be properly raked back. Too-thing may be done where future construction is contemplated but shall not be used alternative to raking back. For half brick partition to be keyed into main walls, indents shall be left in the main walls.

20. Alignments and Perpend

The wall shall be taken truly plumb or true to required batter, where specified. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Vertical joints in alternate

course directly one over the other. (Quoins, jambs) and other angles shall be properly plumbed as the work proceeds. The maximum permissible tolerance in masonry shall be as under.

- Deviation from vertical within a storey per 3 M height - 6 mm
- Deviation from vertical in total height of building - 12.5 mm
- Deviation of bed joints from horizontal.
 - In any length up to 12 M – 6 mm
 - In any length over 12 M – 12.5 mm total

21. Thickness of Joints

Thickness of joints be such that four courses and three joints shall be taken consecutively shall measure as follows unless and otherwise specified.

- a) Old size brick – equal to four lines the actual thickness plus 4 cms.
- b) Modular brick – equal to 39 cms

22. Striking Joints

Where no pointing, plastering or other finish is indicated, the green mortar shall be neatly struck flush, where pointing, plastering or other finishes indicated, the joint shall be raked out to a depth of not less than 10 mm for plastering and 15 mm for pointing.

23. Protection Against Damage

Care shall be taken during the construction, the edges of jambs, sills, heads etc., are not damaged. In inclement weather, newly built work shall be covered with gunny bags or tarpaulins, so as to prevent the mortar from being washed away.

24. Curing

The Brick work shall be constantly kept wet for at least seven days.

25. Facing

In the case of walls of one brick thick and under at least one face shall be kept even and in proper plane, while the other face may be slightly rough. In the case of walls more than one brick thick, both the faces shall be kept even and in proper plane.

26. Cleaning

Face of the brick work shall be cleaned on the same day it is laid and all mortar droppings removed.

27. Half Brick Masonry

Half brick masonry walls shall be provided with PCC 1:3:6, 75 mm thick band reinforced with 2 no's, 8 mm tor steel rods at every 5th course for the full length of wall.

D. Concrete Block Masonry Works - Solid/ Hollow/ Light Weight Concrete Blocks

1. Indian Standards

The following Indian standards applied to solid block masonry:

I.S. No	SUBJECT
IS:2185 (Part II)-1983	Specification for concrete masonry units (Part II) hollow and solid light weight concrete blocks

2. Materials

• Concrete Block

- Concrete block, hollow or solid shall be referred to by its nominal dimensions. The term “Nominal” means that the dimension includes the thickness of the mortar joint. Actual dimensions shall be 10 mm short of the nominal dimension.
- The nominal dimensions of the concrete block shall be as follows:
 - ✓ Length – 400, 500 or 600 mm
 - ✓ Height – 100 or 200 mm
 - ✓ Width – 75, 100, 150, 200, 250 or 300
- In addition, block shall be manufactured in half length of 200, 250 or 300 mm the correspond to the full lengths. The nominal dimensions of the units are so designed that taking account of thickness of mortar joints, they will produce wall lengths and heights which will conform to the principals of modular co-ordinations
- The maximum variations in the length of units shall not be more than + or – 5mm and maximum variation in height and width of unit, not more than + or - 3mm.
- The surface characteristics of the blocks intended to be plastered or rendered, shall be such as to provide satisfactory bond with the plaster.
- Faces of block shall be flat and rectangular, opposite faces shall be parallel and all arises shall be squared. The ends of block which forms the vertical joints may be plain but unless tongue and grooved or double ends are indicated
- The block shall be cured in an immersion tank or in the curing yard and shall be kept continuously moist for at least 21 days. When blocks are cured in immersion tank, the water in the tank shall be changed at least every four days
- Steam curing of blocks may be adopted provided the requirements of pressure or non-pressure steam curing is fulfilled. After curing the block shall be dried in shade before being on the work. They shall be stacked with voids horizontal (for hollow blocks) to facilitate through passing of air, the block shall be allowed to complete their initial shrinkage before they are laid in a wall.

3. Wetting of blocks

Blocks will be wetted before or during laying in the walls, in case the climatic condition so require the top and the sides of the blocks, may only be slightly moistened so as to prevent absorption of water from the mortar and ensure development of required bond with the mortar.

4. Laying

Blocks shall be laid in mortar, as indicated and thoroughly bedded in mortar spread over the entire top surface of the previous course of the blocks uniform layer of not less than 10mm in thickness and not more than 12mm.

All courses shall be laid truly horizontal and all vertical joints made truly vertical. Block shall break joints with those above and below or not less than quarter of their length. Precast half-length closers (and not cut from a full-size block) shall be used. Care shall be taken during construction to see the edges of the blocks are not damaged.

5. Intersecting Walls

When two walls meet or intersect and a course are to be laid up at the same time, a true bond between at least 50% of the units at the intersection is necessary. When such intersecting walls laid up separately, pockets with 20mm maximum vertical spacing shall be left in the first wall laid. The corresponding course of the second wall shall be built into these pockets

6. Finishes

Rendering shall not be applied to the walls when these are wet, joints for plastering are pointing as specified shall be raked to a depth of 10mm. Joints on internal faces, unless otherwise indicated, shall be raked for plastering. If the internal faces of masonry are not to be plastered, the joints shall be finished flush as the work proceeds or pointed flush where indicated.

7. 100mm Block Work

100 mm solid block wall will be provided with PCC 1:3:6, 75 mm thick band reinforced with two Nos. 8 mm dia. tor steel rods at every 5th course for the full length of wall.

E. Plastering

1. Indian Standards

The following Indian standards apply to the section:

I.S. NO.	SUBJECT
IS:1542-1977	Specification for sand for plaster (First Revision)

2. Materials

• Cement

Cement shall be ordinary port land cement or port land blast furnace cement or port land pozzolana cement as specified.

• Sand

Sand for plastering shall conform to IS: 1542-1977 – Specification for sand for plaster. Sand shall consist of natural sand, except where crushed stone sand or crushed gravel sand or combination of any of these indicated. The sand shall be hard, durable, clean and free from adherent coating and organic matter and shall not contain appreciable amount of clay balls, sand shall be obtained from approved sources.

Sand shall not contain any harmful impurities, such as iron pyrites, alkalis, salts, coal, mica shale or similar laminated materials, soft fragments, sea shells and organic impurities in such quantities as to affect adversely the hardening, the strength and durability or the appearance

of plaster or applied decoration or to cause corrosion of metal lathing, or other metal in contact with plaster. The maximum quantity of clay, fine silt, stone dust shall not be more than 5 percent by weight.

The particle size, grading of sand for plaster work shall be as under, unless otherwise specified to conform to the sample maintained by the Authority's Engineer.

IS SIEVE DESIGNATION	PERCENTAGE PASSING BY WEIGHT
10 mm	100
4.75 mm	95 – 100
2.36 mm	95 – 100
1.18 mm	90 – 100
600 Microns	80 – 100
300 Microns	20 – 65
150 Microns	0 – 5

- **Water**

Water used for mixing and curing shall be clean, free from deleterious matter and also from unusual proportion of dissolved salts. Sea water or tidal astuary or brackish water shall not be used. Water fit for drinking is normally suitable.

3. Workmanship

- **Scaffolding**

Where possible independent scaffolding shall be used to obviate the subsequent restoration of masonry in put log and other breaks in the work. Stage scaffolding shall be provided for ceiling plastering.

- **Cement Mortar**

Mortar should be of the mix as indicated, the mix specified by volume in proportion of dry cement and dry sand.

- **Preparation of cement mortar**

Mixing should be done preferably mechanical mixer. If hand mixing operation shall be carried on a clean watertight platform. Cement and Sand shall be mixed dry in the required proportion to obtain uniform colour. The required quantity of colour shall then be added and the mortar hoed back and forth five to ten minutes with addition of water to a workable consistency. In the case of mechanical mixing the mortar shall be mixed for at least three minutes after addition of water. The cement mortar freshly mixed for immediate use. Any mortar which has commence to set shall be discarded and removed from the site.

- **Preparation of background for application of mortar**

All dirt, dust and other foreign matter all masonry and laitance on the concrete surface shall be removed by watering and brushing as required. If the background contains soluble salts,

particularly sulphates, the application of plaster shall be done one after the efflorescence of the salts is complete and efflorescence is completely removed from the surface. Any trace of Algae or Moss formation shall be removed. Joints in brick work shall be raked out to a depth not less than 10 mm as your proceeds, local projections in brick work beyond the general wall face shall be trimmed off where necessary.

- **Roughness**

Smooth surface of in situ concrete walls and ceiling etc., shall be roughened by wire brushing, if it is not hard, and by hacking or bush hammering if it is hard, to provide for proper adhesion. Projecting burrs of mortar because of gaps at joints in shuttering shall be removed. Surface shall be kept clean with wire brushes, in addition concrete surface shall be pock marked with a pointed tool at facing of about 50 mm the pocks made to be not less than 3 mm deep.

- **Suction Adjustments**

Adequate drying intervals shall be allowed between the erection and plastering to bring the surface suitable for suction adjustment. High rate of suction makes the plaster, weak, pours and friable. The wall shall not be soaked but only damped evenly before applying the plaster. If the surface becomes dry in spots such areas shall be moistened again to restore uniform suction. Excessive water leads to failure of bond between the plaster and background.

- **Evenness**

Any local unevenness must be levelled, and projections removed to avoid variance in thickness of plaster.

- **Immobility**

Differential movements between the background and the plaster due to moisture change, temperature change, structural settlement, deflection etc., cause cracks. The major part of such movements shall be allowed to set in before the plaster is applied.

- **Precaution against discontinuity in background**

All straight cut groove through the plaster at the junction of wall to ceiling may be provided where directed. Holes left in the wall after removing scaffolding, shall be filled up with respective masonry and the patch plaster up true and in conformity with rest of the wall so that no sign of patch work shows out.

- **Plastering**

The type and mix of water for plastering, the number of coats to be applied, and surface finished of the plaster and the background to which the plaster is to be applied shall be as indicated.

The mortar for dubbing out and rendering coat shall be of the same type and mix. Dubbing out may be executed as a separate coat or along with the rendering coat.

Plastering operation shall not be started until all necessary fixtures such as doors and window

frames, mantle pieces or completed and all pipes and conduits to be embedded have been installed and surfaces to be plastered have been passed by Authority's Engineer.

- **Protection**

All existing work and fittings that are likely to be damaged in the application of plastering shall be protected. Care shall be taken to avoid, as far as possible, the splashing of mortar on to the finish surfaces such as joinery, paint work and glazing, all such splashes shall be cleaned off immediately.

Screeds 15x 15 cm. shall be laid vertically and horizontally not more than 2 M apart to serve as guides in bringing the work to an even surface.

Plastering shall be done from top to bottom and care shall be taken to avoid joints in continuous surface.

- **Maintenance of proper time intervals**

To avoid breakdown of adhesion between successive course, drying shrinkage of first coat shall be allowed to be materially completed before a subsequent coat is applied.

All corners, arises angles, junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering of corners, arises and junctions shall be carried out with proper templates to the required size. Plastering of cornices, decorate feature etc. shall normally be completed before the finishing coat is applied.

In suspending the work at the end of the day, the plaster shall be cut clean to the line both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scraped clean and wetted with cement slurry before plaster is applied to the adjacent area. Partially set and dried mortar shall be not be re-tampered for use.

- **Cleaning on completion**

On completion of work affected by plastering shall be left clean, special care shall be taken while removing any set mortar from glass and joinery, etc., to avoid damaging their surface.

4. Trueness of plastering system

The finished plaster surface shall not show any deviation more than 4 mm when checked with straight edge of 2 m length placed against the surface.

5. One coat plaster work

Mortar shall be firmly applied to masonry walls and well pressed into the joints and forcing into surface depression to obtain a permanent bond. The plaster shall be laid in a little more than the required thickness and levelled with wooden float. On concrete walls, rendering shall be dashed on to the roughened surface to ensure adequate bond. The dashing of rendering coat shall be done using a strong whipping motion at right angles to the face of walls. The surface shall be finished even and fair, unless indicated to be finished even and smooth. The surface of the dubbing out, if carried out separately, shall be left rough or scored to provide key for the plaster

coat.

6. Two coat plaster work

- **First Coat:** The first coat of specified thickness shall be applied in a manner similar to one coat plaster work. Before the first coat hardens, the surface of cement plaster shall be scored to provide key for second coat. The rendering coat shall be kept damp for at least two days. It shall then be allowed to become thoroughly dry.
- **Second Coat:** Before starting to apply second coat, the surface of the rendering coat shall be damped evenly. The second coat shall be completed to the specified thickness in exactly the same manner as the one coat plaster work.

7. Water proofing plaster

Integral water proofing compound shall be mixed with cement in proportion indicated by weight. Care shall be taken to ensure water proofing material gets well and integrally mixed with cement.

8. Curing

Each coat shall be kept damp continuously for at least two days. Moistening shall commence as soon as the plaster has hardened sufficiently and is not susceptible to injury. The water shall be applied preferably by using a fine fog spray. Soaking of wall shall be avoided and only as much water as can be readily absorbed shall be used. Excessive vaporization on the sunny or wind word side of buildings in hot dry weather shall prevented by hanging mattings or gunny bags on the outside of the plaster and keeping them wet.

9. Neeru Finish

After applying and finishing the under coats i.e., (under coat + floating coat) as described, and before they set, the finishing coat shall be applied to a thickness of not more than 1.5 mm with specially prepared lime putty i.e., Neeru to which about 5 percent cement has been added.

It shall then be well polished with trowel. While troweling is going on, soap stone powder contained in thin muslin bags shall be dusted over the surface and worked in.

When the surface of outer walls is to be treated with sunk or grooved line works like squares or rectangles, by drawing vertical and / or horizontal lines at intervals, such lines (which may be V-grooved or U-shaped) shall be marked on the floating coat when it is not yet set and neatly finished off in the finishing coat with a wood lath having an edge of requisite thickness and slope on one of its sides.

NOTE: In each case the finishing done shall be uniform all over the surface and to the entire satisfaction of the Authority's Engineer. A sample of considerable area shall be first made in consolation with the Authority's Engineer and shall be got approved before starting the work.

10. Curing

Moistening shall be commenced as soon as the plaster has hardened sufficiently and is not susceptible to injury. Soaking of wall shall be avoided and only as much water as can be readily absorbed shall be used.

All plaster work shall be kept damp continuously for a period of 14 days. To prevent excessive evaporation on the sunny or wind ward side of the buildings in hot, dry weather, matting or gunny bags may be hung over on the outside of the plaster in the beginning and kept moist. Should the mortar of the plaster perish through neglect of watering or for any other default and if the work is not done as specified above, the plaster shall be removed and redone at the contractor's expenses.

F. Floor Finishes

1. Indian Standards

The following Indian standards apply to the section:

SL. No.	SUBJECT
IS:777 – 1970	Specification for glazed earthenware tiles (First Revision with Amendment No. 1)
IS:1237 - 1980	Specification for cement concrete flooring tiles (First Revision)
IS:4557 - 1982	Specification for ceramic unglazed, vitreous acid resistant tiles (First Revision)
IS:8042 - 1978	Specification for white port land cement
IS:5491	Code of Practice for laying in-situ granolithic concrete floor topping.

2. Materials

- Cement shall be ordinary port land cement conforming to IS:269–1976.
- White cement shall conform to IS:8042–1978 specification for white port land cement.
- Aggregates (Coarse and fine) and cement concrete and granolithic concrete shall conform to IS:383–1970.

Aggregate for granolithic concrete shall consist of crushed granite, basalt, trap quartzite. The aggregate crushing value shall not exceed 30 percent. The grading of aggregate shall be as given below.

Table 1 - Grading of Aggregate

IS sieve Designation	Percentage by weight passing IS sieve		
	Coarse aggregate	Fine aggregate	
		Zone I	Zone II
12.5	90 to 100		
10	40 to 85	90 to 100	90 to 100
4.75	0 to 10	60 to 95	75 to 100
2.36		30 to 70	55 to 90

IS sieve Designation	Percentage by weight passing IS sieve		
	Coarse aggregate	Fine aggregate	
		Zone I	Zone II
1.18		30 to 70	55 to 90
600		15 to 34	35 to 39
300		5 to 20	8 to 30
150		0 to 10	0 to 10

Sand for mortar for laying slabs/ tiles shall conform to IS:2116–1980.

3. Cement Concrete Flooring (Cast In-Situ) Granolithic Concrete Floor

- **Proportion of Granolithic Concrete**

The proportion of the granolithic concrete floor topping shall be 1:1:2 (cement, fine aggregate, Coarse aggregate) by volume mixing, laying, finishing and curing etc. shall be carried out as specified.

- **Size of Panels**

The floor topping shall be divided into suitable panels. Size panel is governed by the thickness of floor finish, the type of construction, local condition of temperature, humidity and the season in which flooring is laid. Generally, no dimension of panel shall exceed 4 M in case of floor topping laid monolithically with the base concrete, and 2 M in case of floor topping laid separately on a hardened base. In case of ground floor, topping panel may synchronize with that of the base concrete. Length of a panel shall not exceed one and half a time its breadth. The exact dimensions of the panels shall be as directed by the Authority's Engineer.

- **Form work to sides of concrete flooring**

Form shall be provided as specified, where glass or aluminum dividing strips are provided form work may not be provided. The boarding/ battens shall be fixed in position with their top at proper level, giving slope where require. The flooring shall butt against the masonry of the wall. Before being laid in position, the form or screed strips shall preferably have coated with thick coat of lime wash.

- **Joints**

Construction joints between base of the floor finish need only be plain, untreated vertical butt joints and shall be placed over any joint in the base.

- **Laying the topping**

The surface of base concrete shall be thoroughly cleaned of all dirt, loose particles, caked mortar droppings and laitance, if any, by scrubbing with coir or steel wire brush. Where the concrete has hardened so much that roughening of surface by wire brush is not possible, the entire surface shall be roughened by chipping or hacking. Before laying the topping, the surface shall be soaked with water at least for twelve hours and surplus water shall be removed by mopping immediately before the topping is laid in position.

The form shall be fixed over the base concrete dividing it into suitable panels. Before placing the concrete mix for topping, neat cement slurry at the rate of 3 Kg/ Sqm. shall be thoroughly brushed into the prepared surface of the base concrete just ahead of the finish. The topping then shall be laid, thoroughly tamped or vibrated, the surface floated with wooden float to a fair and even surface. The surface shall be tested and finished and specified.

- **Finishing the surface fair smooth**

Where an even smooth surface is indicated, the surface, after being floated with a wooden or steel float, shall be finished with a steel trowel. Finishing operations shall start shortly after the compaction of concrete and shall be spread over the period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be trowel three times at intervals so as to produce a uniform, hard and close-knit surface. Immediately after laying, only just sufficient troweling shall be done to give a level surface. Excessive troweling in the earlier stages shall be avoided as this tends to work a layer rich in cement to the surface. Sometimes after the first troweling and after duration depending upon the temperature and atmospheric conditions, the surface shall be retrowelled to close in pores in the surface, and to bring to surface and scrap of any excess water in concrete laitance (it shall not be troweled back into the topping). The final troweling shall be done well before the concrete has become too hard but at such a time the considerable pressure to make any impression on the surface. Spreading and troweling of a rich mix of dry cement and fine aggregate on the surface shall not be permitted. Where the surface is to be finished with a steel trowel using extra cement, it shall be clearly indicated.

4. Vacuum dewatering method and power troweling method with skim flotter finish to concrete flooring

- Cement concrete shall be laid between steel forms acting as a stop end and also rail to be used for surface vibration. The preparation and laying of concrete all as per para 3.4.5 & 3.4.6. Thickness and mix of the concrete as indicated.
- The concrete thus laid shall be vibrated with poker vibrator. During poker vibration, proper compaction of coarse aggregate, fine aggregate and cement shall be obtained. The surface will be then finished in level with the help of surface vibrator to give a dense level surface of concrete.
- Vacuum de-watering method will be used to remove excess water from the laid concrete and filter pad and suction mat shall be laid on the freshly laid concrete which will not allow cement paste to flow out, and the suction pump are then started immediately to remove the excess water. The suction time normally is 20 to 30 minutes. This vacuum process will enable to remove 15 to 25 percent of water content and making the surface hard enough to enable to carry the floating operation.
- The top surface of the removal of the mat shall be floated with a mechanical skim floater with troweling blade to enable the top surface to grind and give a uniform water

resistance surface on top. Under no circumstances neat cement be sprinkled directly on concrete surface to absorb bleed water as surface scaling may occur later. Similarly, water should not be applied between troweling operation as it may cause surface weakness. Minimum two passes shall be carried out.

- **Curing**

Immediately after the flooring surface is finished, it shall be protected from rapid drying and strong sun light. As soon as the surface has hardened sufficiently to prevent damage to it, it shall be kept continuously moist for at least 15 days by means of wet gunny bags or 50 mm thick layers of damp sand spread over the surface or pooling water on the surface. During this period the flooring shall not be exposed to any traffic. Regular traffic on the floor shall be allowed only after 28 days.

5. Glazed earthenware tiles/ ceramic tile flooring, dado and skirting

- Glazed earthenware tile shall conform to IS:777-1970 - Specification for glazed earthenware tiles. When fractured they shall appear fine grained in texture, dense and homogeneous. The tile shall be flat true to shape, sound and free from flaws and other manufacturing defects. The top surface of the tiles shall be glazed. The underside of the tiles shall be free from glaze in order that the tiles may adhere properly to the base. The sides of the tiles shall be preferably free from glaze, if unavoidable, glaze shall be permitted provided that number of edges with complete glaze is not more than one and glaze present in remaining three edges not exceed 15 percent of the surface are of the edge. The glaze shall be uniform in quality and shall be free from welts, chips, craze, specks, crawling or other imperfections, detracting from appearance when viewed at a distance of one meter. The glaze shall be either glossy or matt, as directed and white in colour except in the case of coloured tiles when the tint, shade and finish shall be as indicated. Tiles shall be of sizes and thicknesses as indicated.

- IS:1443 - Laying and finishing of C.C. flooring tiles.

- **Tolerances**

- Facial dimensions: The length of all the four sides of tiles shall be measured to the nearest 0.1 mm. The average value shall not vary more than + or – 0.8 mm from the dimension of the nominal size. The variation of the individual dimension from the average value shall not exceed (+/-) 0.5 mm.
- Tolerance on thickness: (+/-) 0.5 mm.

- **Trueness of shape**

Squareness – Any variation from right angle in angle contained by any two and joining sides shall be limited, so that if a builder Steel Square is placed against the angle, the distance between the inner edge of the square and the adjacent side of the tile shall not be more than 0.5 mm per 100 mm.

- **Warpage**

The tiles when tested for warpage on the diagonal shall not have warpage exceeding the value specified below.

Size of tile	Warpage
99 x 99 mm	+ or – 0.5 mm - 0.3 mm
149 x 149 mm	+ 0.7 mm - 0.4 mm

- **Performance Requirement**

- **Water absorption** – The average water absorption of the tile when tested and evaluated shall exceed 18 percent.
- **Crazing** – Tiles when tested for crazing shall satisfy the requirement.
- **Impact strength** – Tiles when tested for impact strength shall not have a value less than 0.020 Kg fm/ cm.
- **Chemical Resistance** – When tested the glazed surface of tiles having a white/Cream coloured glossy glaze shall show no deterioration.

- **Bedding**

Bedding over which the glaze tiles shall be laid as indicated and shall not be less than 10 mm at any place. Mix of bedding layer should be as specified. Tiles shall be soaked in water before laying.

- **Laying**

Base shall be cleaned and wetted. The bedding shall then be laid evenly over the surface, tamped and corrected to desired levels and allow to harden enough to offer a rigid cushion to tiles. Before laying the tiles, cement slurry of honey like consistency 3 Kg./ Sqm. shall be applied over the bedding. At a time, area to accommodate about 20 tiles shall be applied with cement slurry. Tiles shall then be washed clean and fixed in the grout one after the other. Each tile being gently tapped in its position till it is properly bedded and in level and line with adjoining tiles. The joint shall be as thin as possible but not exceeding 1.5 mm wide.

In the case of skirting and dado, the wall surface shall be covered with about 10 mm thick plaster of cement and sand mortar 1:3 and allow to harden. The plaster shall be roughened with wire brushes or by scratching diagonal lines. The back of the tiles shall be buttered with cement paste and set on bedding mortar. The tiles shall be gently tapped in position one after the other. Top of skirting or dado shall be truly horizontal and the joints vertical or as per required pattern.

- **Jointing and finishing**

The joints shall be raked to a depth of 5 mm and all dust and loose mortar removed. Joints shall then be flush pointed in White cement or in coloured cement in the case of coloured tiles. The surface shall be cured for seven days and then wash clean.

6. Kota stone flooring

- **Stone Slabs**

The slab shall be of selected quality, hard, sound, dense and homogeneous in texture, free from cracks, decay, weathering and flaws. They shall be hand or machine cut to the requisite thickness as indicated and they shall be of uniform colour. The slab shall have on top (exposed) face polished before being brought to site. Before starting the work, contractor shall get the samples of slabs approved by Authority's Engineer.

- **Dressing of slabs**

Every slab shall be cut to the required size and shape and fine chisel dressed on the sites to the full depth so that a straight edge laid along the side of the stone shall be in full contact with it. The sides (edges) shall be table rubbed with coarse sand or machine rubbed before paving. All angles and edges of the slabs shall be true, square and free from chippings and the surface shall be true and plain. For staircase treads, single piece slab to full length and width of treads shall be provided. The nosing shall be rounded off and two parallel grooves of ten by ten (10 mm x 10 mm) immediately behind the nosing edge shall be provided as per drawing to avoid skidding.

- **Preparation of surface and laying:**

Sub grade concrete or the RCC slab on which the slabs are to be laid shall be cleaned, wetted and mopped. The bedding for the slab shall be with cement mortar 1:4 (one cement: four coarse sand). The thickness of the screed shall be as indicated.

The slabs shall be laid in the following manner

- ✓ Mortar of the specified mix shall be spread under the area of each slab, roughly to the average thickness as indicated.
- ✓ The slab shall be washed and cleaned before laying. It should be laid on top, pressed, tapped with wooden mallet and brought to level with the adjoining slabs. It shall be lifted and laid aside.
- ✓ The top surface of the mortar shall then be corrected by adding fresh mortar at hollows. The mortar is allowed to harden a bit and cement slurry of honey like consistency shall be spread over the same at the rate of 4 Kgs of cement per Sq. mt.
- ✓ The slab to be paved shall be lowered gently back in position bedded in level. Subsequent slab shall be laid in the same manner and joints between adjacent slab shall be thin as possible and run in straight line. After each slab has been laid, surplus cement grout coming out of the joints of slabs shall be cleaned off.
- ✓ The surface of the flooring as laid shall be true to levels, lines and shapes as instructed by Authority's Engineer.
- ✓ The slabs shall be matched as shown in drawings or as instructed by the Authority's Engineer.
- ✓ Slabs, which are fixed in the floor adjoining the wall shall enter not less than twelve (12) mm under the plaster, skirting or dado. The junction between wall plaster and the floor shall be finished neatly and without waviness.

- Curing, polishing and finishing

The floor shall be kept wet for a minimum period of seven (7) days. The surface shall thereafter be ground evenly with machine fitted with grade blocks (No.120). The final grinding with machine fitted with the finest grade grit blocks (No.320) shall be carried out the day after the first grinding described above or before handing over the floor, as ordered by the Authority's Engineer.

For small areas of where circumstances so require, hand polish may be permitted in lieu of machine polishing after laying. For hand polishing the following carborundum stone shall be used.

- ✓ First Grinding – Medium stone (No. 8)
- ✓ Final Grinding – Fine grade (No. 120)

In all other aspects, the process should be similar as for machine polishing.

After the final polish, oxalic acid shall be dusted over the surface at the rates of thirty-three (33 gms) per Square meter sprinkled with water and rubbed hard with pad of woolen rags. The following day the floor be wiped with moist rag and dried with a soft cloth and finished clean.

If any slab is disturbed or damaged, it shall be refitted or replaced, properly jointed and polished. The finished floor shall not sound hollow when tapped with wooden mallet.

7. Polished Slab Granite Flooring

- **Materials**

Polished granite slab shall be machine cut. Machine cut slabs shall have fine tooled dressing on all sides to full depth.

- **Laying stone slabs**

Slabs shall be washed clean before laying. The bedding mortar of the specified mix shall be spread under each slab, slab shall be then laid on top, pressed so that the hollows underneath get filled and surplus mortar works up through the joints. The slabs should be tapped with wooden mallet and brought to level and close to adjoining slabs with thickness of joints not exceeding 1.5 mm. After laying each slab surplus mortar on the surface of the slabs shall be cleaned off and joint finished flush. Subsequent slabs shall be laid in the same manner. The joint shall be left raked out uniformly to a depth not less than 10 mm, when the mortar is still green. The surface of the flooring laid, shall be true to levels as directed by the Authority's Engineer. Slabs, which are fixed in the floor and joints the wall not less than 12 mm under the plaster, and floor shall be finished neatly and without waviness.

The flooring shall be cured for Fourteen days. The finished floor shall not sound hollow when tapped with wooden mallet.

8. Cement Concrete Flooring Tiles

- Cement concrete flooring tiles shall be of heavy-duty floor tiles as per IS:1237-1980.

- **Materials**

- ✓ **Cement** – Cement used in the manufacture of tiles shall be ordinary Portland cement conforming to IS:269-1976.
- ✓ **Aggregate** – Aggregates used in the backing layer of tiles shall conform to requirement of IS:383-1970. For the wearing layer unless otherwise specified aggregate shall consist of marble chips or any other natural stone chips of similar characteristics and hardness, marble powder or dolomite powder or mixture of the two.

- **Manufacture**

Cement concrete flooring tiles shall be manufactured from a mixture of cement, natural aggregate and coloring material where required by pressure process. During manufacture, the tiles shall be subjected to a pressure of not less than 140 Kg per Sq.cm.

The proportion of cement to aggregate in the backing of the tiles shall not be leaner than 1:3 by mass. On removal of mold, the tiles should be kept in moist condition continuously for such a period that would ensure their conformity to the requirements of the IS standards. Tiles shall be stored under cover.

- **Dimensions**

The size of cement concrete flooring shall be as follows;

Table 2 - Size of cement concrete flooring

Length (MM)	Breadth (MM)	Thickness (MM)
200	200	20
250	250	22
300	300	25

- **Tolerances**

Tolerances for length or breadth of tiles shall be + or – 1 mm.

Tolerance on thickness shall be + 5 mm. In addition, the difference in thickness between the thickest and thinnest tile in the sample shall not exceed 3 mm. Thickness of wearing layer for heavy duty cement tile shall be 6 mm.

- **General Quality**

Unless otherwise specified the tiles shall be supplied with initial grinding and grouting of the wearing layer. The wearing layer of the tiles shall be free from projections, depressions, cracks, holes, cavities and other blemishes. The edge of the wearing layer may be rounded.

- **Finish**

The colour and texture of wearing layer shall be uniform throughout its thickness. No appreciable difference in appearance of the tiles, from the point of view of colour aggregate, its type and its distribution on the surface of wearing layer shall be present.

- **Physical Requirements**

- Flatness of the tile surface - The tiles when tested, the amount of concavity and convexity shall not exceed 1 mm.
- Perpendicularity – When tested the longest gap between the arm of the ‘square’ and the edge of the tile shall not exceed 2 percent of the length of the edge.
- Flatness of the tile surface - The tiles when tested, the amount of concavity and convexity shall not exceed 1 mm.
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- Perpendicularity – When tested the longest gap between the arm of the ‘square’ and the edge of the tile shall not exceed 2 percent of the length of the edge.
- Straightness - When tested the gap between thread and plane of the tile shall not exceed 1 percent of the length of the edge.
- Flatness of the tile surface - The tiles when tested, the amount of concavity and convexity shall not exceed 1 mm.
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- Perpendicularity – When tested the longest gap between the arm of the ‘square’ and the edge of the tile shall not exceed 2 percent of the length of the edge.
- Straightness - When tested the gap between thread and plane of the tile shall not exceed 1 percent of the length of the edge.
- Water absorption – When tested, the average percentage of water absorption shall not exceed 10.
- Wet Transverse Strength – When tested the average wet transverse strength shall not be less than 30 Kg. Per Sq.cm.
- Resistance to Wear – When tested the wear shall not exceed the following value; For general purpose tiles
- Average wear – 3.5 mm
 - Wear on individual specimen – 4.0 mm
 - For heavy duty floor tiles
 - Average wear – 2.0 mm
 - Wear on individual specimen – 2.5 mm

- **Cement Mortar Screed**

The screed bed for laying cement concrete tile shall be cement and sand mortar 1:6 in the case of floor and cement and sand mortar 1:3 in the case of skirting and dado. The base shall be cleaned of all scum, laitance or plaster droppings or any other loose foreign matter. It shall be properly wetted without allowing any water pools on the surface. The mortar shall then be evenly spread over the base for two rows of tiles and about 3 to 5 metres in length. The top of mortar shall be kept rough, so that cement slurry can be absorbed. The thickness of the bedding shall be not less than 15 mm in any place.

- ***Laying of tiles***

Laying of tiles shall commence by the time the bedding becomes sufficiently hard to offer rigid cushion for the tiles. Neat cement slurry of honey like consistency shall be spread over the mortar bed, over such an area at a time as would accommodate about 20 tiles. The tiles shall be fixed in this grout one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joint shall not exceed 1.5 mm width.

After the tiles have been laid in a room or the days laying work is completed, the surplus cement slurry and the joints shall be cleaned and washed fairly deep with the help of broom stick. It shall be seen that the cement slurry is cleaned before it sets hard.

The day after the tiles have been laid, the joints shall be filled with cement grout of the same shade as the colour of the matrix of the tiles.

Tiles which are fixed in the floor adjoining the wall, shall go about 10 mm under the plaster, skirting or dado. For this purpose, the wall plaster may be left and finished by about 50 mm above the level of the proposed finished flooring, skirting or dado and the unfinished strip may be plastered later on after the tiles are fixed.

After fixing, the flooring shall be kept moist and allowed to mature undisturbed for seven days, so that the bedding and joints set properly. After this it may be used for light traffic. Heavy traffic shall not be allowed on the floor for at least fourteen days after fixing the tiles.

Wherever big area floors are to be laid, the level of the centre portion of the floor shall be kept about 10 mm higher than the level marked at the wall.

- ***Grinding and Polishing***

Grinding and polishing of the tiles shall be commenced only after the floor as well as the joints are properly set but in no case earlier than fourteen days of laying.

Grinding shall preferably be done using a machine except for skirting and dado, chequered or grooved tiles shall be polished by hand.

For grinding tile flooring, the first grinding shall be with carborundum stone of 48 to 60 grit. When the floor is rubbed even, the chips show uniformity it shall be cleaned with water making bare pin holes. Grouting in the same shade is then briskly applied so that all pin holes are properly filled in. The grout shall be kept moist for a week for proper setting. Thereafter the second grinding operation with carborundum stone of 120 grit is commenced. The floor is grouted again to fill in fine pin holes. After curing for a week, the floor is left with this protective film till other works are completed. Final grinding is done with carborundum of 220 to 350 grit using plenty of water. When surface is rendered

smooth it is washed with water. Afterwards oxalic acid powder is vigorously applied with machine fitted with Hessian bobs to bring out shine. Floor is then washed clean and dry linen applied to suck in moisture.

Where indicated, wax polish shall finally be applied mechanically with clean Hessian bobs. Superfluous wax is mopped-up with saw dust to prevent slipperiness. Saw dust may be allowed to remain on the surface till occupation. This will protect the surface and help to increase luster. When saw dust is spread, water should not be spilled as this is likely to leave stain on the polished surface.

In the case of plain cement and coloured cement tiles, the process of polishing shall be the same as described for terrazzo tiles except that initial grinding with carborundum stone to 48 to 60 grit is not necessary.

G. Joinery

1. Indian Standards

The following IS standards applying to this section

Table 3 - IS standard for Joinery

IS No.	Subject
IS:2202 (Part I)-1983	Specification for wooden flush door shutters (solid core type) Part I - Plywood face panels (Fourth revision)
IS:287-1973	Recommendation for maximum permissible moisture content of timber used for different purpose (second revision with Amdt. 1)

2. Materials

- Timber for door frames (First class teak wood)
- Timber shall be of good quality, well-seasoned, fairly uniform in colour and texture and free from blemishes, hollow pockets and loose knots. Non-coniferous sawn timber (hard wood) shall be free from bow, any kind of decay, live insect attack, spiral or twisted grains, splits across the grains, spring, warp, cup shake.
- Timber shall be obtained either in cut sizes or as sleepers and cut to required size well in advance of commencement of fabrication and stacked at site of work in a suitable manner for seasoning.

3. Seasoning

Timber shall be seasoned, before being planned to the required sizes to a moisture not exceeding the specified maximum moisture content.

4. Moisture Content

The maximum permissible moisture content of timber for different uses, whether kiln or air seasoned, shall not exceed the limits laid down in IS:287-1973. Recommendation for maximum

permissible moisture content of timber used for different purpose.

5. Tolerances

Seasoned timber (whether air or kiln dried) shall be deemed to conform to the moisture content requirements if the average moisture content of all samples from a given lot is within + 3 percent and the moisture content of individual sample is within + 5 percent of the maximum permissible content for the particular end use and locality.

6. Workmanship

All members of the timber frames shall be straight without any warp or bow, and shall be exactly at right angles, which shall be checked from the inside surface of the respective members. Frame shall have smooth well-planned surfaces except the surface touching the wall, lintels, sills etc., which may be left clean sawn, unless it is required for straightening up or to obtain over all sizes. Rebates, rounding's and molding etc. shall be done before the members are jointed into frame.

Timber frames shall have dovetail joints. The jam post shall be through tenoned into the mortices of the transom to fill width and the thickness of tenoned shall not be less than 15 mm. The tenons shall be closely fitted into the mortices without any wedging or filling and shall be pinned with hard wood or bamboo dowels not less than 10 mm dia. The depth of the rebate in the frames for housing the shutter shall be 15 mm. The joints before putting together shall be glued with synthetic adhesive conforming to IS: 851-1978 or IS:4835-1979.

All door frames shall be clamped together so as to square and flat before being built in. Each assembled door frame shall be fitted with temporary cross batten. The faces of frame abutting the wall, lintel, cill etc., shall be given two coats of hot tar before fixing, unless otherwise indicated.

7. Fixing of Chowkates and Frames

Timber frames of door shall be installed by "Built in method". Unless indicated to be installed by prepared opening method. Precaution shall be taken to fix the door frames so as to take care of final floor level, and whether shutter opens inside or outside. Hold fast shall be tightly fixed to the frame by means of bolts or screws as indicated, the bolt hole in the frame being plugged suitably and flush neat unless otherwise indicated.

8. Built in Method

Masonry in the wall shall be built after installation of frames, so that the hold fast and pins, if any, at the bottom are well anchored to them. Suitable arrangements shall be made to hold the frame in rectangular shape and prevent warping and distortion of frames during construction. Usually one cross batten at the middle, one cross batten at the bottom and two cross battens diagonally will be necessary to hold the frame rectangular.

9. Pressed steel frames of doors

Steel frames for wooden shutter shall be pressed out of commercial mild steel sheets of 1.25 mm thickness and shall comply with the requirements of IS:4351-1976, specification for steel door

frames. The size, type (profile) and dimensions of the frames as indicated. The tolerance over the profile size shall be + or – 2 mm. Steel frame shall be of approved make.

10. Flush door shutters

Flush door shutters shall be solid core type with block board coat, as indicated and shall conform to IS:2202 (Part I)-1983, specification for wooden flush door shutters (solid core type) Part-I plywood face panels. Except with regard to the sizes of shutter which shall be as indicated. Flush door shutter shall be non-decorative (commercial) type. Flush door shutters internally lipped, internal lipping may be provided separately or as one piece with the frame. The width of frame including lipping shall not be less 50 mm. Where separate lipping is specially desired, it shall be as indicated. Internal lipping shall have total depth of not less than 25 mm, joints shall not be permitted in lipping.

In the case of doubled leaved shutters, rebating shall be splayed or square as directed. Where separate lipping is indicated the depth of lipping at the meeting of stiles shall not be less than 35 mm.

Flush door shall be free from twist, or warp in plane and all the four edges of the door shutters shall be square. Both the faces of the door shutter shall be sanded to a smooth even texture.

Tolerance on nominal thickness shall be + or – 1.2 mm. Thickness of shutter shall be uniform through the variation not exceeding + or – 0.8 mm when measured at any two points.

11. Hardware

- Aluminum butt hinges

Hinges shall be well made, shall be free from flaws and defects. All hinges shall be cut clean and square. The hole for the hinge pin shall be central and square to the knuckles/ boss. All sharp edges and corners shall be removed. The movements of hinges shall be free, easy and square and working shall not have any play or shake. The hinge pin shall fit inside the knuckles firmly notched and properly finished, so as to not to allow any play or shake. All screw holes shall be clean counter sunk, suitable for counter sunk head wood screws. Aluminum butt hinges shall comply with IS:205-1978, specification for nonferrous metal butt hinges, and shall be of extruded Aluminum alloy. Aluminum hinges shall be anodized. The hinge pin shall be Aluminum alloy, shall be hard, anodized and sealed with oil, wax or lanolin. Aluminum butt hinges shall be of the size indicated.

- Mortice Lock (Vertical Type)

These shall conform to IS:2209-1976, specification for mortice lock (vertical type). These shall be brass or aluminum or as indicated. Number of levers shall also be as indicated.

- Handles

These shall conform to IS:208-1979, specification for door handles. Handles shall be of cast aluminum, aluminum alloy fabricated handles. Door handles shall be finished smooth, when

the grip portion of the handle is jointed with the base piece by mechanical means, the arrangements shall be such that the assembled handle shall have adequate strength. Aluminum handles shall be anodized.

- ***Aluminum Tower Bolt***

These shall conform to IS:204 (Part-II)-1978, specification for tower bolts (Part-II) nonferrous metal. Aluminum tower bolts shall be of extruded section of aluminum alloy, shall be of barrel bolts shall have a knob integral with bolts and of robust construction. The type and size as indicated.

- ***Aluminum Alloy Sliding Door Bolt (Aldrop)***

These shall comply with I.S. 2681-1979 specification for nonferrous sliding door bolt for use with pad lock. Aluminum alloy sliding door bolts with hasp, staple and fixing clips of sheet, casting or extruded sections or casting of aluminum alloy.

The sliding door bolt shall have smooth sliding action. The hasp, when not cast integral with the bolt, shall be properly secured to the bolt. Sliding bolt shall be provided with fixing bolts. Aluminum bolts shall be anodized.

- ***Workmanship***

All hardware shall be fixed to joinery in a secure and efficient manner. Special attention shall be given to the size and fixing of screws to ensure that the screws are driven (and not hammered) tight and heads of the screw do not protrude. All hinges shall be counter sunk into the edge of the timber joinery and frames to a depth equal to the thickness of the leaf of hinge.

H. Metal Works - Anodized Aluminum Doors, Windows and Ventilators

1. Material

Aluminum sections incorporated in doors, windows, ventilators shall conform to designation 63400 given in IS:737-1986.

2. Workmanship

- Minimum average thickness of anodising (coating of anodising) on all aluminum section and fittings shall be 15 microns and shall conform to IS:1868-1983.
- Testing of anodising coating shall be in accordance with IS:5523-1983.
- Fixing of frames, shutters shall be as per manufacturer's instructions.
- PVC protected sheeting shall be used while fixing the frame of doors/ windows and ventilators to avoid damages, scratches etc.

3. Glazing

- Sheet glass for glazing shall conform to IS:2835-1977, specification for transparent sheet glass, and shall be of the quality.
 - "A" Quality or selected quality (SQ) for selected glazing/ where indicated.
 - "B" Quality, ordinary quality (OQ) for glazing purpose.

- Sheet glass shall be flat, transparent and clear, as judged by the naked eye, it may however, possess a light tint when viewed edge wise. It shall be free from cracks and other defects.
- Tolerance on the thickness of glass sheet shall be as under.

Table 4 - Tolerance on the thickness of glass sheet

Nominal thickness	Tolerance
2.0, 2.5, 3.0 & 4.0 mm	+ or – 0.2 mm
4.0, 5.5 & 6.3 mm	+ or – 0.3 mm

4. Cleaning of glazing

Glass shall be washed with warm water and soap or mild detergent followed by clean water rinse and dried with cloth or wash leather. Glass with broken or textured surface shall be cleaned with stiff plastic or bristle brush. For removing any obstinate dirt, glass shall be polished with whiting in water or spirit. Organic solvents may be used for special purpose such as petrol or benzene for removing tar, turpentine for paint that as not dried hard and paraffin for grease. The solvent shall be carefully cleaned off the glass afterwards. Plaster or mortar splashes on the glass shall be removed with thin razor blade.

5. Frosting or obscuring

The grinding of glass shall be done uniformly and evenly as to avoid any patchy work. The ground glass shall be thoroughly cleaned so that does not catch stains.

I. METAL WORKS – ROLLING SHUTTERS AND ROLLING GRILLS

1. Indian Standards

The following IS standards applying to this section

Table 5 - IS standard for metal rolling shutter and rolling grills

IS NO.	SUBJECT
IS:6248-1979	Specification for metal rolling shutters and rolling grills.

2. Types of shutters and applicable sizes:

Rolling shutter shall be supplied in the following alternative types based on different methods of operation. The size range applicable to each type is as follows.

- **Self-Coiling type (Push and pull type or manual type)** – It shall be used up to a maximum of 8 Sq. mt. clear area without ball bearings and up to a clear area of 12 Sq. mt. with ball bearings.
- **Gear operated type (mechanical type)** – It shall be fitted with ball bearings. It shall be used up to a maximum of about 25 Sq. mt. clear area, the rolling shutter is operated by a bevel gear box and crank handle and up to a maximum of about 35 Sq. mt. clear area.

- **Electrically operated type** – It shall be used up to a maximum of 50 Sq. mt. clear area.

3. Materials

- **Cold rolled steel strips**

Cold rolled steel strips used for rolling shutters lath section shall conform to IS:4030-1973, specification for cold rolled carbon steel strips for general engineering purposes (First Revision).

- **Mild steel section**

Mild steel sheets and plates used for manufacturing the guide channels, brackets and lock plate shall be of hot rolled steel of thickness more than 3.15 mm and shall be free from defects and edges cleanly sheared.

- **Steel Pipes**

Mild steel pipes used for the suspension shaft of the roller shall be heavy duty pipe suitable for mechanical purpose and shall conform to IS:1161-1968, specification for steel tubes for structural purposes (Second Revision).

- **Cast iron castings**

Cast iron castings used for roller pulley wheels, U-clamps and bevel gears shall be free from blow holes, surface defects such as cracks, burns etc., and shall conform to grade 15 of IS:210-1970, specification for grey iron castings (Second Revision).

- **Springs**

Springs used in the roller for counter-balancing the rolling shutter shall be made either from high tensile spring steel wire or flat spring steel strip.

- **Malleable cast iron**

Malleable Cast Iron used for clips shall conform to I.S. 2108-1962.

- **Aluminum alloy sheets**

Aluminum alloy sheets used for curtain in case of rolling grill shall conform to IS:737-1974

- **Aluminum alloy extrusions**

Aluminum Alloy extrusions for the components of rolling shutters of aluminum shall be of IS:733-1975.

4. Fabrication

- **Curtain**

The curtain shall be built up of interlocking lath section formed from cold rolled steel strips. The thickness of the sheets from which the lath section has been rolled shall not

be less than 0.9 mm for shutters up to 3.5 M width and not less than 1.2 mm for shutters above 3.5 M width. The lath section shall be rolled so as to have interlocking curls at both edges and deep corrugation at the center with a bridge depth of not less than 12 mm to provide sufficient curtain stiffness for resisting manual pressure and normal wind pressure. Each lath section shall be continuous single piece without any welded joint. When interlocked, the lath sections shall have a distance of 75 mm between rolling centers. Each alternative lath section shall be fitted with malleable cast iron or mild steel strips securely riveted at either end, thus locking the lath section on both ends and preventing lateral movement of the individual lath sections. The clips shall be so designed as to fit the contour of the lath sections.

- **Lock Plate**

A fabricated lock plate of riveted construction made of mild steel sheet of not less than 3.15 mm thickness, reinforced with mild steel angle section of not less than 35 x 35 x 5 mm size at the bottom, shall be interlocked with bottom most lath section of curtain so as to provide contact against the sill, when closed. Alternatively, the lock plate may also be fabricated out of unequal mild steel angles or 'Tee' section, of not less than 5 mm thickness. The lock plate shall be fitted with sliding bolts at either end to engage with suitable receiving pockets at the bottom of guide channels. The sliding bolts shall be capable of being locked by means of padlocks both from outside and inside. The lock plate shall also be provided with pulling handles, one handle for width up to 2.5 m and two handles for widths of above 2.5m. Pulling handles shall be fixed on both the interior side and exterior side of the lock plate.

- **Guide Channels**

The guide channels shall be of mild steel deep channel section and of rolled, pressed or built up (fabricated) construction. The thickness of the sheet used shall not be less than 3.15 mm. The depth of the guide should be such that there is sufficient clearance between the curtain and the inner surface of the guide to avoid any rubbing or obstruction for free movement of the curtain. The curtain shall project into the guide at least 40 mm up to 3.5 m width and 60 mm for greater width and there shall be a clearance of 10 mm minimum between the guide wall and the end clips of the curtain to permit free movement of the curtain.

- **Size of the guide channel**

The depth and width of the guide channel shall be as under

Table 6 Depth and width of the guide channel

Clear width of the shutter	Depth	Width
Up to 3.5 m	65 mm	25 mm
3.5 m up to 8 m	75 mm	32 mm
8 m and above	100 mm	32 mm

Each guide channel shall be provided with a minimum of three fixing cleats or supports

for attachment to the walls or column by means of bolts or screws.

The guide channel shall be attached to the jambs, plumb and true, either in the overlapping fashion, projecting fashion depending on the method of fixing.

- **Bracket Plate**

The bracket plate shall be fabricated out of mild steel of 3.15 mm thickness. The size of the bracket plate for different height of different rolling shutters shall be as follows:

Table 7 Size of the bracket plate

Clear height in meters	Size of bracket plate, Min
Up to 3.0 m	315 x 315 x 3.15 mm
Above 3.0 and up to 3.5 m	375 x 375 x 3.15 mm
Above 3.5 and up to 4.5 m	400 x 400 x 6 mm
Above 4.5 and up to 5.5 m	450 x 450 x 6 mm
Above 5.5 and up to 6.5 m	500 x 500 x 10 mm
Above 6.5	To be designed

The bracket plate shall be hexagonal, square or circular contour. The bracket plate shall have fitted at the centre a U- shaped cast iron or mild steel clamp riveted or welded to it. Since the bracket plate carried full load of the shutter, it should have sufficient cross-sectional area to resist the shear force and it shall hold in position rigidly by means of suitable foundation bolts. In the case of push and pull shutter, extra tying of the bracket plate to the guide channel is provided by means of a square bar of not less than 20 mm size. This square bar shall be welded on the back of the guide channel for a length of at least 20 cms. The bracket shall then be attached to the top of this square bar by means of 6 mm counter sunk rivets at a spacing of not more than 100 mm. Angle 40 x 40 x 6 mm split at one end is firmly riveted or welded at the top line of the bracket so that this will act as a foundation hold fast. The angle shall extent at least 20 cms from the edge of the bracket plate. This angle is grouted firmly into the wall with the split end of the angle well buried in concrete. When the bracket is to be fixed on concrete the angle is suitably bent and fixed to the concrete beam or lintel with anchor sleeves and bolts of at least 16 x 75 mm size.

A stopper made out of 40 x 6 mm flat is bolted on to the square bar so that the lock plate may be arrested going beyond the limit.

- **Roller**

The suspension shaft of the roller shall be made of steel pipe of heavy duty and of sufficient diameter so as to resist deflection due to the weight of the rolling shutter. The deflection shall not exceed 5 mm per meter width. The size of pipes for various width of rolling shutter/ grill is as given below. The height of the shutter being limited to a maximum of 5 m.

Table 8 Size of pipes for rolling shutters / grills

Width	Size of pipe
Up to 3 m	40 mm nominal bore
Up to 6 m	50 mm nominal bore

The pipes of the suspension shaft which are clamped to the bracket shall be fitted with rotatable cast iron pulleys to which the curtain is attached, the pulleys and the pipe shaft shall be connected by means of pre-tensioned helical springs to counter-balance the weight of the curtain and to keep the shutter in equilibrium in any partly opened position.

When the width of the opening is greater than 3.5 m, the pulley shall be inter-connected with a cage formed out of mild steel flats of at least 32 x 6 mm and mild steel dummy rings made of similar flats so that the torque is distributed uniformly. In such cases, self-aligning two row ball bearings shall be provided with special cast iron castings at the extreme pulleys at either ends. The caging rings shall have a minimum spacing of 15 cm and there shall be at least 4 number flats running throughout the length of the roller.

In the case of shutters for larger openings where the operation of the shutter is carried out using mechanical gear the roller shall be fitted with a pinion wheel at one end which is in contact with a worm fitted to the bracket plate. In this case also the pulleys shall be interconnected with caging with two ball bearings.

- **Hood Covers**

Hood covers shall be made of mild steel sheets not less than 0.900 mm thick. They shall be of hexagonal, square or circular contour depending on the contour of the bracket plate.

The hood cover shall be stiffened with angle or flat stiffeners at top and bottom edges to retain shape. The hood cover shall be fixed to the bracket plate by means of angle, cleats and supported at the top at suitable intervals for preventing sagging.

- **Gears, worms etc.**

All gears, worms, etc. used in the assembly of the rolling shutters shall be machine cut. Worm gear wheels shall be of high-grade cast iron or mild steel or phosphor bronze. The worms shall be of mild steel or gun-metal or phosphor bronze.

- **Fixing Bolts**

All fixing bolts shall be of good quality and adequate strength and at sufficiently close pitch to ensure strength and rigidity of the rolling shutter after erection.

5. Operation

- **Self-coiling type rolling shutters**

Self-coiling type rolling shutters shall be raised or lowered manually by means of a pulling hook applied to the pulling handles fixed on the bottom lock plate. The length of the

pulling hook shall be adequate to push the bottom lock plate to the topmost position with ease.

- **Gear operated type rolling shutters**

Gear operated type rolling shutters ordinarily employ a worm drive arrangement, the worm driving the worm wheel attached to one end of the roller. Worm drive is preferred in view of its irreversible nature, which provides a safeguard against any accidental downward descent of the curtain due to failure of the springs.

Gear operated type rolling shutters shall be operated by means of bevel gear box and crank handle. The bevel gear box shall be mounted on the wall adjacent to the shutter at a height of approximately 0.85 m from the floor. The gear box shall operate the worm by a straight shaft connecting the top of the gear box and the worm. The crank handle of the gear box shall be detachable. If so desired by the customer, the crank handle operation shall be provided on both sides of the wall by extending the horizontal shaft of the gear box backwards and providing an extra crank handle at the back of the wall. The gear reduction shall be calculated to reduce the pressure exerted, on the crank handle.

6. Rolling Grills

- Rolling grills are similar in design, construction and operation to rolling shutters and consequently all the provisions applicable to rolling shutter apply equally to rolling grills, except in respect of the curtains. Rolling grill curtains may be built of aluminum alloy or cold rolled steel sheet links of 0.90 mm thickness assembled on tubes or rods. Grills may also be manufactured out of 8 mm diameter mild steel or aluminum alloy round bars.
- Rolling grill links may be manufactured in a number of designs to suit manufacturer's convenience and customer's preference as also the purpose, the degree of safety required, etc. The details of fabrication and assembly of the rolling grill curtain depend on the actual type of links chosen. The function of a rolling grill is to provide visibility and/or ventilation, where necessary. At the same time, it provides less protection and less safety as compared to a rolling shutter. This factor shall be borne in mind when specifying rolling grills.
- Rolling Shutter-cum-Grill: In situations where a certain amount of ventilation combined with safety is called for, for example, in transformer rooms, sub-stations, etc., the rolling shutter may have a small rolling grill portion either at the top or at the bottom or at both PLACES. The height of the grill portion shall be a maximum of 0.5 m.

7. Painting (Shop Coat)

All component parts of the rolling shutter (excepting springs and the inside of guide channels) shall be given one coat of a brushing quality ready mixed primer conforming to IS:102-1962 before dispatch. Where a rust inhibiting quality of paint is called for, a zinc chromate primer shall be used. The portions of a rolling shutter where there is contact between aluminum and steel shall be painted with a zinc chromate primer to avoid possibility of corrosion due to electrolytic

action.

J. Painting Works

1. Indian standards

The following IS standards applying to this section

Table 9 - IS. Standard for Painting works

IS NO.	SUBJECT
IS:5410-1969	Specification for cement paint, colour as required.
IS:2932-1974	Enamel, synthetic, exterior, under coating and finishing (First Revision)

2. Cement Paint

- Cement paint shall comply with IS:5410-1969, Specification for cement paint, colour as required. The material shall be in powder form, free from lumps that are not friable and when mixed with required volume of water shall be suitable for use on porous surface of masonry, concrete and rough plaster work.
- **Preparation of surface**
 - The surface shall be thoroughly cleaned of all dirt, mortar drops, efflorescence, chalking, grease and foreign matter.
 - Before applying cement paint the surface shall be thoroughly wetted to control surface suction. The surface shall be moist but not dripping wet when paint is applied. Surfaces which readily absorb moisture, shall be wetted in one operation not more than one hour before painting. Surface which absorb moisture slowly shall be wetted in at least two operations not less than 30 minutes.
- **Preparation of cement paint**

Cement paint shall be made by adding equal volume of paint powder to water and the mix stirred to obtain a thick paste, which shall then be diluted to a brushable consistency in the proportion recommended by manufacturer. The recommendation of manufacturer shall be invariably followed. The water mixed paint shall be kept well stirred during use and shall be applied within one hour of preparation. To prevent algae and moss growth and efflorescence, silicon base water repellent compound may be added to mixture at the rate as recommended by the manufacturer. The lids of cement paint drums shall be kept tightly closed and not in use as the cement paint rapidly become air set.
- **Application of paint**
 - To maintain uniform mixture and to prevent segregation, the paint shall be stirred frequently in the bucket.
 - Unless otherwise indicated new surface shall be treated with a minimum of two coats of cement paint of the same colour. Not less than 24 hours shall be allowed between two coats and the second, or subsequent coat shall not be started until the preceding coat has become sufficiently hard to resist marking by the brush being used. In hot dry weather

the preceding coat slightly moisten before applying the subsequent coat. The paint shall be brushed in uniform thickness and free from excessive brush marks. The laps shall be well brushed out.

- The colour shall be even shade over the whole surface. If it is patchy or otherwise badly applied the work shall redone by the contractor at his own cost.

- **Curing**

Painted surface shall be sprinkled with water using a fog spray two or three times a day. Curing shall be done between coats and for at least two days following the final coat. The curing shall be started as soon as the paint has hardened so as not to damage of the spray, about twelve hours after the application.

3. Painting Woodwork

- **Preparation of new surface**

All woodwork shall be dried free from dust, dirt or any extraneous materials. Flat portion shall be smoothened with abrasive paper used across the grain prior to painting. All loose knots removed, and holes filled.

- **Priming Coat**

On clean prepared surface a priming coat of paint shall be applied by brushing. Unless otherwise directed, the priming coat shall be applied before the woodwork fixed in position.

- **Filler Coat**

Filler coat where indicated, shall be applied with a putty knife and subsequently rubbed down to a level surface, with the abrasive paper. The filler coat shall be of an optimum thickness and shall be allowed to fully harden and flatten before subsequent coat is applied. As many layers or filler is necessary shall be applied allowing each coat to harden and flatten before next coat is applied.

- **Under Coat**

Under coat shall be applied by brush after the surface has been primed, stopped, filled and rubbed down to a smooth surface. After drying, the under coat shall be carefully rubbed down and wiped clean before the finishing coat is applied.

- **Finishing Coat**

The finishing coat shall be applied by brush, the finished surface shall be free from hair or brush marks, streaks, clogging of paint, puddles in the corner etc.

4. Painting Steel and Iron Work

- **Preparation of new surfaces**

The surface shall be thoroughly cleaned of dirt, fluxing material, other foreign material and scrapped thoroughly with hand scrapper followed by wire brushing first with course and then with fine wire brushed and finally sand papering the surface to remove all mill scale and dust. The surface shall then be wiped finally with mineral turpentine to remove oil and grease etc.

Temporary rust protective materials applied to steel sheets to protect during transport and storage shall be removed with suitable solvent as a preliminary to other preparatory treatment.

Surfaces already pre-treated or primed in a factory shall be carefully inspected and damage areas shall be thoroughly degreased and cleaned of all dust and touch up.

- **Primer Coat**

Immediately after the preparation of the surface priming coat shall be applied by brush, working in the paint into the fine dents and ensuring a continuous film without runs and holds.

- **Filler Coat**

After the primer coat is harden and dry, the surface shall be rough sanded without scratching or in any way damaging primer coat and surface cleaned free from dust. Deep dents and scratches, if any shall be filled with paste filler using a good putty knife pressing firmly into the dents applying in optimum layers. Each layer shall be allowed to dry hard and then cut down by wet rubbing to a smooth finish.

Where indicated, after the paste filler is hard dry, a coat of liquid filler shall be applied by brush to fill all fine dents allowed to hard dry and then wet rubbed to a smooth finish.

- **Under Coat**

Under coating shall be applied by brush. The film shall be allowed to hard dry, wet rubbed and cut down to a smooth finish ensuring that at no place under coat is completely removed.

- **Finishing Coat**

Finishing coat shall be applied by brush. Special care shall be taken while painting over bolts, nuts, rivets and overlaps etc.

K. Anti-Termite Treatment

The buildings shall be adequately protected against attack by subterranean termites by suitable chemical treatment measures. The work shall be carried out by a specialist pest control agency approved by the Authority's Engineer.

The work to be carried out by the specialist firm and shall carry a guarantee for the satisfactory performance of the treatment for a minimum period of 10 years.

The treatment shall be carried out generally in accordance with the stipulations laid down by IS:6313 (Part –II)-1971 (code of practice for anti-termite measures in buildings - Part II – pre-construction chemical treatment measures) subject to the minimum requirements given in these specifications.

1. Minimum specifications

The earth filling immediately under the stone soling (under floors) bottom and side fills of all foundations (excepting foundations) and soil along external perimeter of all buildings shall be chemically treated against termites. The chemicals to be used for the treatment shall be Choropyriphos 20% E.C. conforming to the requirement and concentration laid down in IS:6313 (Part-II)-1981.

The chemical solution shall be prepared by mixing the chemical with the appropriate quantity of water to obtain a chemical emulsion of the correct concentration as stipulated above. The prepared emulsion shall be applied as described below.

Column pits, wall trenches etc. – The bottom surface and sides of the excavations (up to a height of 30 cm from the bottom) made for column foundations, wall foundations etc. (excepting RCC foundations) shall be treated with the chemical emulsion at the rate of 5 litres per Sqm of surface area.

2. Treatment to back fill

After the column foundations, wall foundations etc. come up the back fill in immediate contact with the foundation structure shall be treated @ 15 litres per Sqm of the surface of the sub-structure for each side. If water is used for ramming, operation is completely by roding earth at 15cm. centres close to the wall face and spraying the chemical with the above doze. The earth is to be returned in layers and the treatment shall also be carried out in similar stages. The chemical emulsion shall be directed towards the masonry wall surfaces so that the earth in contact with these surfaces is well treated with the chemicals.

In the case of RCC walls and columns, the treatment shall start at the depth of 50cm below natural ground level. From this depth the back fill around the RCC columns, walls etc. shall be treated at the rate of 15 litres per Sqm of the surfaces.

3. Top surfaces of plinth filling

The top surface of the plinth fill (just below the stone soling) shall be treated with chemical emulsion at 5 Litres per Sqm. of the surface before the stone laid. If the filled earth has been well consolidated and does not permit the emulsion to seep through, holes up to 50 to 75mm deep at 150mm centres both ways may be made with crowbars to facilitate saturation of the soil with the chemical emulsion.

4. Junction of wall and floor

A channel of size 3 x3 cm shall be made at all the junctions of walls and columns with the floor (before laying the soling) and rod holes made in the channel up to the ground level at 15 cm centres. The solution is poured into the channel@ 15 litres per Sqm of the vertical surface and allowed to soak through the holes fully so that the solid in contract with the chemical. The soil shall be tamped back into the channel and consolidation to original conditions.

5. External perimeter of building

After the building is complete, holes shall be made along the external perimeter of the building at intervals 15cm and depths of 30cms and the emulsion shall be allowed to soak through these holes fully at the rate of 5 litres per R.M. of the perimeter wall.

6. Soil surrounding pipes

Wherever may service pipes enter the soil inside the area of the foundation of any building, the soil surrounding the point of entry of each pipe at the foundation, floor etc., shall be fully soaked with the chemical solution for a distance of at least one meter from the point of such entry.

7. Expansion joints

Soil beneath expansion joints at ground floor level shall be specially treated as directed. The joint itself shall also be treated as directed by the Architect.

8. Treatment under apron

The soil below the concrete for stone aprons to be provided around the perimeter walls of all building shall also be treated with the chemical solution @ 5 litres per Sqm.

9. Treatment over DPC

Top of concrete damp proof course in external and internal walls shall be given a liberal coat of chemical solution when the concrete is still green.

10. Spraying equipment

To facilitate proper penetration of the chemical into the soil, a pressure pump of adequate capacity and sprayers shall be employed to apply the solution.

L. Miscellaneous Items

1. Brush bond

Surface should be cleaned from oil, grease, wax, dirt and any other foreign material spelled and deeply disintegrated into concrete should be removed to sound concrete and repaired. This has 2 components, brush bond powder and NITO bond BB acrylic emulsion.

Then the NITO bond BB is poured into a plastic or metal drum to this an equal volume of clean water is added. Then mixing is started with a slow speed drill (350 to 450 RPM). The powder component is added gradually to the liquid avoiding lump formation and mixed for 2.3min, Mix and use, do not mix none material.

Then the material will be applied on the surface by mixing a short, stiff bristle brush, preferably 100 to 150mm wide. Apply with a paint in 2 coats.

2. Cinder Concrete Filling

• General

This specification covers the requirement for filling under flooring of toilets, balconies etc. This shall generally conform to the specifications No.TS-3

- **Materials**

Cinders shall be obtained from furnace of steam boilers using coal fuel only. It shall be cleaned and free from clay dirt, wood ashes or other deleterious matter. It shall be 12.5mm nominal size i.e. passing through IS sieve designation 22 micron and 70 to 90 percent retained on IS sieve designation 106 micron. Cinder obtained from brick kiln shall not be used.

- **Preparation of Mix**

Cement and cinder shall be measured separately by volume in the ratio of 1:15 unless otherwise stipulated in the description of the item. Cement used need not however be actually measured but a bag of cement of 50 Kgs shall be taken as equivalent to 0.35 cum in ingredients shall then be thoroughly mixed together so that the cinders are uniformly and completely with neat cement.

- **Laying**

The top surface of the roof slab shall be thoroughly cleaned of all dust, dirt and other foreign matter. The cinder concrete shall then be laid and spread on the area to the required slope and well rammed with wooden therapies to give a uniform sponge concrete, correct to slopes and levels.

- **Curing**

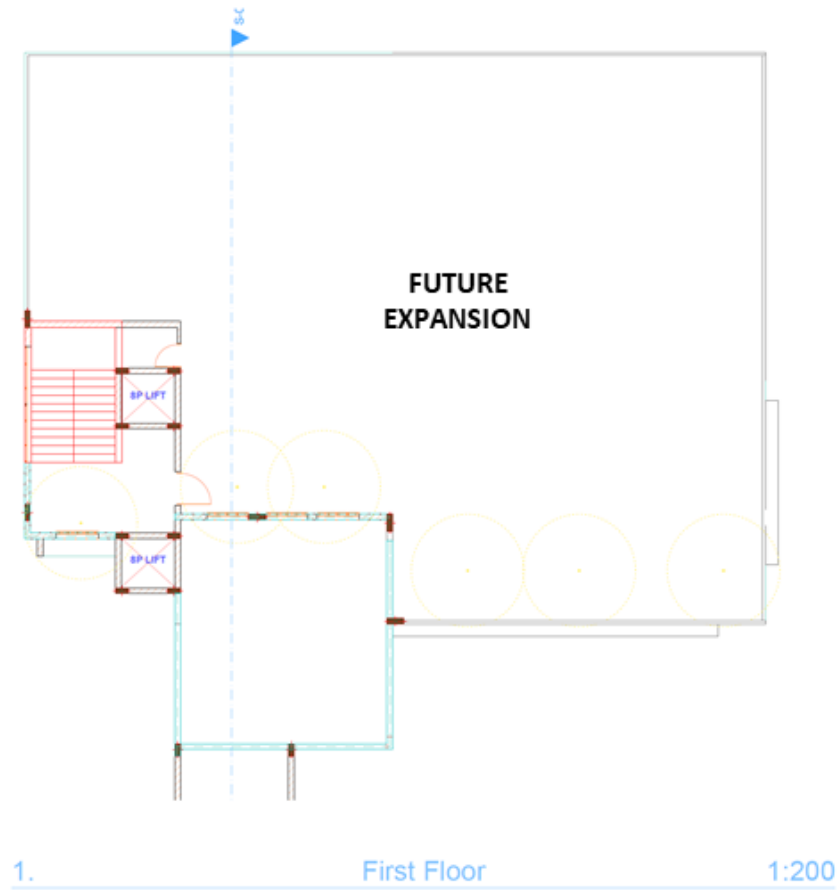
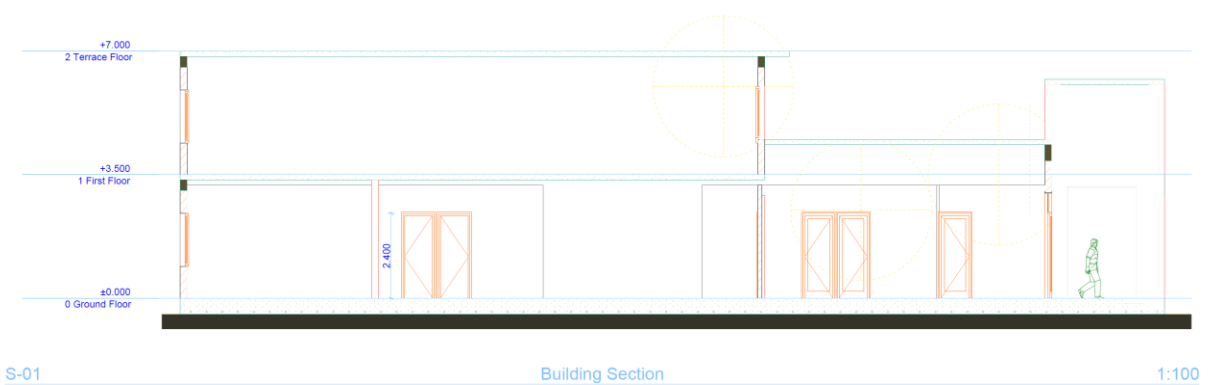
The finished surface shall be cured for at least 7 days. During this period, it shall be protected from sun, rain and other damage.

1.4 List of Drawings / Details

Please also refer to the following for reference to the Intent Diagrams (in A3 size)

Schedule number	Reference number	Title
8	7.1	Administrative building - Plan and Section



A. Ground Floor Plan**B. First Floor Plan**

C. Typical Section



2. Internal electrification work

2.1 Design brief

The Electrical and allied works installation shall comprise the following:

- Internal electrification works
- LT panels
- LED light fixtures (Indoor and Outdoor type)
- Networking and communication
- CCTV with IP cameras for surveillance system
- UPS and Batteries for computers, critical devices
- Solar Photo Voltaic (Solar Roof Top Panels) – 20% of Overall Load

Standard

The following standards are to be followed in the same order of priority.

- Indian Standards [Bureau of Indian Standards]
- Indian electricity act-1980(b)
- Indian electricity rules-1956 (c)
- Electricity supply act-1948
- International electro technique commission (IEC)

- NBC (National Building Code)
- As per Local Electrical Inspectorate, TN PWD, TANGEDCO, regulations.

Detailed electrical design

The Following Facilities are to be provided as mentioned below,

- LIGHTING, RAW POWER, NETWORKING & TELEPHONE SYSTEM

❖ Meeting room

- LED Light Fixtures for 400 Lux as per norms
- Ceiling fans as required based on the area
- Data & Telephone point provision
- UPS Sockets point provision
- AC Sockets provision.
- 6/16A Switched sockets.

❖ Conference room

- LED Light Fixtures for 400Lux as per norms
- Ceiling Fans as required based on the area
- Projector with Motorized Screen
- UPS Sockets point provision
- Data & Telephone point provision
- 6/16A Switched sockets

❖ Cabin

- LED Light Fixtures for 300Lux as per norms.
- Ceiling Fans as required based on the area.
- UPS Sockets point provision.
- Data & Telephone point provision.
- 6/16A Switched sockets.
- AC point provision.

❖ Working stations

- LED Light Fixtures for 300-350Lux as per norms.
- Ceiling Fans as required based on the area.
- UPS Sockets point provision.
- 6/16A Switched sockets.
- AC point provision.

❖ Surveillance room

- LED Light Fixtures as per norms.
- Ceiling fans as required based on the area.

- UPS Sockets & Data point provision.
- 6/16A Switched sockets.

❖ **Pantry**

- LED Light Fixtures as per norms.
- Ceiling fans considered as required based on the area.
- Telephone points provision.
- 6/16A Switched sockets.

CCTV System

- High resolution IP camera points are considered for CCTV surveillance system for all entry, exist, lift lobby, staircase & surveillance room.

Networking and Communication System

Cat-6, RJ45 sockets, Cat-6 Cables, Network Racks of suitable Capacity, Network Switches, Jack Panels, etc.

2.2 Load computation for Administrative Building (G+2)

SI No.	Description	Area in Sqft / Qty / TR / HP	LOAD IN WATTS	TOTAL LOAD IN KW	REMARKS
					TR=AC TONNAGE, HP=HORSE POWER
	LIGHTING AND FAN LOAD				
1	GROUND FLOOR (APPROXIMATE 5700SQFT)	5700	1	5.7	Considered 1W / sqft For internal lights and fans
2	FIRST FLOOR & FUTURE EXPANSION	5700	1	5.7	
3	SECOND FLOOR & FUTURE EXPANSION	5700	1	5.7	
4	BUILDING FACADE & EXTERNAL LIGHTING LOAD	1	1000	1	
	TOTAL LIGHTING & FAN LOAD IN KW			18.1	KW
	RAW POWER LOAD				
	PANTRY LOAD	3	4000	12	
	TOILET VENTILLATION	3	750	2.25	
	UTILITY LOADS	3	2000	6	
	LIFT LOAD	2	5500	11	Considered future lift
	ADMIN PHE LOADS	2	3000	6	
	TOTAL RAW POWER LOAD IN KW			37.25	KW
	HVAC LOAD				
	GROUND FLOOR (4300 SQFT OFFICE SPACE)	26.875	1200	32.25	Considered at every 160Sqft 1TR at 1.2 KW Each.
	FIRST FLOOR (2000 sqft OFFICE SPACE)	12.5	1200	15	
	SECOND FLOOR (2000 sqft OFFICE SPACE)	12.5	1200	15	
	FIRST & SECOND FUTURE OFFICE SPACE HVAC LOAD (4000SQFT)	25	1200	30	
	TOTAL HVAC LOAD IN KW			92.25	KW

	UPS LOAD				
	GROUND FLOOR				
	COMPUTER LOAD	35	200	7	
	PRINTERS	5	250	1.25	
	MEETING HALL TABLE TOP PROJECTORS	3	500	1.5	
	FIRST FLOOR				
	COMPUTER LOAD	10	200	2	
	PRINTERS	2	250	0.5	
	MEETING HALL TABLE TOP PROJECTORS	1	500	0.5	
	SECOND FLOOR				
	COMPUTER LOAD	10	200	2	
	PRINTERS	2	250	0.5	
	MEETING HALL TABLE TOP PROJECTORS	1	500	0.5	
	OTHER LOADS				
	SERVER / HUB LOAD	3	500	1.5	
	CCTV, NVR	1	1000	1	
	FA, PA & ACCESS CONTROL	1	1000	1	
	TOTAL UPS LOAD IN KW			19.25	KW
	TOTAL ADMIN CONNECTED LOAD IN KW			166.9	KW

The Contractor shall make exact load requirements for comprehensive functioning of the Administrative Block. Main Panel to be designed for total admin building load (for 3 floors) considering above mentioned loads, complying with Standards defined in this document.

2.3 Scope of work

- 1) PVC Conduits
- 2) Point wiring
- 3) FRLS PVC insulated 1100V Grade, multistrand Copper with low conductor resistance single core wire in open or concealed system of wiring with as per IS-694: confirming to latest amendments. (1.5/2.5/4.0/6.0/10.0 Sqmm)
- 4) Flexible multicore cable manufactured with electrolytic grade flexible copper with low conductor confirming to table 3 class 5 of IS:8130-1984 and (virgin) PVC insulation and sheathed suitable for working voltage upto 1100volts as per IS-694:1990 – 4Cx2.5Sqmm
- 5) Modular switch/Socket/stepped electronic fan regulator/dimmer/telephone socket etc. including GI/MS boxes, polycarbonate plate as per IS 3854 and IS 1293.
- 6) MCB distribution boards using necessary fixing materials and 'C' Type curve, indicator ON/OFF, energy cross-3 with short circuit breaking capacity of 10K and complete wiring as required confirming to IEC 60898.
- 7) Double Door MCB distribution boards on wall / wood board / flush mounting using required clamps, bolts, nuts etc., with provision for fixing suitable type capacity MCB'S single phase / 3 phase / single door with powder coated painting. Made out of 14 SWG MS Enclosure. Acrylic door
- 8) Residual Current Circuit breaker [RCCBO] 240/450V up to 300mA sensitivity on existing wood/ panel board.
- 9) Metal Socket set of 2 pole and earth plugs and socket for incorporating SP and TP MCB (without MCB). The entire Plug and Socket shall be mounted in a thermoplastic / powder coated metal box & wired completely.
- 10) Earthing: Body and Neutral Earthing As per IS 3043 Latest Edition / Maintenance Free Copper coated Earth rod of 3 mtr length having the dia of 14.2mm - 25mm with copper coating thickness of 250 microns. The rod has been tested for Dimension, Marking, Tensile Strength, Salt mist, coating thickness, Electrical resistivity test before and after corrosion test as per IEC 62561-2 & UL 467, with earth enhancing mineral compound tested for leaching and TCLP with NABL accredited Lab as per IEC 62561-7 -25 kg, Universal Clamp made up of stainless steel for terminating cable / flat conductor, Earth Chamber

Inspection Pit made up of concrete material. Resistance value below 5 Ohm, as per Technical Specification.

- a) GI / Copper strips inside Sleeves of proper color for grounding connections, minimum sizes as mentioned below for different components earthing,
- b) GI strip - 25x6mm
- c) GI strip - 40x6mm
- d) GI strip - 50x6mm
- e) 600x600x3mm GI plate
- f) CU strip - 25x6mm
- g) CU strip - 50x6mm
- h) 600x600x3mm Copper plate
- i) Copper wire - 8SWG

11) 1.1KV LT UG Aluminum conductor Cable XLPE or heat resistant PVC insulated, PVC extruded inner sheathed, armoured UG LT cable as per the IS - 1554 (part-1) or IS-7098 part-1, Armoring strip thickness in average + 5% and resistivity 14 Ohms/Kms (Max) as per IS -3975, Including tinned copper lug, glands, etc.

- a) 2 core 10 sq.mm
- b) 4 core 10 sq.mm
- c) 4 core 16 sq. mm
- d) 3.5 core 70 sq.mm
- e) 3.5 core 185 sq.mm

12) 2mm thick perforated cable tray with powder coated paint on existing MS angle support using necessary GI bolts/nuts and washer or welding as required- 150x50mm

13) Raceways with cover in ceiling and floor for power & data cabling, junction boxes: Raceways of following sizes made of 1.6mm thick pre galvanized sheet steel complete with 2mm thick screwed counter sunk type screws / Push to fit type cover. The raceways shall be of ready-made or fabricated GI type - 100x50mm

14) Exhaust fan of 1440RPM heavy duty with bracket blades complete for lighting duty suitable to operate on 230V 50Hz, AC supply, 15" sweep (375mm)

15) BEE Energy efficient 1200mm sweep ceiling fan 5 star rated, inverter driven controlled by microprocessor with 300mm down rod with regulator/ remote control (35 W) complete with down rod blades, shackle, canopies etc., for operation on 230 volts, 50cycles. Single phase AC supply conforming to ISS-374-1979 and with double ball bearing system.

- 16) LED light fixtures – 6W, 12W, 18W Surface / recess mounting nonintegrated type LED down light ...W luminaire comprising of pressure diecast/extruded aluminum housing, with spring loaded false ceiling clamps, LED of Power / COB with CCT 6500-degree K, CRI >70%. efficacy >100 lumen per watt, 120degree beam spread, life > 25000 burning hours and Compliance to IS 10322/IEC 60598, LM 79 & LM 80. The lamp compartment is enclosed with anti-glare opal diffuser which enhances the lighting level. LEDs are driven by HF electronic driver integrated in a separate control gear assembly., with PF > 0.95, power loss should < 5% of lamp wattage., short circuit & open circuit protection to be integrated in the circuit THD Less than 20%, Life as per LM 79, The operating input voltage should be between 130 to 275 volts, BIS Approved and tested by NABL/CPRI accredited laboratory with 2 years Warranty against any manufacturing defect working under standard electrical condition.
- 17) 2'X2', 36W, LED recessed / surface luminaire with watts system wattage. Housing shall be with pressure die cast aluminum alloy with corrosion proof resistant polyester powder coated. Driver operates with voltage range from 100V to 270V 50/60Hz with short circuit, overloaded, & miswiring. Lumen maintenance of 70% @ 50000 Hrs. injection moulded polycarbonate diffuser for better mechanical stability, light transmission & avoid pothole effect. Junction temperature shall be < 70 deg Celsius. Driver is on constant current driver @ 0.06A with PF > 0.92 with line voltage @220-240V @ 50/60Hz, driver efficiency >85% & THD<15%. LED efficiency > 130lm/w at 1w and fixture efficiency > 75lm/w with CRI > 75 with injection moulded polycarbonate lens. 5 years warranty against any manufacturing defect working under standard electrical condition.
- 18) LED Flood light for Building Illumination with 70-100W system power consumption pressure die cast aluminum housing with powder coating with IP 65 protection. 1 200-270v voltage with electronic driver, PF>0.9, should meet ANSI 2G vibration test, compliance to UL/CE with class 1. System rating shall be 50K hr. @ lumen maintenance of 70%. system efficiency >80lm/w. Overload & short circuit protection ensures reliable operation in spite of problem in output side. Compliance to IS 10322/IEC 60598, LM 79 & LM 80 Adherence with RoHS. UL approved MCPCB. Top access streetlight with single screw to ensure ease of maintenance at the sight site location with minimized minimal tools. LED Light fixture withW system power consumption. LED efficiency > 130lm/w at 1w and fixture efficiency > 75lm/w with CRI > 75. luminaire Manufacturer should have in-house facility accredited by NABL/CPRI & any government certified agency & design & development facility certified by ISO 9001:2008. Housing with supplier word mark/name shall be engraved / embossing on the die cast housing / body part. 2 years warranty

against any manufacturing defect working under standard electrical condition as mentioned above should be given by LED manufacturer.

- 19) LED Bollard light fitting of 8W, 600mm height, with pressure die cast aluminum housing body for optimal thermal dissipation. Lamp compartment comprising of anti-glare clear diffuser with injection moulded polycarbonate / clear glass material, delivering superior light output. Rated life burning Hrs. 50000 hr. @ Lumen Maintenance of 70%, CCT > 5500K, IP 66 optical and electrical compartment & impact resistance of complete luminaire > IK08. Power factor > 0.9 with mains, surge protection- Min 5KV along with Over voltage / Overload, Short circuit / miss - wiring protection. Universal voltage Driver to operate wide voltage range from 100V to 270V 50/60HZ application. Compliance to IS 10322/IEC 60598, LM 79 & LM 80 Adherence with RoHS. UL approved MCPCB, with 2 years warranty against any manufacturing defect working under standard electrical condition.

- 20) LED Street light, 43W, with pressure die cast aluminum housing body with optimal heat sink for better thermal dissipation. Diffuser with injection moulded & is made of polycarbonate material with high transmission index, delivering superior light output. Rated life burning Hrs. 50000 hr. @ lumen maintenance of 70%. CCT > 5500K, IP 66 optical and electrical compartment and impact resistance of complete luminaire > IK08. Power Factor > 0.9 with mains current should not be greater than 0.1A to 0.7A & surge protection - min 4KV along with over voltage/overload, short circuit/ mis wiring protection. Compatible for pole mounting with outer dia of 40mm to 50mm. Universal voltage driver to operate wide range from 100v to 270V 50/60Hz application. Overload & short circuit protection ensures reliable operation in spite of problem in output side. Compliance to IS 10322/IEC 60598, LM 79 & LM 80 Adherence with RoHS. UL approved MCPCB. Top access streetlight with single screw to ensure ease of maintenance at the sight site location with minimized minimal tools. LED Light fixture withW system power consumption. LED efficiency > 130lm/w at 1w and fixture efficiency > 75lm/w with CRI > 75. luminaire Manufacturer should have inhouse facility accredited by NABL/CPRI & any government certified agency & design & development facility certified by ISO 9001:2008. Housing with supplier word mark/name shall be engraved / embossing on the die cast housing / body part. 2 years warranty against any manufacturing defect working under standard electrical condition as mentioned above should be given by LED source manufacture. Suitable for B1/B2 roads as per IS 1944 Part 1 & Part II.

- 21) Aesthetically designed 43 watt AIO solar street light with IP 65 protected components, inbuilt MPPT charge controller, LED's with CCT of 6000-6500k with a system efficacy of min. 150 lm/watt total lumen output of 6000 lms along with lenses of wide spread 145x75

degree for better spread and throw , LED module should be Tilttable/adjustable for adjusting the Light without disturbing the mounting of the fixture , dual Mounting arrangement of aluminum die-cast for facilitating Top and side mounting , Aluminum extrusion body with Inbuilt Monocrystalline solar panel of 100wp within the fixture , Lifepo4 battery 12.8 V 24 Ah with BMS , with PIR/microwave sensor for dimming . Low voltage and charging indication, Fixture should be with over charge and deep discharge protection. fixture should be suitable for a backup of 24 hrs. of operating time. complete system warranty should be 2 years. Certification required are LM 79 from third party, LM 80 for the LED chip, BIS for battery cell, Mounted on Existing 4.0m pole.

22) LT ADMIN PANELS – a) MAIN ADMIN BLOCK MV PANEL, b) MAIN COMMON SERVICE PANEL AS PER SLD

23) UPS AND BATTERIES FOR EMERGENCY LIGHTING SYSTEM– 1KVA OFF-LINE UPS System suitable for operation on 230V Input and 230V, Output, 50Hz, A/C supply with all accessories complete and excluding batteries and wiring complete, with 30Minutes Backup, SMF Batteries.

24) ON-LINE UPS – 15KVA suitable for operation on 415V Input and 415V, Output, 50Hz, A/C supply with Isolation Transformer, built in static bypass, all accessories complete and excluding batteries and wiring complete, with 30Minutes Backup, SMF Batteries.

25) CCTV SYSTEM - CAMERAS & ACCESSORIES -1/3" progressive scan CMOS, 3.0 megapixel, IP based Color camera, with 3-12mm varifocal lens, Up to 30 m IR range, Color: 0.01Lux, 1000TVL, Digital WDR (Wide Dynamic Range), 3D DNR (Digital Noise Reduction), PoE (Power over Ethernet/1 RJ45 10M/100M self-adaptive Ethernet port), IP67, Motion detection, Alarms (Video tampering, network disconnected, IP address conflicted), Protocols (TCP/IP, ICMP, HTTP, HTTPS, FTP, DHCP, DNS, DDNS, RTP, RTSP, RTCP, NTP, UPnP, SMTP, IGMP, 802.1X, QoS, IPv6, Bonjour), Standard (ONVIF(PROFILE S,PROFILE G),PSIA,CGI,ISAPI), General Function (Anti-flicker, heartbeat, mirror, password protection, privacy mask, watermark), with base box, other necessary accessories. The cost shall include end terminations.

26) 8port 10/100/1000 Smart POE Switch with 4 SFP (192W) for camera connection including all necessary accessories.

27) NVR (Networkable Video Recorder) - 8Channel NVR, Up to 8ch IP cameras input, Up to 5 Megapixels resolution recording, HDMI and VGA output at up to 1920×1080P resolution, HDD quota and group management 4 SATA, 3 USB, interface, 1 RJ-45 10 /100 /1000 Mbps self-adaptive Ethernet interface, 4TB HDD/30Days recording storage, whichever is higher,

support 10TB external HDD connected through SATA Ports DVR should have 2 external SATA Port, Alarm in (8) Alarm out (8), 100~240VAC, 6.3A, 50~60Hz, rack mountable, Password protection, Upto 8 simultaneous views from different DVRS on same LAN on single screen, etc. with all necessary Accessories.

28) NETWORKING AND COMMUNICATION: Modular Type Data, telephone, TV socket (RJ45 / RJ11 / TV Aerial Plug)

29) UTP-CAT 6 LAN cable.

30) PVC flexible one pair telephone unarmored tinned copper cable – for Telephone

31) PVC insulated gas injected physical foam jelly flooded co-axial TV cable. RG-6.

32) Network Switch mounting rack with power manager & cable manager – min.12U with 650mm depth, fan, power strip, as per standard accessories.

33) 24 Port Gigabyte (Manageable) Network switch

34) Patch Panel for LAN cabling, 24 Port 10/100/1000 Patch Panel

35) Cat6 Patch Cable - 1 mtr / 2mtr for terminating at Rack side /workstation side.

36) 6 Core Multimode OM3 outdoor Fiber Cable.

37) Commissioning and Handing over with documents including Fluke Test for Networking Works

38) Contractor will be responsible for arranging service of the installation with the projected charges and arranging required approval from the required government Electrical Inspectorate and securing permission for energizing LT installation works. Arranging temporary power supply for construction and making payments, monthly bills and renewal/upgrading temporary power supply will be Contractor's responsibility

39) Handing Over Documents

2.4 General conditions and technical specification

2.4.1 General technical requirements for electrical works

A. Scope: -

1.1 The Scope of Electrical works includes complete Internal Electrification works starts from the Building Main Panel as shown in the drawings. The detailed scope covers the following:

Design, engineering, supply on for destination site basis, including transportation & insurance, storage, erection, testing and commissioning of the following equipment's/ items complete in all respects.

- (i) 415 V LT switchboards/distribution boards
- (ii) 1.1kV grade PVC / XLPE insulated cables
- (iii) Internal Electrifications
- The Contractor shall also be responsible for the overall co-ordination with internal/external agencies, project management, training of Authority's manpower, loading, unloading, handling, moving to final destination for successful erection, testing and commissioning of the equipment/works.
- Design of systems includes preparation of single line diagrams and electrical layouts, control and protection schematics, wiring and termination schedules, indoor and outdoor lighting/illumination and other relevant drawings & document required for engineering of all facilities under this contract, are covered under the scope of the Contractor.
- Any other items not specifically mentioned in the specification, but which are required for erection, testing and commissioning and satisfactory operation of the equipment's are deemed to be included in the scope of the specification unless specifically excluded.
- The reference drawing SLD, which form a part of the specifications, are provided in later section of this document.

B. General requirement: -

2.1 The Contractor shall furnish catalogues, engineering data, technical information, design documents, drawings etc., fully in conformity with the technical specification.

C. Standards: -

3.1 The works covered by the specification shall be designed, engineered, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India.

- 3.2 The Contractor shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IS/IEC.

D. Services to be performed by the equipment being furnished: -

- 4.1 All equipment's shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation.
- 4.2 All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc. for the equipment.

E. Engineering data and drawings: -

- 5.1 The engineering data shall be furnished by the Contractor in accordance with the Schedule.

The Contractor shall necessarily submit all the drawings/documents unless anything is waived.

The Contractor shall submit 4 (four) sets hardcopy along with the soft copy of drawings/design documents/data/ test reports as may be required for the approval of the Authority.

F. Degree of protection: -

- a) The enclosures of the LT Panels to be installed shall provide degree of protection as detailed here under:
- b) All indoor Panels to be supplied with minimum: IP-54 protection

7.0 As built drawings both hard copy and soft copy: -

At the completion of the works and before issue of the certificate of virtual completion, the Contractor shall submit to the Authority 4 sets of layout drawings (both hard copy and soft copy) drawn at approved scale indicating the complete wiring system as installed. These drawings must provide the following minimum information:

- a. Run and size of conduits, inspections, junction and pull boxes.
- b. Size of conductors in the conduits.
- c. Location and rating of sockets and switches controlling the light and power outlets.
- d. Location and details of distribution boards, mains, switches, switchgear, main panel and other particulars.

- e. A complete wiring diagram, as installed and schematic drawings showing all connections in the complete electrical system.
- f. Location of outlets, junction boxes, sizes of various conduits for telephones.
- g. Location of all earthing stations, routes, sizes of all earthing conductors, manholes, layout of earth link strips, etc.
- h. Layout and particulars of all cables.

Above indicates the general requirement. However, the Contractor must include all information desired by the Authority in the final as built documents.

8.0 Pre-commissioning tests: -

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Authority and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The list of pre-commissioning tests to be performed is given in respective chapters and shall be included in the Contractor's quality assurance programme.

The testing equipment required for testing and commissioning shall be arranged by the Contractor.

10. Packaging & protection: -

- 10.1 All the equipment's shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Authority, the Contractor shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Authority to repack any equipment/material at a later date, in case the need arises. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Authority takes no responsibility of the availability of the wagons.
- 10.2 All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and pilings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

11.0 Finishing of metal surfaces: -

- 11.1 All metal surfaces shall be subjected to treatment for anti-corrosion protection. All steel conductors Including those used for earthing/grounding (above ground level) shall also be galvanized according to IS:2629.
- 11.2 After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting.
- 11.3 In case the Contractor proposes to follow his own standard surface finish and protection procedures or any other established painting procedures, like electrostatic painting etc., the procedure shall be submitted for Authority's review & approval.

12.0 Handling, storing and installation: -

- 12.1 In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Authority or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment / Panel shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented.
- 12.2 Contractor may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment / Panel being procured by them separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall full cooperation to them.
- 12.3 In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Authority. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.
- 12.4 Where assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of equipment / Panel. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.
- 12.5 Contractor shall be responsible for examining all the shipment and notify the Authority immediately of any damage, shortage, discrepancy etc. for the purpose of Authority's information only. The Contractor shall submit to the Authority every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and

erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

- 12.6 The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Authority in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over the Authority, as well as protection of the same against theft, element of nature, corrosion, damages etc.
- 12.7 The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.
- 12.8 The words 'erection' and 'installation' used in the specification are synonymous.
- 12.9 Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.
- 12.10 The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the minimum clearances as per the statutory requirement, the Contractor shall immediately proceed to correct the discrepancy at his risks and cost.

Various codes for electrical works

A. Applicable IS Standards: -

The design engineering manufacturing and the installation shall be in accordance with established codes, sound engineering practices and specifications and shall confirm to the statutory regulations, applicable in the country. Contractor shall obtain all approvals from statutory authorities e.g. Electrical Inspector, pollution control boards, BESCOMs as applicable before commissioning of electrical equipment. Relevant Indian standards are listed below.

- | | | |
|----|---|----------|
| 1. | MEASURING METERS | IS:1248 |
| 2. | INSTALLATION AND MAINTENANCE OF SWITCH GEARS | IS:3072 |
| 3. | CODE OF PRACTICE FOR EARTHING | IS:3043 |
| 4. | SWITCH GEARS AND FUSES FOR
VOLTAGE NOT EXCEEDING 1000 VOLTS | IS:4064 |
| 5. | GENERAL REQUIREMENTS FOR SWITCH GEAR AND
GEAR FOR VOLTAGE NOT EXCEEDING 1000 VOLTS | IS:13947 |
| 6. | DEGREE OF PROTECTION PROVIDED BY
ENCLOSURES FOR LV S/GEARS | IS:13947 |
| 7. | ENCLOSED DISTRIBUTION FUSE BOARDS AND CUT-OUTS | |

	FOR VOLTAGE NOT EXCEEDING 1000 VOLTS	IS:2675
8.	MINIATURE CIRCUIT BREAKER	IS:8828
9.	FUSE WIRE USED IN RE-WIRABLE TYPE ELECTRIC FUSES UP TO 650 VOLTS	IS:9926
10.	PVC INSULATED ELECTRIC CABLES HEAVY DUTY	IS:1554(PART I)
11.	RECOMMENDED CURRENT RATING FOR CABLES	IS:3961(PART II)
12.	COPPER CONDUCTOR IN INSULATED CABLES AND CORES	IS:2982
13.	CONDUCTOR FOR INSULATED ELECTRIC CABLES AND FLEXIBLE CORDS	IS:8130
14.	MILD STEEL WIRES, STRIPS AND TAPES FOR ARMOURING CABLES	IS:3975
15.	PVC INSULATION AND SHEATH OF ELECTRIC CABLES	IS:5831
16.	ALUMINIUM CONDUCTOR FOR INSULATED CABLES	IS:8130
17.	PVC INSULATED AND PVC SHEATHED SOLID ALUMINIUM CONDUCTOR CABLES OF VOLTAGE RATING NOT EXCEEDING 1100 VOLTS	IS:4288
18.	RECOMMENDED CURRENT RATING FOR CABLE	IS: 3961
19.	CODE OF PRACTICE FOR ELECTRICAL WIRING INSTALLATION SYSTEM VOLTAGE NOT EXCEEDING 650 VOLTS	IS: 732
20.	CODE OF PRACTICE FOR FIRE SAFETY OF BUILDINGS GENERAL) ELECTRICAL INSTALLATION	IS: 1646
21.	PVC INSULATED CABLES (WIRES)	IS:694
22.	RIGID NON-METALLIC CONDUITS FOR ELECTRICAL WIRING	IS:9537
23.	FLEXIBLE (PLAYABLE) NON-METALLIC CONDUITS FOR ELECTRICAL INSTALLATION	IS:6946
24.	THREE PIN PLUGS AND SOCKETS	IS:1293
25.	CONDUCTORS FOR INSULATED ELECTRICAL CABLES AND FLEXIBLE CODES	IS:8130
26.	SPECIFICATION FOR CONDUIT FOR ELECTRICAL INSTALLATION	IS:9537
27.	ACCESSORIES FOR NON-METALLIC CONDUITS FOR ELECTRICAL WIRING	IS:3419
28.	SWITCHES	IS:3854
29.	PLUGS	IS:6538
30.	SHUNT CAPACITORS FOR POWER SYSTEMS	IS:13925
31.	HRC CARTRIDGE FUSES AND LINKS UP TO 660 VOLTS	IS: 9224
32.	GENERAL AND SAFETY REQUIREMENT FOR LIGHTING FITTINGS	IS:1913
33.	CODE OF PRACTICE FOR LIGHTING PUBLIC THOROUGH FARES	IS:1944
34.	WATERPROOF ELECTRIC LIGHTING FITTINGS	IS:3528
35.	WATERTIGHT ELECTRIC LIGHTING FITTING	IS:3553
36.	MILD STEEL TUBULAR AND OTHER WROUGHT STEEL PIPE	

	FITTING	IS:1239
37.	LUMINARIES FOR STREET LIGHT	IS:2149
38.	HRC FUSES HAVING RUPTURING CAPACITY OF 90 KA	IS:13703
39.	EXHAUST FAN	IS:2312
40.	CLASS I CEILING FAN	IS:374
41.	DANGER NOTICE BOARDS	IS: 2551

Note: -

All codes and standards means the latest edition where not specified, otherwise the installation shall generally follow the Indian Standard codes of practice or relevant British Standard Codes of Practice in the absence of corresponding Indian Standards.

2.4.2 General technical specification for electrical works

2.4.2.1 LT panels

I. Type of panel:

All the LT Panels shall be metal clad, totally enclosed, rigid, floor mounted, air - insulated, cubical type suitable for operation on three phase / single phase, 415 / 230 volts, 50 Hz.

The Panels shall be designed to withstand the heaviest condition at site, with minimum expected ambient temperature of 45 degree Celsius, 80 percent humidity and dusty weather.

Should conform to Indian Electricity Act and rules (till last amendment) & approved as per FIA norms.

II. Various codes for electrical panels

A. Applicable IS standards

1.	METERS (MEASURING) FOR ANALOG METERS	IS:1248
2.	INSTALLATION AND MAINTENANCE OF SWITCH GEARS	IS:3072
3.	H.D. AIR BREAKER, SWITCH GEARS AND FUSES FOR VOLTAGE NOT EXCEEDING 1000 VOLTS	IS:4064
4.	GENERAL REQUIREMENTS FOR SWITCH GEAR AND GEAR FOR VOLTAGE NOT EXCEEDING 1000 VOLTS	IS:13947
5.	DEGREE OF PROTECTION PROVIDED BY ENCLOSURES FOR LV S/GEARS	IS:13947
6.	ENCLOSED DISTRIBUTION FUSE BOARDS AND CUT-OUTS FOR VOLTAGE NOT EXCEEDING 1000 VOLTS	IS:2675
7.	FUSE WIRE USED IN RE-WEARABLE TYPE ELECTRIC FUSES UP TO 650 VOLTS	IS:9926
8.	CONDUCTOR FOR INSULATED ELECTRIC CABLES AND FLEXIBLE CORDS	IS:8130
9.	SHUNT CAPACITORS FOR POWER SYSTEMS	IS:13925
10.	HRC CARTRIDGE FUSES AND LINKS UP TO 660 VOLTS	IS:9224
11.	HRC FUSES HAVING RUPTURING CAPACITY OF 50 KA	IS:13703
12.	AC ELECTRICITY METERS: PART – 1 GENERAL REQUIREMENTS AND TESTS	IS:722 PART 1
13.	DIRECT ACTING ELECTRICAL INDICATING INSTRUMENTS	IS:1248
14.	CURRENT TRANSFORMERS	IS:2705
15.	ELECTRICAL RELAYS FOR POWER SYSTEMS PROTECTION	IS:3231
16.	PHOSPHATE TREATMENT OF IRON AND STEEL FOR PROTECTION AGAINST CORROSION	IS:3618

17.	GUIDE FOR MARKING OF INSULATED CONDUCTOR	IS:5578
18.	CODE OF PRACTICE OF PHOSPHATING OF IRON AND STEEL	IS:6005
19.	FACTORY BUILT ASSEMBLIES OF SWITCHGEAR AND CONTROL-GEAR FOR VOLTAGES UPTO AND INCLUDING 1000V AC AND 1200V DC.	IS:8623
20.	GUIDE FOR UNIFORM SYSTEM MARKING AND IDENTIFICATION OF CONDUCTORS AND APPARATUS TERMINALS	IS:11353
21.	LOW VOLTAGE FUSES	IS:13703
22.	LV SWITCHGEAR AND CONTROL GEAR (PART 1 TO PART 5)	IS:13947
23.	STRUCTURE CONSTRUCTION (IP-54)	IS:13947
24.	MINIATURE CIRCUIT BREAKER (MCB)	BS:3871 (PART-1) IS:8825
25.	FUSE	IS:9926
26.	AIR CIRCUIT BREAKER	IS:13947
27.	CONTACTORS	IS:2959 & BS:775
28.	DIGITAL METER	IS:13779
29.	ELECTRICAL POWER & CONTROL WIRING CONNECTION WIRING INSIDE THE MODULE FOR POWER, CONTROL PROTECTION	IS:694 & IS:8130
30.	DANGER NOTICE PLATE	IS:2551-1982 & IS:5-1978
31.	MCCB	IEC 60947 IS: 13947
32.	ELCB/ELMCB	IS - 12640 – 1988/ IEC 61008

Note: -

All codes and standards means the latest edition where not specified, otherwise the installation shall generally follow the Indian Standard codes of practice.

III. Structure:

The Panels shall be metal clad enclosed and be fabricated out of high quality CRCA sheet, suitable for indoor installation, front operated, free standing and floor mounting type.

CRCA sheet steel used in the construction of LT PANELS shall be 2 mm thick for structure, main frame & Doors, 1.6 mm thick for shrouds/Internal partition and 3 mm thick for gland plate and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet shall be seam welded, all welding slag grounded off and welding pits wiped smooth with plumber metal.

The LT PANELS shall be totally enclosed, completely dust and vermin proof and degree of protection being no less than IP-42. Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust proof. All doors and covers shall be fully

gasketed with neoprene gaskets and shall be lockable.

All panels and covers shall be properly fitted and secured with the frame, and holes in the panel correctly positioned. Fixing screw shall enter into holes tapped into an adequate thickness of metal or provided with bolts and nuts.

A base channel of 75 mm x 75 mm x 5 mm or as per the weight of the panel shall be provided at the bottom.

PCCs / MCCs / PDBs shall be arranged in multi-tier formation. The LT PANELS shall be of adequate size to facilitate enough space for maintenance and cooling. The size of the LT PANELS shall be designed in such a way that the internal space is sufficient for hot air movement, and the electrical component does not attain temperature more than 40°C over an ambient temperature of 50°C while carrying rated current. Openings shall provide for natural ventilation, but the said openings shall be screened with fine wire mesh.

Knockout holes of appropriate size and number shall be provided in the PCCs / MCCs/ PDBs in conformity with number, and size of incoming and outgoing conduits / cables.

Alternatively, the LT PANELS shall be provided with removable sheet plates at top and bottom to drill holes for cable / conduit entry at site.

The LT PANELS shall be designed to facilitate easy inspection, maintenance and repair.

The LT PANELS shall be sufficiently rugged in design and shall support the equipment without distortion under normal and short circuit condition they shall be suitable braced for short circuit duty.

The panel shall have sufficient space at least 20% of outgoing feeders with wiring provision for future use.

The front of each compartment shall be provided with hinged single leaf door with locking facilities. Panel shall be provided with suitable lifting facilities. MCCB/ACBs and accessories shall be of fixed/draw out type as per Legend provided in the SLD.

IV. Protection class:

All the indoor LT PANELS shall have protection class of minimum IP - 52.

V. Powder coating:

All sheet steel material shall undergo seven-tank process after all the necessary shearing and other mechanical works are completed. After the seven-tank process powder coating treatment shall be adopted using powder of reputed make. After the powder coating is

complete welding in the panel or any sort of shearing, bending or cutting activity shall not be done. The color shall be Siemens Grey RAL 7032/Smoke Gray.

VI. Circuit compartment:

Each circuit breaker and switch fuse units shall be housed in separate compartments and shall be enclosed on all sides. Sheet steel hinged lockable door shall be duly inter-locked with the breaker / switch fuse units in ON and OFF position. Safety interlocks shall be provided for non-opening of the door when the breaker is in ON position. Safety interlock with operating handle shall be provided. All MCCB shall be Rotary Handled, Operating Mechanically.

The door shall not form integral part of the draw out position of the circuit breaker. All instruments and indicating lamp shall be mounted on the compartment door. Sheet steel barriers shall be provided between the tiers in a vertical section.

VII. Instrument compartment:

Separate and adequate compartment shall be provided for accommodating instruments, indicating lamp, control contactors, relays and control fuses etc. These components shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, switch fuse units, bus bars and connections.

VIII. Busbars:

The bus bar shall be air insulated and made of high quality, high conductivity, high strength Aluminum and as per relevant IS code. The bus bar shall be for three phases and neutral system with separate neutral and earth bar. The busbar and interconnection between busbar and various components shall be of high conductivity, hard drawn, electrolytic Aluminum. The busbar shall be of rectangular cross section designed to withstand full load current for phase busbar and full rated current for neutral busbar and shall be extendable type on either side. The busbar shall be rated for the frame size of the main incoming breaker. The busbar shall have uniform cross section throughout the length. Ratio of 1 Sq. mm = 0.8 A shall be adopted for tinned copper bus bars. The busbars to be sized based this ratio.

The busbar and interconnection shall be insulated with heat shrinkable PVC sleeves and be color coded as per relevant IS. The busbar shall be supported on unbreakable, non-hygroscopic DMC/SMC/FRP insulated supports at sufficiently close interval to prevent busbar sag and shall effectively withstand electromagnetic stresses in the event of short circuit capacity of 35 / 50 KA, as mentioned in the SLD.

The busbar shall be housed in a separate compartment. The busbar shall be isolated with 3 mm thick FRC sheet to avoid any accidental contact. The busbar shall be arranged such

that minimum clearances between the bus bar are maintained as per relevant IS/BIS.

All busbar connection shall be done by drilling holes in busbars and connecting by chromium plated bolt and nuts. Additional cross section of busbar shall be provided in all LT PANELS to cover-up the holes drilled in the busbars. Spring and flat washers shall be used for tightening the bolts.

All connection between busbar and circuit breaker / switches and between circuit breaker/ switches and cable terminals shall be through solid copper strips of proper size to carry full rated current. These strips shall be insulated with insulating strips.

Copper earth bus of suitable size shall be provided at the bottom of the panel throughout the length. Similarly, suitable size of Copper strip in each vertical section for earthing the individual equipment/accessories shall be provided and connected to main horizontal bus.

IX. Electrical power & control wiring connection:

Terminal for both incoming and outgoing cable shall be suitable for 1100 volts grade, aluminum/copper conductor PVC / XLPE insulated and sheathed, armored cable and shall be suitable for connections of solder less sockets for the cable size as indicated on the appended drawing for the PCCs, MCCs, PDBs.

Both control and power wiring shall be brought out in cable alley for ease of external connections, operation and maintenance. Control and power wiring shall not be mingled.

Both control and power terminals shall be properly shrouded.

10% spare terminal shall be provided on each terminal block. Sufficient terminals shall be provided on each terminal block so that not more than one outgoing wire connected per terminal.

Terminal strip for power and control shall preferably be separated from each other by suitable barriers of enclosures.

Wiring inside the module for power, control protection and instrument etc. shall be done with use of 1100 V conforming to IS 694 and IS 8130. For current transformer circuits and other control wiring shall be done with 2.5 sq. mm copper conductor wires. All door frames of L.T switch boards shall be earthed with bare braided copper wire. All conductors shall be crimped with solder less sockets at the ends before connections are made to the terminals.

Particular care shall be taken to ensure neat and orderly laying of the wiring. Identification ferrules shall be tagged to all the wire termination for ease of identification and to

facilitate and testing. The color coding shall be as per latest edition of IS:375.

Final wiring diagram of the PCC, MCC, PDB power and control circuit with ferrules number shall be submitted along with the PCC/MCC/PDB as one of the documents.

X. Terminals:

The outgoing terminals and neural link shall be brought out to a cable alley suitably located and accessible from the panel front. The current transformer for instrument metering shall be mounted on the disconnecting type terminal blocks. No direct connection of incoming and outgoing cables to internal components connection of the distribution board is permitted. Only one conductor may be connected in one terminal.

XI. Wireways:

A horizontal PVC wire way with screwed covers shall be provided at the top/bottom to take interconnecting control wiring between different vertical sections.

XII. Cable compartment:

Cable compartment of adequate size shall be provided in the PCCs, MCCs, and PDBs for easy termination of all incoming and outgoing cables entering from top. Adequate support shall be provided in the cable compartment.

XIII. Earthing:

Aluminum earth bus bar of minimum 25 mm x 6 mm size (or as shown in the SLD) shall be provided in the Panels for the entire length of panel. As per the rating of the main bus bars the size of earthing bus bar shall be decided. The framework of the LT PANELS shall be connected to this earth busbar. Provisions shall be made for connection from earth busbar to the main earthing bar coming from the earth pit on both sides of the LT PANELS.

The earth continuity conductor of each incoming and outgoing feeder shall be connected to this earth bar. The armor shall be properly connected with earthing clamp and the clamp shall be ultimately bonded with the earth bar.

XIV. Labels:

Engraved Aluminum sheet labels shall be provided on all incoming and outgoing feeders. Single line circuit diagram showing the arrangements of circuit inside the distribution board shall be pasted on inside of the panel door and covered with transparent laminated plastic sheet.

XV. Name plate:

A prominent engraved name plate with panel designation in bold letter shall be fixed at top of the central in panel. A separate name plate giving feeder details shall be provided for each feeder module door.

Inside the feeder compartment, the electrical component, equipment's, accessories like switchgear, contactor, lamp, relays etc. shall suitably be identified by prominent engraved identification plates.

Engraved nameplates shall be of Aluminum strip of black color and WHITE letters format. Inscription and lettering sizes shall be subject to the Authority's approval.

Nameplate shall be fastened by counter sunk screws / riveted and not by adhesives.

Suitable stenciled paint marks shall be provided inside the panel/module identification of all equipment's in addition to the plastic sticker labels. These labels shall be partitioned so as to be clearly visible and shall have the device number, as mentioned in the module wiring design.

XVI. Danger notice plate:

The danger plate shall be affixed in a permanent manner on operating side of the panel.

The danger notice plate shall indicate danger notice both in Hindi, English & local language and with a sign of skull and bones.

The danger notice plate in general shall meet to requirements of local inspecting authorities.

Overall dimension of the danger notice plate shall be 200 mm wide and 150 mm high. The danger notice plate shall be made from minimum 1.6 mm thick mild steel sheet and after due pre-treatment to the plate, the same shall be painted white with vitreous enamel paint on both front and rear surface of the plate.

The letter, the figure, the conventional skull and bones shell etc. shall be positioned on the plate as per recommendations of IS: 2551.

The said letter, the figure and the sign of skull and bones shall be painted in single red color as per IS: 5-2007.

XVII. Internal components:

The LT PANELS shall be equipped complete with all type of required number of MCCB, switch fuse unit, contactor, relays, fuses, meters, instruments, indicating lamps, push

buttons, equipment, fittings, bus bar, cable boxes, cable glands etc. and all the necessary internal connections /wiring as required and as indicated on relevant drawings (SLD). Components necessary for proper complete functioning of the LT PANELS but not indicated on the drawing shall be supplied and installed on the LT PANELS

All part of the LT PANELS carrying current including the components, connections, joints and instruments shall be capable of carrying their specified rated current continuously, without temperature rise exceeding the acceptable values of the relevant specifications at any part of the LT PANELS.

XVIII. Inspections / Testing:

Authority's Engineer shall have the right to inspect and test or get inspected and tested any/all the goods supplied by the Contractor.

2.4.2.2 L. T. Switchgears:

2.4.2.2.1 General:

The type, size, and rating of the components shall be as indicated on the relevant single line diagrams.

2.4.2.2.2 Miniature circuit breaker (MCB):

Miniature circuit breakers shall be quick make and break and break type conform with British standard IEC: 898-1987 and IS: 8828 as amended up to date. The housing of MCBs shall be heat resistant and having high impact strength. The fault current of MCBs shall not be less than 10000 amps (10KA), at 230 volts. The MCBs shall be flush mounted and shall be provided with trip free manual operating mechanism with mechanical "ON" and "OFF" indications.

The circuit breaker dollies shall be of trip free pattern to prevent closing the breaker on a faulty current.

The Each pole of the breaker shall be provided with inverse time thermal overload and instantaneous over current tripping elements, the overload or short circuit devices shall have a common trip bar in the case of DP and TPN miniature circuit breakers. All the MCB's shall be tested/certified as per Indian Standard, prior to Installation.

Tripping characteristics of the MCBs (B/C/D curve) should be based on the load connected to the MCB

2.4.2.2.3 MCB (For control, Indication and metering Circuit):

MCBs used in control, indication and metering circuit shall be of approved make.

2.4.2.2.4 Moulded case circuit breaker (CLASS P-2 DUTY)

MCCB shall confirm to the latest IS: 13947/IEC: 947

The MCCB shall be air brake type and having quick make quick break with trip free operating mechanism.

Housing of the MCCB shall be of heat resistant and flame-retardant insulating material.

Rotating Handle Operating handle (RHOM) of the MCCB shall be in front and clearly indicate ON / OFF (or) TRIP positions. In case of 4 pole MCCB the neutral shall be defined and capable of offering protection.

The MCCB shall be provided with Microprocessor based / Thermal based trip units as provided in the SLD. All the releases shall operate on common trip bus bar so that in case of operation of any one of the releases in any of the three phases, it will cut off all the three phases and thereby single phasing of the system is avoided.

The MCCB whenever called for in the drawings shall be provided with Overload, Short Circuit protection

The MCCB shall provide two sets of extra auxiliary contacts with connections for additional controls at future date.

2.4.2.2.5 Contactors:

The contactors shall meet with the requirements of IS: 2959 /BS: 775.

The contactors shall have minimum making and breaking capacity in accordance with utilization category.

If the contactor forms part of a distribution board then a separate enclosure is not required, but the installation of the contactor shall be such that it is not possible to make an accidental contact with live parts.

2.4.2.2.6 Multi data meter

Flush mount 96 x 96 x 80 mm Load manager type Enercon EM 6400 or equivalent meter of accuracy class 1 as per IS 13779/IEC 62052-11 & 62053-21 shall be provided. The meter shall be capable of simultaneous sampling of voltage and amperes. It shall have low burden on PT and CT shall have bright display, shall view 3 parameters together and shall have auto scaling from kilo to mega to giga units, shall have programmable CT, PT ratios. Communication with PC; PLC DCS shall be possible through RS 485 serial port. It shall be dust proof, tamper proof with data import export option.

Parameters to be monitored shall be Frequency, Line to line and average and line to neutral and average voltage, phase wise and average current, phase wise and total KVA, KW and P.F. reading and KWH monitoring.

User programmable facility for delta 2e and star 3e measurement, C.T. and P.T. ratios, Sensing shall be 3 phase, 4 wire measuring True RMS with voltage input range of 110 to 415 V nominal and current input of 5 amps or 1 amps as per field configuration. Current range shall be from 50 mA to 6A and burden on PT or CT shall be Max 5 VA.

Accuracy for kW / kWh shall be as per IS 13779 / CBIP88/62052-11 & 62053-21, for Kvar/Kvarh 2% and for all other parameters 1% for class 1. Digital readout shall be of 3 rows of 4 digits each with 7 segments bright red LED. Input frequency shall be 50Hz / +/-

5%.

Resolution for power parameters shall be for 4 digits and energy parameters shall be 8 digits. Display update shall be at every 15 seconds for demand parameters and 1 sec for other parameters. Temperature range shall be 0-50°C and humidity <95% non-condensing.

Display parameters shall be as follows:

Instantaneous – VLL, VLn, A, F, KVA, kW, PF
Individual phases of above parameters.

Integrated – kVAh, KWh, Run hours, On hours & Interruption.

2.4.2.2.7 Current transformer:

Where called for, CT's shall be of Resin Cast type provided for current measuring. Each phase shall be provided with separate CT of class I accuracy and VA burden as shown in SLD for operation of associated metering and controls. Current transformer shall be in accordance with IS: 2705 as amended up to date.

2.4.2.2.8 Push button:

The push button unit shall comprise of the contact element, a fixing holder, and push button actuator. The push button shall be momentary contact type. The contacts shall be of silver or silver alloy and rated at 10 Amps. Continuous current rating. The actuator shall be of stranded type and color as per its usage for ON, OFF and Trip.

2.4.2.2.9 Indicating lamp:

Indicating Lamp shall be LED type and shall supplied complete with translucent covers to diffuse the lamp light. Indicating lamps shall be part of push buttons.

Color shade for the indicating lamps shall be as below:

ON indicating lamp	:	RED
OFF indicating lamp	:	GREEN
TRIP indicating lamp	:	Amber
PHASE indicating lamp:		Red, Yellow, and Blue.

2.4.2.2.10 Workmanship: -

The Contractor shall erect the panel at site in co-ordination with the support of OEM(s) / OEM's authorised dealer, if required. Physical and continuity tests, if required, shall be

carried out by Contractor.

2.4.2.2.11 Tools: -

The Contractor shall, at its own expense, shall arrange for a complete set of all special or non-standard tools required for installation, operation and maintenance of the switchboard.

2.4.2.2.12 Spares

The Contractor shall also supply a complete list of commissioning spares and tools till Defects Liability Period.

2.4.2.3 Cable laying in trenches and trays

A. Specifications: -

Cable Trench: -

Cable trench shall be dug to the minimum depth of minimum 0.75 mt as per site condition in co-ordination with other services such as, PHE, Networking etc. and the width shall dependent on the no of cables to be kept with the layer of brick in between two cables.

Bricks: -

The bricks shall be hand or machine moulded and made from suitable soils and kiln burnt. They shall be free from cracks, flaws and modules of free lime. They shall have smooth rectangular faces with sharp corners and shall be uniform in color. The bricks shall be moulded with a frog of size 100 mm. x 40 mm., and 10 mm. to 20 mm. deep on one of its flat sides. The bricks shall not break when thrown on the ground from a height of 6 m. Class 35 designated bricks shall be used.

Sand: -

Sand shall be natural sand, clean, well graded, hard, strong, durable and gritty. Sand particles should be free from injurious amounts of dust, clay, kankar nodules, soft or flaky particles of shale, alkali, salts, organic matter loam, mica or other deleterious substances and shall be got approved from the Authority. The sand used by civil agency shall be used.

Cable Trays and Raceways: -

Cable trays shall be fabricated from Hot Dip GI and channels of minimum 14 / 16 gauge and shall be powder coated with 7 tank process if specified. The design shall be ladder type with optional cover.

The perforated tray should be minimum 1.6 mm thick hot dip galvanized iron with powder coated paint.

Trays shall be fixed or suspended from the ceiling with the help of suspenders which shall have adequate diameter to sustain the weight of the cables and channels. Also, if necessary, anchor fasteners shall be used for grouting purpose.

Floor / Ceiling raceway with cover of hot dip galvanized sheet of minimum 16G mm shall be used. The raceways shall be free of any sort of welding edges or other sharp edges to protect cutting of wires during pulling. The raceways shall be laid with use of junction boxes fabricated from minimum 16 g hot dip GI as per drawing.

Raceways shall be supported from the ceiling using minimum 12mm threaded rods for carrying the Electrical and Networking cables.

Minimum 300mm distance to be maintained between Electrical and Networking Raceways during the execution.

B Cable laying

- a) Cable network shall include power, control, lighting and communication cables, which shall be laid in trenches, cable trays or conduits as detailed in the relevant drawings. Erection of cable trays as required shall be the responsibility of Contractor. Cable routing given on the layout drawings shall be checked in the field to avoid interference with structures, piping or air-conditioning ducts, and minor adjustments shall be done to suit the field conditions, wherever deemed necessary, without any extra cost.
- b) High voltage, medium voltage and other control cables shall be separated from each other by adequate spacing or running through independent pipes, trenches or cable trays, as applicable.
- c) All cable routes shall be carefully measured, and cables cut to the required lengths, leaving sufficient length for the final connection of the cable to the terminal of the equipment. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. The Contractor shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structures, foundation, pipe work or any other works.
- d) Cables as far as possible shall be laid in complete uncut lengths from one termination to the other.
- e) Straight through joints if required shall be made by using epoxy resin type jointing kit.
- f) Cables shall be neatly arranged in the trenches / trays in such a manner so that crisscrossing is avoided, and final take off to the switchgear is facilitated. Arrangements of cables within the trenches / trays shall be the responsibility of the Contractor.
- g) All cables will be identified close to their termination point by cable numbers as per cable schedule. Cable numbers will be punched on aluminum straps (2mm thick), securely fastened to the cable and wrapped around it. Alternatively, cable tags shall be circular in construction to which cable numbers can be conveniently punched.
- h) Each underground cable shall be provided with identity tags of lead securely fastened every 30 mts of underground length with at least one tag at each end before the cable enters the ground.

- i) All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all PVC insulated cables shall be tapped with an approved PVC or rubber insulating tape. Use of friction tape or other type of tape is not permitted. Lead sheathed cables shall be plumbed with lead alloy.
- j) RCC cable trenches with removable covers as shown on the drawings will be provided by the Contractor. Concrete cable trenches shall be filled with sand where specified to avoid accumulation of hazardous gases. RCC covers of trenches, in process areas shall be effectively sealed to avoid ingress of chemicals etc. Removal of concrete covers for purposes of cable laying and reinstating them in their proper positions after the cables are laid shall be done by the electrical Contractor at no extra cost.
- k) Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cables leaving the trenches shall be provided with a protective pipe or cover, until such times the final termination to the equipment is completed.
- l) Directly buried cables shall be laid underground in excavated cable trenches where specified on layout drawings. Trenches shall be of sufficient depth and width for accommodation of all cables correctly spaced and arranged with a view of heat dissipation and economy of design.

Depth of burying shall allow minimum 750 mm soil cover for LT cables as per standard. Cables shall be laid in trenches at depth as shown in the drawing. Before cables are placed, the trench bottom shall be filled with a layer of sand not less than 50mm for LT cables. The sand shall be leveled, and the cables laid over it. The cables shall be covered with 150 mm of sand on top of the largest diameter cable, and sand shall be hand pressed. A protective covering of 75 mm thick second-class red bricks shall be then laid flat. The remainder of the trench shall then be backfilled with soil, rammed and leveled.

As each row of cables is laid in place, and before covering with sand, every cable shall be given an insulation test in the presence of the Authority Engineer. Any cable, which proves defective, shall be replaced before the next group of cables are laid.

All wall openings shall be effectively sealed after installation of cables to avoid leakage of water.

- m) Where cables rise from trenches to control station, lighting panels etc., they shall be taken in vertical trays for mechanical protection.

Cable ends shall be carefully pulled through the conduits to prevent damage to the cable. Where required, approved cable lubricant shall be used for this purpose. Where cable enters conduit, the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.

- n) After the cables are installed and all testing is complete conduit ends above ground shall be plugged with a suitable weatherproof plastic compound / PUTTI for sealing purpose. Alternatively, G.I. lids or PVC bushes shall be employed for sealing purposes. The cost for the same shall be deemed to be included in the Contractor's cost.
- o) Where cables pass through foundation walls or other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures the Contractor shall determine the location, and obtain approval of the Authority's Engineer before cutting is done.
- p) At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends after back filling.
- q) Drum number of each cable from which it is taken shall be recorded along with the cable number.
- r) Cables installed above ground shall be run in trays exposed on walls, ceiling, structures and shall be run parallel or at right angles to beams, walls or columns. Cables shall be so routed that they will not be subjected to heat from adjacent hot piping or vessels.
- s) Individual cables or small groups which run along structures / walls etc. will be by means of 16 SWG G.I. saddles on 25 x 6 mm saddle bars. The cost of saddle and saddle bars shall be deemed to have been included in the installation of cables and no separate payment shall be made on this account. They shall be rigidly supported on structural steel and masonry, individually or in groups, as required. If drilling of steel must be resorted to, approval must be secured, and steel must be drilled where the minimum weakening of the structure will result. Cables shall be supported so as to prevent unsightly sagging. In general distance between supports shall be approximately 300 mm for cables up to 25 mm diameter and maximum 450 mm for cables larger than 25 mm diameter.
- t) All PVC Pipes shall be laid as per requirements. Before fabrication of various profiles of pipe by hydraulically operated bending machine (which is to be arranged by the Contractor), all the burs from the pipes shall be removed. PVC pipes buried in soil; bitumen coating shall be applied on the buried lengths. Installation of PVC Pipes shall be undertaken well before paving is completed and necessary coordination with paving agency shall be the responsibility of the Contractor. The open ends of pipes shall be suitably plugged with G.I. plugs/PVC Glands after they are laid in final position. G.I. Plugs/PVC Glands shall be supplied by the Contractor at no extra cost.
- u) Cable laid on supporting angle in cable trenches, structures, columns and vertical run of cable tray shall be suitably clamped by means of G.I. saddles / clamps, whereas cable in horizontal run of cable trays shall be tied by means of nylon cords.

- v) Supporting steel shall be painted before laying of cables. The painting shall be done with one coat of red lead paint and two coats of approved bituminous aluminum paint.

C. Workmanship: -

The cable shall be laid as mentioned above, the trench shall be terminated in Manholes with specified size of R.C.C. hume pipes as shown in drawing. Cable markers shall be provided throughout the route of cable at 10 mts distance. The trenches shall be refilled after the cable is laid and the Ground level shall be done as per original after pressing the same. The cables shall be checked for insulation resistance and continuity tests shall be carried out.

2.4.2.4 1.1 KV grade L.T. cables and cable termination

A. Specifications

L. T. XLPE cable:

General:

The medium voltage cables shall be supplied, laid, connected, tested and commissioned in accordance with the drawings, specifications, relevant Indian Standards specifications, manufacturer's instructions. The cables shall be delivered at site in the original drums with manufacturer's name, size and type clearly written on the drums.

All cables shall be adequately protected against any risk of mechanical damage to which they may be liable in normal conditions of handling during transportation, loading, unloading etc.

The cable shall be supplied in single length i.e. without any intermediate joint or cut unless specifically approved by the Authority.

The cable ends shall be suitably sealed against entry of moisture, dust, water etc. with cable compound as per standard practice.

Conductor:

Uncoated, annealed copper / aluminum, of high conductivity, up to 4 mm² size the conductor shall be solid Circular and above 4 mm² the conductors shall be stranded compacted shaped.

Insulation:

Cross link polyethylene (XLPE) extruded insulation rated at 70°C.

Core Identification:

Two cores	:	Red and Black
Three cores	:	Red, Yellow and Blue
Four cores	:	Red, Yellow, Blue and Black
Single core	:	Green for earthing.

Black shall always be used for neutral and green shall be used for earthing.

Assembly:

Two, three or four insulated conductors shall be laid up, filled with non-hygroscopic material and covered with an additional layer of thermoplastic material.

Aarmor:

Galvanized steel flat strip / round strips applied helically in single layers complete with covering the assembly of cores.

Sheath:

The inner sheath shall be of PVC type. Outer sheath shall be of an extruded type layer of suitable PVC TYPE-ST-2 material compatible with the specified ambient temp. of 50°C and operating temperature of cables. The sheath shall be resistant to water, ultraviolet radiation, fungus, termite and rodent attacks. The color of outer sheath shall be black.

Sequential length marking along with size and other standard parameters shall be required at every 1.0 mt on the outer sheath.

Testing:

Finished cable tests: The finished cables shall be tested at manufacturer's works for all the routine tests for all the length and size of cables to be delivered at site and the certificate for the same shall be furnished to Authority. If required, the cables shall be tested in presence of the Authority's representative.

- 1) Voltage test: Each core of cable shall be tested at room temperature at 3 KV A.C. R.M.S. for duration of 5 minutes.
- 2) Conductor resistance test: The D.C. resistance of each conductor shall be measured at room temperature and the results shall be corrected to 20°C to check the compliance with the values specified in the IS 8130.

Cable tests before and after laying cables at site:

1. Insulation resistance test between phases, phase to neutral and phase to earth.
2. Continuity test of all the phases, neutral and earth continuity conductor.
3. Earth resistance test of all the phases and neutral.

Testing instruments shall be of reputed make and shall have valid calibration.

All the tests shall be carried out in accordance with the relevant IS code of practice and Indian Electricity Rules. The Contractor shall provide necessary instruments, equipment's and labor for conducting the above tests and shall bear all the expenses in connection with such tests. All tests shall be carried out in the presence of Authority's Engineer and the

results shall be prescribed in forms and submitted.

Cable Marking:

The outer sheath shall be legibly embossed at every meter with following legend:

ELECTRIC CABLE: 1100 V, SIZE: ____C X ____ MM² with Manufacturers name, year of manufacturing and ISI symbol.

Sealing drumming and packing:

After tests at manufacturer's works, both ends of the cables shall be sealed to prevent the ingress of moisture during transportation and storage.

Cable shall be supplied in length of 500 mts or as required in non-returnable drums of sufficiently sturdy construction.

Cables of more than 250 meters shall also be supplied in non-returnable drums.

The spindle hole shall be minimum 110 mm in diameter.

Each drum shall bear on the outside flange, legibly and indelibly in the English literature, a distinguishing number, the manufacturer's name and particulars of the cable i.e. voltage grade, length, conductor size, cable type, insulation type, and gross weight shall also be clearly visible. The direction for rolling shall be indicated by an arrow. The drum flange shall also be marked with manufacturer's name and year of manufacturing etc.

Cable Termination:

1. All LT cables up to 1100 V grade shall be terminated at the equipment by means of double compression type cable glands of aluminum / copper conductor. Cable glands to be supplied by the Contractor should be preferably of leading and approved brands only. They shall have a screwed nipple with conduit, electrical thread and check nut.
2. Power cables shall be identified with Red, Yellow and Blue PVC tapes. Where copper to aluminum connections are made necessary, bimetallic washers shall be used. For trip circuit identification, additional red ferrules shall be used only in the particular cores of control cables at the termination points in the switchgear / control panels and control switches.
3. In case of control cables all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules, or self-sticking cable markers. Wire numbers shall

be as per the schematic / wiring / interconnection diagrams. The Contractor shall have the samples of PVC ferrules / cable markers approved before starting of the work.

4. Where threaded cable gland is screwed into threaded opening of different size, suitable galvanized threaded reducing bushing of approved type shall be used, at no extra cost. Contractor shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic materials / aluminum sheet in case of single core cables.
5. The cable shall be taken through glands inside the panels or any other equipment such as motors. The individual cores shall then be dressed and taken along the cableways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals.
6. In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom, close fit hole should be drilled in the bottom plate for all the cable in on line: then the bottom plate should be split into parts along the center line of holes. After installation of bottom plate and cables, it should be sealed with cold setting compound. Cables shall be clamped over the open armoring to connect it to the earth bus.
7. Cable leads shall be terminated at the equipment terminals by means of crimped type solder less connectors as manufactured by leading and approved companies / brands. Crimping shall be done by hand crimping / hydraulically operated tool and conducting jelly shall be applied on the conductor. Insulation of the leads should be removed immediately before the crimping. Conductor surface shall be cleaned and shall not be left open.

B. Workmanship

Cables shall be laid as per the routes marked in the drawings. Where the route is not marked, the Contractor shall mark it out on the drawings and also on the site and obtain the approval of the Authority before laying the cable. Procurement of cables shall be on the basis of actual site measurements.

Cables shall be laid on walls, cable trays, inside shafts or trenches. Saddling or support for the cable shall not be more than 500 mm apart. Plastic identification tags shall be provided at every 30 m.

Cables shall be bent to a radius not less than 12 (twelve) times the overall diameter of the cable or in accordance with the manufacturer's recommendations whichever is higher.

In the case of cables buried directly in ground, the cable route shall be parallel or

perpendicular to roadways, walls etc. unless marked on drawing. Cables shall be laid on an excavated, graded trench, over a sand or soft earth cushion to provide protection against abrasion. Cables shall be protected with brick or cement tiles on all the three sides as shown on drawings. Width of excavated trenches shall be as per drawings. Back fill over buried cables shall be with a minimum earth cover of 750 mm to 1000 mm. The cables shall be provided with cables markers at every 10 meters and at all loop points.

All cables shall be full runs from panel to panel without any joints or splices. Cables shall be identified at end termination indicating the feeder number and the Panel/Distribution board from where it is being laid. Cable termination for conductors up to 4 sq.mm. may be insertion type and all higher sizes shall have compression type lugs. Cable termination shall have necessary brass glands. The end termination shall be insulated with a minimum of six half-lapped layers of PVC tape. Cable armoring shall be earthed at both ends.

In case of cables entering the buildings. It would be done duly only through pipes. The pipes shall be laid in slant position, so that no rainwater may enter the building. After the cables are tested the pipes shall be sealed with M. seal & then tarpaulin, shall be wrapped around the cable for making the entry watertight.

Testing:

MV cables shall be tested upon installation with a 500 V Meggar and the following readings established:

1. Continuity on all phases.
2. Insulation Resistance: Between conductors and all conductors & ground.

All test readings shall be recorded and shall form part of the completion documentation to be submitted by the Contractor.

Cable joints shall be done as per regular practice and check shall be carried out for loose connections and leakages. Insulation cutting shall be done properly taking care that no area of the conductor remains exposed. Crimping shall be done with the help of hydraulic tool. Proper insulation tape shall be applied at the cable and lug joint.

Format for cable testing certificate:

- a. Drum no. from which cable is taken :
- b. Cable from _____ to _____
- c. Length of run of this cable _____ mt
- d. Insulation resistance test
 - Between core 1 to earth _____ mega-ohm
 - Between core 2 to earth _____ mega-ohm
 - Between core 3 to earth _____ mega-ohm

Between core 1 to core 2 _____mega-ohm

Between core 2 to core 3 _____mega-ohm

Between core 1 to core 3 _____mega-ohm

Duration used:

2.4.2.5 Distribution boards

A. Specifications

Distribution boards shall be readymade as specified in the make of material list. It shall be of double door type with hinged (lockable if required) door suitable for recessed mounting in wall.

The distribution boards shall be provided with phase barriers, wiring channels to accommodate wires and individual per phase neutral links. There shall be separate or individual earth link as per requirement. Proper arrangement shall be made for mounting of MCB's and other accessories.

Distribution boards shall meet with the IS requirements and marking arrangement of bus bars shall be in accordance with I.S. standards.

Bus bars shall be suitable for the incoming switch rating and sized for a temperature rise of 35°C over the ambient. Each board shall have two separate earthing terminals. Circuit diagram indicating the load distribution shall be pasted on the inside of the DB as instructed. One earthing terminal for single phase and two terminals for 3 phase DB's shall be provided with an earth strip connecting the studs and the outgoing copper earth bar.

The top and the bottom faces of the D.B. shall be provided for conduit entry of minimum 1" dia. The faces if asked shall be kept detachable.

Miniature Circuit Breakers (MCB):

MCB's shall have quick make and break for 10 KA short circuit both on the manual and automatic operation. Each pole of the breaker shall be provided with inverse time thermal overload and instantaneous over current tripping elements, with trip-free mechanism. In case of multi-pole breakers, the tripping must be on all the poles and operating handle shall be common. Breakers must confirm to **IS:8828** with facility for locking in OFF position.

Tripping characteristics of the MCBs (B/C/D curve) should be based on the load connected to the MCB

RCCB / ELCB / RCBO / ELMCB

The RCCB should suffices all the requirements of IS as per code IS - 12640 – 1988/IEC 61008. The RCCB should be current operated and not on-line voltage.

The RCCB should ensure mainly the following functions:

- i) Comparison of the fault current with a reference value.
- ii) The RCCB should have a toroidal transformer which has the main conductors of primary (P - N) which check the sum of the current close to zero.
- iii) All metal parts should be inherently resistant to corrosion and treated to make them corrosion resistant.
- iv) It should be truly current operated.
- v) It should operate even in case of neutral failure.
- vi) It should trip at a present leakage current within 100mA for Lighting circuit and 300mA for Raw power and AC circuits.
- vii) Its enclosure should be minimum protection of IP 30.
- viii) Its mechanical operation life should be more than 20,000 operations.
- ix) It should conform to all national and international standards like IS: 12640-1988, IEC 61008

B. Workmanship

The D.B. shall be properly grouted in the wall in concealed manner taking care that the powder coating is not scratched, and dents are not formed on the D.B. The MCBs and ELMCBs. In the distribution boards shall be fixed as per the circuit details provided. All the wires terminating in the MCBs and the ELMCBs shall be lugged for proper contact and ferrules depicting the circuit nos. shall be provided. D.B.s mounted in concealed manner shall have a groove around it so as to save the finish of the plaster and color during future opening of the door. The distribution boards shall have circuit chart tagged on the door for future maintenance. Danger notice plates shall be fitted to the distribution boards with screws and not stuck so as to assure its presence for a longer duration.

2.4.2.6 Internal wiring

A. Specifications

Rigid PVC And Flexible PVC Conduits:

All conduits shall be rigid PVC alloy low in halogens pipe having minimum wall thickness of medium gauge 1.6 to 2.0 approved by F.I.A. & I.S.I. and shall confirm to IS 9537 part 3 and complying with fire safety standards.

Up to 38 mm diameter in slab - minimum 1.8 mm. wall thickness.

Up to 38 mm diameter in floor - minimum 2.0 mm. wall thickness.

Above 40 mm. diameter - minimum 2.2 mm. wall thickness.

Flexible conduits shall be formed from a continuous length of spirally wound interlocked steel strip with a fused zinc coating on both sides. The conduit shall be terminated in brass adapters.

Accessories:

PVC conduit fittings such as bends, elbows, reducers, chase nipples, split couplings, plugs etc. shall be specifically designed and manufactured for their particular application. All conduit fittings shall conform to IS: 2667-1964 and IS: 3857-1966. All fitting associated with galvanized conduit shall also be galvanized.

Wires:

All wires shall be single core /multi-strand flexible copper or single strand Copper, PVC insulated FRLS grade as per IS: 694 and shall be 660 V\1100 V.

All wires shall be color coded as follows:

Phase	Color of wire
R	Red
Y	Yellow
B	Blue
N	Black
Earth	Green (insulated)
Control (If any)	Grey

Switches & Sockets:

Switches and sockets shall be modular type approved brands. Sockets shall be 3 OR 6 pins

with switch and Modular plate type cover. Combination of multiple switch units and sockets should be used to minimize the switch boxes.

For heavy duty, metal clad sockets with M.C.B / Isolator mounted in a galvanized steel box shall be provided.

Switch plate and box:

Plates of the same make, as that of switches shall be used with the modular range. Also M.S. boxes shall be taken as switch boxes.

B. Workmanship: -

The size of conduit shall be selected in accordance with the number of wires permitted under table given below. The minimum size of the conduit shall be 19/20 mm diameter unless otherwise indicated or approved. Size of wires shall not be less than 1.5 sq.mm. Copper or 2.5 sq.mm. Aluminum.

Nominal Cross sec. Area	20 mm		25 mm		32 mm		38 mm	
(mm ²)	S	B	S	B	S	B	S	B
1.50	4	3	8	6	15	9	--	--
2.50	4	2	6	4	10	8	--	--
4.00	2	2	4	3	8	6	--	--
6.00	1	--	4	3	6	6	--	--
10.00	1	--	3	2	5	4	6	5
16.00	--	--	1	1	2	2	5	4

S - runs of conduits which have distance not exceeding 4.25 m. between draw boxes & which do not deflect from the straight by an angle more than 15 degree.

B - runs of conduits, which deflect, from the straight by more than 15°.

Conduits shall be kept at a minimum distance of 100 mm. from the pipes of other non-electrical services. And maintain minimum 300 mm distance between telephones, TV & Computer piping.

Wiring for short extensions to outlets in hung ceiling or to vibrating equipment's, motors etc., shall be installed in flexible conduits. Otherwise rigid conduits shall be used. No flexible extension shall exceed 1.25 m.

Conduits run on surfaces shall be supported on metal 1.2 mm. thick G.I. pressure saddles which in turn are properly screwed to the wall or ceiling. Saddles shall be at intervals of not

more than 500 mm. Fixing screws shall be with round or cheese head and of rust-proof materials. Exposed conduits shall be neatly run parallel or at right angles to the walls of the building and shall be painted in color matching the adjoining area. Unseemly conduit bends and offsets shall be avoided by using fabricated mild steel junction/pull through boxes for better appearances. No cross-over of conduits shall be allowed unless it is necessary and entire conduit installation shall be clean and neat in appearance.

Conduits embedded into the walls shall be fixed by means of staples at not more than 500 mm. intervals. Chases in the walls shall be neatly made and refilled after laying the conduit and brought to the finish of the wall.

Conduits buried in concrete structure shall be put in position and securely fastened to the reinforcement and got approved by the Authority, before the concrete is poured. Proper care shall be taken to ensure that the conduits are neither dislocated nor choked at the time of pouring the concrete suitable fish wires shall be drawn in all conduits before they are embedded.

Where conduit passes through expansion joints in the building, adequate expansion fittings shall be used to take care of any relative movement.

Inspection boxes shall be provided for periodical inspection to facilitate withdrawal and removal of wires. Such inspection boxes shall be flush with the wall or ceiling in the case of concealed conduits. Inspection boxes shall be spaced at not more than 12 meters apart or two 90° solid bends or equal. All junction and switch boxes shall be covered by 6 mm clear plate. These junction boxes shall form part of point wiring or conduit wiring as the case may be including the cost of removing the cover for painting and re-fixing.

Conduits shall be free from sharp edges and burrs and the threading free from grease or oil. The entire system of conduits must be completely installed and rendered electrically continuous before the conductors are pulled in. Conduits should terminate in junction boxes of not less than 32 mm. deep.

Lighting & Power Wiring:

All final branch circuits for lighting and appliances shall be single conductor/ stranded/ flexible wires run inside conduits. The conduit shall be properly connected or jointed into sockets, bends, and junction boxes.

All circuits shall preferably be kept in a separate conduit up to the Distribution Board. No other wiring shall be bunched in the same conduit except those belonging to the same phase. Each lighting branch circuit shall not have more than ten outlets or 800 watts whichever is lower. Each conduit shall not hold more than three branch circuits.

Flexible cords for connection to appliances, fans and pendants shall be 650/1100 V grade

(three or four cores i.e. with insulated neutral wire of same size) with tinned stranded copper wires, insulated, twisted and sheathed with strengthening cord.

Looping system of wiring shall be used. Wires shall not be jointed. Where joints are unavoidable, they shall be made through approved mechanical connectors. No such joints shall be made unless the length of the sub-circuit, sub-main or main is more than the length of the standard coil. No reduction of strands is permitted at the terminations.

Control switches shall be connected in the phase conductors only and shall be 'ON' when knob is down. Switches shall be fixed in 3 mm. thick painted or galvanized steel/MS boxes with cover plates as specified. Cadmium plated brass screws shall be used.

Power wiring shall be distinctly separate from lighting wiring. Conduits not less than 20mm. and wires not less than 1.5 sq.mm. copper shall be used.

Every conductor shall be provided with identification ferrules at both ends matching the drawings.

Testing: the entire installation shall be tested for:

Insulation resistance.

Earth continuity.

Polarity of single pole switches.

General: All the wiring switch board, outlet points shall be done in a concealed manner in wall & slab in PVC conduit of minimum 20 mm dia. (medium gauge) & with 650v / 1100v grade PVC insulated flexible copper conductor wire. The switches should be modular with moulded cover plates, blank plates for outlet boxes. The accessories, connectors, sockets, should be fixed with brass chrome / cadmium plated machine screw. For fan points the regulator should be 300W with hum -free type as required to complete the point wiring. The wiring shall be as per IS: 732 and IS: 4648. The wiring shall be done in a looping manner so as to avoid junction boxes at any place. All the looping shall be done only in the switchboard and outlet points. The size of the wire shall be as per the specification. Color code shall be strictly followed.

The size of wires shall be followed as per given Electrical Distribution Diagram.

Separate pipes shall be laid for point wiring and circuit mains.

Circuit mains of same phase shall be drawn in one pipe with prior permission/discussion with the Authority.

Separate phase, neutral and earthing wire of sizes shall be drawn for each and every circuit main.

Mains for lighting and on-board plug points shall be of one-size higher wires than those used in off.

The point definition shall be conduiting and wiring from D.B. to S.B. and there from to final outlet point including switches and accessories, junction boxes, fan boxes, zarri work with cement –sand etc. of approved make.

C. SEPARATE CONDUITS/RACEWAYS

Separate conduits/Raceways shall be used for:

Separate **PVC conduits to be used for following services cable/wires**

- a) Normal lights and 5 A 3 pin sockets on lighting circuit.
- b) Power outlets - 15 A/20A 3/6 pin
- c) D.B. to switch board.
- d) Emergency lighting.
- e) Fire alarm system.
- f) T.V. Cable

Separate Conduit, Cable Tray and Raceways to be used for following services cable/wires

- a) Data and Telephone Cables.
- b) UPS and Raw Power Wires.

Separate Raceways shall be provided for UPS and Raw Power wiring, wires shall be taken through the Raceways supported to ceiling from the Distribution Board and drop to the nearest Brick wall / Partition wall and connected to UPS / Raw power sockets through the PVC conduit laid inside the wall or below floor.

2.4.2.7 Light fixtures

A. Specifications

Light fixtures with the catalogue numbers and makes shall be installed. The fixtures shall be complete with ballast and shall be prewired.

All outdoor fixtures should have high efficiency Lamp and same shall be confirmed by the Authority.

B. Workmanship

The fixture shall be installed on wall / ceiling with necessary accessories for surface, concealed, suspended from ceiling, bracket mounting etc. The job also includes connection of fixture with respective outlet point with heat resistant wires through heat resistance sleeve and PVC connector. The exhaust fan shall be installed complete with M.S. angle iron mounting frame/ ring, G.I. louvers, wire mesh and plug at the end of the cord including wiring & earthing etc. Proper earthing shall be provided to the fixtures

2.4.2.8 Earthing

All electrical equipment is to be earthed by connecting two earth strips from the frame of the equipment to a main earth ring. The earth ring will be connected via several earth electrodes.

Following equipment shall be earthed.

- a. Non-current carrying metallic parts of electrical equipment such as switchgear, bus ducts, rising mains, panel boards, motor control centers, power panels, distribution boards, cable trays, metal conduits etc.
- b. The shop drawing for earthing system shall be prepared by the Contractor based on the GFC drawing and be got approved by the Authority. The work shall be done in accordance with approved drawings.

A. Specification

i) Plate Electrode Earth Station: -

The earth electrode shall be plate of COPPER PLATE with Copper Strip of required size coming out to ground level.

The earth resistance shall be maintained with a suitable soil treatment. The resistance of each earth station should not exceed 5 ohms.

Where the above stated earth resistance is not achieved, necessary improvement shall be made by additional provisions, such as additional electrode(s), different type of electrode or artificial chemical treatment of soil etc. as may be directed by the Authority Engineer.

The earth lead shall be fixed to the pipe with a nut and safety set screws. The clamp shall be permanently accessible.

G.I. pipe with funnel of approved quality shall be used for watering the earth electrode \ station.

The block masonry chamber with Cast Iron hinged cover shall be provided for housing the above referred funnel and pipe.

The hardware and other consumable for earthing installation shall be brass or hot dip galvanized iron material as shown on the drawing.

ii) Earth Leads and Connections:

Copper lead shall have a phosphor content of not over 0.15%. At road crossing necessary Hume pipes shall be laid. Earth lead run on surface of wall or ceiling shall be fixed on saddles so that strip is at least 8 mm away from the wall surface.

The complete earthing system shall be mechanically and electrically bonded to provide an independent return path to the earth source.

B. Workmanship: -

Following activities shall be carried out for the earthing station

- Excavation in hard murrum.
- Laying Watering pipe.
- Brick masonry with hinged covers.
- Charcoal and Salt fill.
- Earth station should be **2** mt. away from wall of foundation
- Keep minimum **3.5** mt. distance between two earth pits.
- The pit should be minimum 10ft deep. (3.5 Mt.)
- The earth resistance should not exceed 5 ohm
- All earth pits of same category shall be interlinked with strip.

Following points shall be followed strictly.

The plate electrode, as far as practicable, shall be buried below permanent moisture level

but in no case not less than 3.5 M below finished ground level.

The plate 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.

20-40 mm. dia. G.I. pipe for watering, shall run from top edge of the pipe electrode to the mid-level of block masonry 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 to 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 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 inside the building shall properly be clamped / supported on the wall with Galvanized Iron clamps and Mild Steel Zinc Passivated screws / bolts. The conductors outside the building shall be laid at least 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 equipment 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.

Additional equipment earthing shall be done with Cu strip / Bare Cu Wire.

Lightening arrestors shall be installed at topmost point of the building. The quantity for the same shall be designed & specified to cover total building area. Early streamer emission type arrestor shall be connected to separate earth pit with Cu Strip.

Following tests shall be carried out:

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 stations
- ◆ Earthing system as a whole
- ◆ Earth continuity conductor

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.

C. Marking:

- i. Earth bars/terminals at all switch boards shall be marked permanently with suitable nomenclature
- ii. Main earthing terminals shall be marked "SAFETY EARTH-DO NOT DISCONNECT"

2.4.3 Testing of installation works

2.4.3.1 Scope

This chapter describes the details of tests to be conducted by the Contractor in the completed internal electrical installations, before commissioning. All test report shall be submitted to the Authority's Engineer.

2.4.3.2 General

2.4.3.2.1 Tests

On completion of installation, the following tests shall be carried out: -

- 1) Insulation resistance test.
- 2) Polarity test of switch.
- 3) Earth continuity test.
- 4) Earth electrode resistance test.

2.4.3.2.2 Witnessing of tests

Testing shall be carried out for the completed installations, in the presence of and to the satisfaction of the Authority's Engineer by the Contractor. All test results shall be recorded and submitted to the Authority.

2.4.3.2.3 Test instruments

All necessary test instruments for the tests shall be arranged by the Contractor if so, required by the Authority's Engineer.

2.4.3.3 Insulation resistance

2.4.3.3.1 The insulation resistance shall be measured by applying between earth and the whole system of conductors, or any section thereof with all fuses in place, and all switches closed, and except in earthed concentric wiring, all lamps in position, or both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure, provided it need not exceed 500 volts for medium voltage circuits. Where the supply is derived from a three wire D.C, or a polyphase A.C. system, the neutral pole of which is connected to earth either directly or through added resistance, the working pressure shall be deemed to be that which is maintained between the phase conductor and the neutral.

2.4.3.3.2 The insulation resistance shall also be measured between all the conductors connected to one pole, or phase conductor of the supply, and all the conductors connected to the neutral, or to the other pole, or phase conductors of the supply with

all the lamps in position and switches in "off" position.

- 2.4.3.3.3 The insulation resistance in mega ohms measured as above shall not be less than 12.5 mega ohms for the wiring with PVC insulated cables, subject to a minimum of 1 mega ohm.
- 2.4.3.3.4 Where a whole installation is being tested, a lower value than that given by the formula, subject to a minimum of 1 mega ohm, is acceptable.
- 2.4.3.3.5 A preliminary and similar test may be made before the lamps etc. are installed, and in this event the insulation resistance to earth should not be less than 25 mega ohms for the wiring with PVC insulated cables, subject to a minimum of 2 mega ohms.
- 2.4.3.3.6 The term "outlet" includes every point along with every switch, except that a switch combined with a socket outlet, appliance or lighting fitting is regarded as one outlet.
- 2.4.3.3.7 Control rheostats, heating and power appliances and electric signs may, if required, be disconnected from the circuit during the test, but in that event the insulation resistance between the case or frame work, and all live parts of each rheostat, appliance and sign, shall be not less than that specified in the relevant Indian Standard Specifications, or where there is no such Specification, shall be not less than one mega ohm.

2.4.3.4 Polarity test of switch

- 2.4.3.4.1 In a two-wire installation, a test shall be made to verify that all the switches in every circuit have been fitted in the same conductor throughout, and such conductor shall be labeled or marked for connection to the phase conductor, or to the non-earthed conductors of the supply.
- 2.4.3.4.2 In a three wire or a four-wire installation, a test shall be made to verify that every non-linked single pole switch is fitted in a conductor which is labeled or marked for connection to one of the phase conductors of the supply.
- 2.4.3.4.3 The installation shall be connected to the supply for testing. The terminals of all switches shall be tested by a test lamp, one lead of which is connected to the earth. Glowing of test lamp to its full brilliance, when the switch is in "on" position irrespective of appliance in position or not, shall indicate that the switch is connected to the right polarity.

2.4.3.5 Testing of earth continuity path

The earth continuity conductor, including metal conduits and metallic envelopes of cables in all cases, shall be tested for electric continuity. 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 shall not exceed one ohm.

2.4.3.6 Test certificate

On completion of an electrical installation (or an extension to an installation), a certificate shall be furnished by the Contractor's Representative. This certificate shall be in the prescribed form as provided in the National Building Code of India, PART 8 BUILDING SERVICES – SECTION 2 ELECTRICAL AND ALLIED INSTALLATIONS, ANNEX E, (Clause 9.3.2.6), FORM OF COMPLETION CERTIFICATE (REFER NBC Latest Edition).

2.4.4 Technical specification for HVAC

2.4.4.1 General requirements

- a. Supply, installation, testing and commissioning of VRV/VRF cassette type indoor system with capsule AC units (4-way)
- b. All the VRF air conditioners shall be fully factory assembled, wired, internally piped & tested. The outdoor unit shall be pre-charged with first charge of refrigerant. Additional charge shall be added as per refrigerant piping at site.
- c. All equipment and valve connections etc. shall be through flanges / unions as required for mating connections.
- d. All welding of piping is subject to approval of Authority.
- e. Piping material shall be as per technical specifications.
- f. Piping shall be given one primary coat of Red Oxide / Zinc Rich Primer paint (As per piping material requirement) and given two (2) coats of finish paints of approved shade after installed. Pipes shall be sloping towards drain points.
- g. Piping shall be properly supported or suspended from brackets, hangers, stand, clamps etc. as per site requirement. The supports shall be steel, prime coated with rust preventive paint and given two (2) coats of finish paints.
- h. All fitting such as branches, reducers etc. shall have same dia. & thickness as the main pipe and its length shall be at least twice the pipe diameter.
- i. Blank ends shall be formed with flanged joints with blank between flange pair.
- j. Valves/capped connection shall be provided for all low points in piping system, necessary or required for draining all systems and also to permit repairs without interference with rest of the system.
- k. During construction, open ends of pipes shall be temporarily closed with sheet metal caps to prevent debris from entering piping system.
- l. Drain valves shall be provided at all low point in piping system and shall be minimum 25 mm size.
- m. All pipes, supports, fittings etc. shall be given two coats of red oxide & then two (2) coats of finish paint in approved shade/color. All work of indication on piping, valves etc. shall be carried out by the contractor including proper labeling. Color coding and arrow marking.

2.4.4.2 VARIABLE REFRIGERANT VOLUME/ FLOW SYSTEM

The system selected is a modular system, with number of indoors connected to centrally located outdoor units. The outdoor units for all the system shall be air cooled type, variable refrigerant volume air conditioner consisting of an outdoor unit and multiple indoor units. Each indoor unit shall have the capability to cool independently for the requirement of

the rooms.

Compressor installed in each modular outdoor unit shall be equipped with multi inverter compressors for higher reliability, improved life, better backup and duty cycling purpose. The system shall be capable of changing the rotating speed of inverter compressor by inverter controller to follow variations in cooling and heating load.

Outdoor unit shall be suitable for mix match connection of all type of indoor units.

Both indoor units and outdoor unit shall be factory assembled, tested and filled with first charge of refrigerant before delivering at site.

2.4.4.2.1 OUTDOOR UNITS

- i. The outdoor unit shall be factory assembled, weatherproof casing, constructed from heavy gauge mild steel panels and coated with baked enamel finish.
- ii. Outdoors units of the VRV system shall be compact air-cooled type.
- iii. The outdoor unit should comprise of Inverter controlled Twin Rotary Compressor / Scroll Compressor
- iv. Each module of outdoor unit must have at least 50 % of Variable compressor which can work on Part load Suitable to operate at heat load proportional to indoor requirement.
- v. The outdoor units must be suitable for up to 225 m refrigerant piping between outdoor unit & the farthest indoor units. Allowable level difference between outdoor unit & indoor units shall be 50 m in case of outdoor unit on top & 40 m in case of outdoor unit at bottom.
- vi. Allowable level difference between various indoor units connected to one outdoor unit shall be up to 15 m.
- vii. The outdoor units shall be suitable to operate within an ambient temperature range of 5 Deg C to 43 Deg C in cooling mode; & -20 Deg C to 15 Deg C in heating mode.
- viii. The entire operation of outdoor units shall be through independent remotes of indoor units. No separate Start/ Stop function shall be required.
- ix. Complete refrigerant circuit, oil balancing/ equalizing circuit shall be factory assembled & tested

2.4.4.2.2 INDOOR UNITS

The units include pre-filter, fan section and DX coil section. The housing of units shall be light weight powder coated galvanized steel. Units shall have external casing of ABS Plastic for supply and return air.

Indoor units shall be ceiling mounted cassette type indoor system with capsule AC units (4-way). Each unit shall have electronic control valve to control refrigerant flow rate respond to load variations of the room.

The address of the indoor unit shall be set automatically in case of individual and group control. In case of centralized control, it shall be set by remote controller.

The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/mechanically expanded for minimum thermal contact resistance with fins.

The capacity of the AC shall be 40 tons.

i) Concealed duct type units

- a. These units shall be ceiling suspended with suitable supports to take care of operating weight of the unit, without causing any excessive vibration & noise.
- b. The cold air supplied by these units will be supplied to the area to be airconditioned, through duct system specified in the tender.
- c. Each indoor unit must have electronic expansion valve operated by microprocessor thermostat-based temperature control to deliver cooling/ heating as per the heat load of the room
- d. The Sound Pressure level of unit at the highest operating level shall not exceed 38 dB (A), at a vertical distance of 1.5 m below the units with duct connected to the unit.
- e. The unit must have provision of adding drain pump kit if required & specified. The drain pump must be suitable to lift drain up to 750 mm from the bottom of the unit.

ii) Installation

- a. The units shall be mounted on ribbed rubber pads for vibration isolation. The contractor shall supply the required charge of refrigerant, lubricant and other consumables, for commissioning and testing of the equipment.
- b. All the equipment shall be thoroughly tested and checked for leaks. All safety controls shall be suitably set, and a record of all setting shall be furnished to the project supervisor.
- c. Providing and fixing structural support for condensing unit with vibration isolator pad in-between support and structure and vibration isolation suspender and pads for evaporating units shall be in scope of contractor.

iii) Painting:

Shop coats of paint that have become marred during transportation or erection shall be cleaned off with mineral spirits, wire brushed, and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop-painted surfaces.

iv) Refrigerant Piping

- a. All refrigerant pipes and fittings shall be type 'L' hard drawn copper tubes and wrought copper fitting suitable for connection with silvers older. The copper thickness of wall shall be 20G/ 22G(0.7 to 1mm)
- b. All joints in copper piping shall be swaged joints using low temperature brazing and/ or silver solder. Before joining any copper pipe or fittings, its interior shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while construction of the joints. Subsequently, it shall be thoroughly blown out using nitrogen.
- c. All refrigerant piping shall be installed strictly as per the instructions and recommendations of air conditioning equipment manufacturers.

2.4.4.3 AIR HANDLING UNITS

2.4.4.3.1 General

The AHUs shall be ceiling suspended. The unit shall comprise of various sections such as Pre-filters, cooling coil, fan, motor etc.

AHUs shall have hinged quick-opening insulated access door on fan and filter sections. Access doors shall be double skin type.

All connecting fasteners and related hardware and its accessories shall be in stainless steel.

Casing shall be of air-tight construction and sufficiently rigid to exclude vibrations, throughout the working capacity range of the AHU.

Cooling Coils

The coil section of the AHU shall be of Fin and tube construction, removable from the side of the casing and supported over the entire length of the coil. Fins shall have collars, belled and firmly bonded to the tubes by having the tubes mechanically expanded into the fins. The number of fins provided should be the minimum needed to meet the performance requirements to minimize the pressure drop across the coil. Coil casing shall be 1.5mm thick galvanized, steel with drain holes in the bottom channels to insure condensate drainage. Coil tubes shall be copper mechanically expanded into aluminum plate fins. No soldering or tinning shall be used in the bonding process. Coils shall be mounted in the unit casing on non- corrosive aluminum slide rails to allow for easy removal when required.

2.4.4.3.2 FAN

The fan section of the AHU shall be of rigid constructions, with the fan scroll and bearings mounted on a frame rigidly secured to a formed channel base. Fans shall be of the double – width, double – inlet centrifugal type with Forward curved airfoil blades.

2.4.4.3.3 Filter Section

Each unit shall be provided with a factory assembled filter section containing washable synthetic type air filters media with an efficiency of 95% down to 20-micron filtration mounted on Aluminum Frame. Filter banks shall be easily accessible and designed for easy withdrawal and

replacement of filter cells.

2.4.4.3.4 DAMPERS

Dampers shall be opposed blade type. Blades shall be made of double skin airfoil extruded aluminum sections with integral gasket and assembled within a rigid extruded aluminum or nylon, turning in Teflon bushes.

2.4.4.3.5 NOISE LEVEL

The noise level inside the AHU room should be less than 65 dBA at 1.5 M.

2.4.4.3.6 OTHERS

The AHU shall be provided with the following accessories

- Bulkhead lamp,
- Inspection windows,
- Limit switch.

2.4.4.4 SHEET METAL DUCT WORK

2.4.4.4.1 Material requirement

Ducting shall be fabricated from Galvanized steel sheet (GSS). GSS duct shall be Machine Fabricated zinc coated conforming to IS 277.

2.4.4.4.2 CONSTRUCTION FEATURES

Fabrication details shall be generally in accordance with the details given here under;

LARGER SIDE OF DUCT mm	THICKNESS OF SHEET mm/G		TYPE OF REINFORCEMENT
	GSS / SS	AL	
Up to 250	0.63 / 24	0.80 / 22	As per SMACNA
251 to 750	0.63 / 24	0.80 / 22	
751 to 1000	0.80 / 22	1.00 / 20	
1001 to 1500	0.80 / 22	1.00 / 20	
1501 to 2100	1.00 / 20	1.25 / 18	
2101 to 2415	1.25 / 18	1.50 / 16	
Greater than 2401	1.25 / 18	1.50 / 16	

2.4.4.4.3 DUCT SUPPORTS and HANGERS

Rectangular duct shall be supported from ceiling using trapeze hangers. Ducts shall rest on

supporting GI Slotted angle or channel. The supporting angle or channel shall be supported by GI continuous threaded rods.

Steel anchor fasteners shall be provided by Contractor for duct hanging. Anchor fasteners shall be loaded to maximum 20% of the maximum rated capacity specified by the manufacturer. Authority's Engineer shall approve all anchor fasteners used for supporting duct.

2.4.4.4.4 TRANSFORMATION

Duct transformation shall be used to change the shape of duct and shall be made for easy and noiseless flow of air. Maximum slope of transformation shall be 1:4.

2.4.4.4.5 BENDS, OFFSETS and BRANCH CONNECTIONS

All bends, offsets and branch connections shall be made for smooth and noise less flow of air and minimum pressure drop. In case of full radius elbow optimum ratio of centerline radius of elbow to duct dimension of 1.25 shall be considered. However, due to space constraint shorter radius constraint shorter radius elbow or square elbow with guide vanes may be provided. Contractor shall furnish the details of guide vanes i.e. number of vanes, location etc. in the drawing. The flow of air to the branch duct shall be regulated by a splitter damper or volume control damper.

2.4.4.4.6 DIFFUSERS AND GRILLES

The type and quantity of diffusers and grilles shall be aluminum extruded powder coated type. The contractor shall ensure that the diffusers and grilles offered are of requisite capacity, throw and terminal velocity. Whenever VCD is provided with diffusers or grilles it shall be located within the duct collar. Diffusers and grilles shall be of flush pattern.

The extruded aluminum diffusers shall be provided with removable central core and concealed key operation for volume control damper. Slot diffuser shall be of extruded aluminum construction multi-slot type with air pattern controller provided in each slot. Supply air slot diffusers shall be provided with hit and miss VCDs in each slot. All diffusers, grilles and registers shall be of extruded aluminum construction, and epoxy powder coated.

2.4.4.4.7 VCDS

Contractor shall supply and install all dampers where necessary for proper control of volume and balancing of air distribution system. These dampers shall be separate from any other dampers provided with supply and return air diffusers, registers and grilles.

A multi leaf opposed blade type damper shall be installed in each supply air duct / return air duct / fresh air entry near the air handling unit outlet to adjust the total supply air cfm.

Dampers shall be of rigid construction free of all rattling and vibrations with edges crimped or creased for stiffness. It should be possible to adjust and lock the damper in any position. Fully open and fully closed position shall be clearly marked for ease in operation.

Dampers shall be provided with Teflon or brass bushings for blade shaft.

VCD (manual or motorized) shall be measured by their cross-sectional area perpendicular to air

flow.

Quoted rates shall include necessary collars and flanges for mounting etc. No special allowance shall be payable for extension of cross-section outside the air stream. Volume control dampers in supply and exhaust fan units are part of fan units and no separate payment will be made for the same.

2.4.4.4.8 INSULATION

For Ducting – Thermal insulation

- Insulation material shall be Closed Cell Elastomeric Nitrile Rubber.
- Insulation material shall have Microban Certified anti-microbial product protection. The antimicrobial product protection shall be an integral part of insulation that is built-in during the manufacturing process and the product protection should not allow the microbes to function, grow and reproduce.
- Thickness of the insulation shall be as specified for the individual application.

For Ducting – Acoustic insulation

Material shall be processed Open Cell Nitrile Rubber foam. The material should be fiber free. Thickness of the material shall be as specified for the individual application.

2.4.4.5 MODE OF MEASUREMENT

Sheet Metal Work

- A. Ducting
 - i. All sheet metal ducting work will be measured in terms of final sheet area installed in Sq. Meters.
 - ii. No measurement of vanes, splitters, deflectors, access doors, etc. which are required to be installed in the duct work shall form part of the duct work.
 - iii. Duct fittings such as bends, elbows, tap-off, collars, transformation pieces etc. shall be treated as ordinary duct pieces with their length measured along their center line.
 - iv. No duct supports, stiffening, members, etc. shall be measured separately. All such supports/hangers shall form part of duct work.
 - v. Equipment connections such as canvas/asbestos/resin shall be deemed to be part of the duct work and no separate measurement will be allowed.
- B. Grilles/Diffusers

All grilles/Diffusers will be measured in terms of effective area.
- C. Dampers
 - i. All duct dampers shall be measured in terms of effective area in Sq. meters.
 - ii. Fire dampers will be measured in terms of effective area in Sq. meters.

- iii. Fresh air /exhaust air dampers will be measured as (ii) above. No separate measurement will be made for inlet/outlet louvers, bird screen etc.

D. Piping

- i. Piping will be measured in running length (meters)
- ii. No special measurement of bends, elbows, reducer, expanders ,tees, cross etc. will be made. All such fittings/accessories will be treated as normal piping.
- iii. The length of piping including accessories and fittings will be measured along the center line of piping.
- iv. No measurement for flange, shall be made. All flanges shall form part of piping work.
- v. No measurement of pipe supports, hangers, anchors, etc. will be made. All such items shall be deemed to form part of piping work.

E. Insulation

a. Ducting Insulation

- i. Ducting insulation will be measured on the basis of center line of insulation and not the outer line of insulation.
- ii. No special measurement shall be made for insulation of bends, transformation pieces, tap off, elbows etc. All such insulation shall be treated as standard duct insulation.
- iii. Insulation item shall include all accessories and finishes as specified. No separate measurement will be made for such items.

2.4.4.6 LIST OF BUREAU OF INDIAN STANDARDS CODES

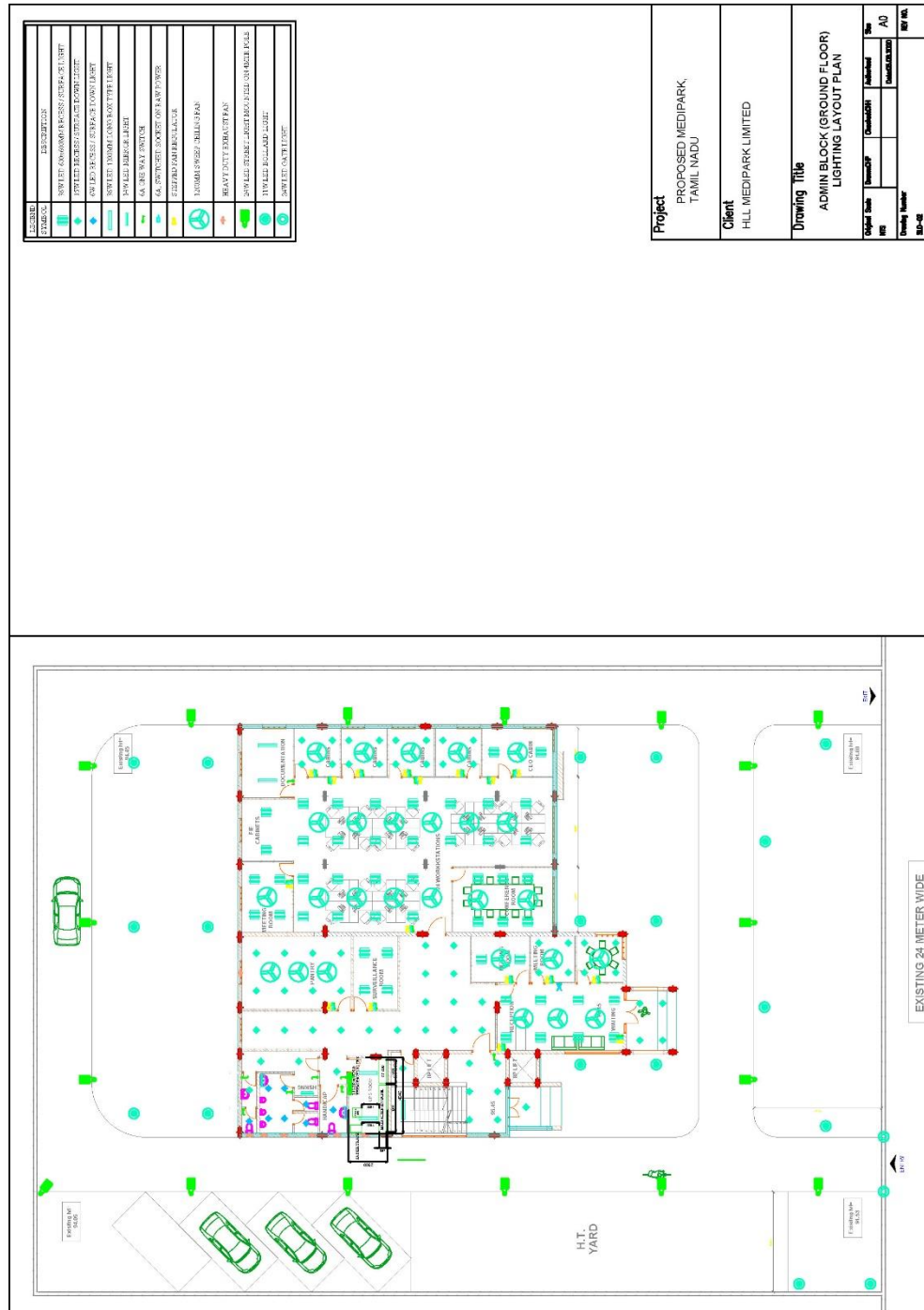
Following relevant IS codes shall apply read in concurrence –

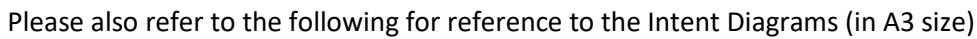
IS:226 - 1975 Specification for structural steel
 IS:277 - 1992 Specification for galvanized sheet (plain and corrugated) required on the threads.
 IS:325 - 1978 Specification for three phase induction motors
 IS:554 - 1975 Dimensions for pipe threads where pressure tight joints are
 IS:655 - 1963 Specification for metal duct
 IS:659 - 1964 (1991) Safety code for air-conditioning (revised)
 IS:660 - 1963 (1991) Safety code for mechanical refrigeration
 IS:778 - 1984 Specification for copper alloy and gate , globe & check valves for waterworks
 IS:780 - 1984 Specification for sluice valves for water works (50 to 300 mm sue)
 IS:800 - 1984 Code of practice for general construction in steel
 IS:808 - 1964 Specification for rolled steel beam channel and angle section
 IS:816 - 1969 Code of practice for metal arc welding for general purpose in mild steel
 IS:823 - 1964 Code of procedure for manual metal arc welding of mild steel

IS:1239 - 1979 (Part I) MS tubes, tubular and other wrought steel fittings 1990
IS:1239 - (Part 2) -1992MS tubes tubular and other wrought steel fittings
IS:1536 - 1976 Flanges configuration
IS:1554 - (Part 1) -1976Specs for PVC insulated (heavy duty electrical cables)
IS:2253 - 1974 Designation for types of construction and mounting arrangement of rotating electric machine.
IS:2312 - 1967 Specs for propeller type AC ventilating fans
IS:2379 - 1963 Colour code for the identification of pipelines
IS:3103 - 1975 Code of practice for Industrial Ventilation
IS:4064 - (Part -II) 1978 Specific requirements for the direct switching of individual motors.
IS:4736 - 1968 Hot-dip zinc coatings on steel tubes
IS:4894 - 1987 Test Code for Centrifugal Fan.
IS:7240 - 1981 Application & Finishing of thermal insulation material
IS:8544 - (Part-IV) 1979 Starters
IS:9224 - (Part II) -1979 HRC cartridge fuse links upto 650 volts.
IS:3069 - 1965 Glossary of terms, symbols and unit relating to thermal insulation material

2.5 List of approved makes - electrical, networking, CCTV works

S. No	ITEM NAME	VENDORS
1	MCCB / ACB	SCHNEIDER, LEGRAND, ABB, C&S, SIEMENS, HAVELLS, L & T
2	MCB/RCCBs/ELCBs/RCBOs/ELMCB	SCHNEIDER, LEGRAND, ABB, C&S, SIEMENS, HAVELLS, L & T
3	CHANGE OVER SWITCH (AUTO / MANUAL)	L&T, C&S, HPL SOCOMEC, HAVELLS
4	FRLS PVC INSULATED COPPER WIRES/CABLES (UNARMoured)	FINOLEX, HAVELLS, KEI,
5	MDM (MULTIDATA METERS) / MEASURING INSTRUMENTS	ELMEASURE, L & T, SCHNEIDER
6	EXTERNAL LED LUMINAIRE	HAVELLS, LIGHTING TECHNOLOGIES, PHILIPS, BAJAJ, EVEREADY, CROMPTON
7	LT PANEL/PCC/MCC/MCBS/APFC/PANELS/CONTROL PANELS	CPWD APPROVED VENDORS - VV SYSTEMS AND POWER PANELS PVT. LTD. / PACE SWITCHGEARS PVT. LTD/ IMPERIAL ELECTRO CONTROL PVT. LTD.
8	RESIN CAST CURRENT TRANSFORMER	AE, KAPPA, KALPA
9	LT CABLE	LASER, HAVELLS, POLYCAB, KEI, AVOCAB, RR CABLE
10	AUTOMATION POWER FACTOR CONTROL RELAY	NEPTUE, BELUK, EPCOS,
11	CAPACITORS	NEPTUNE, EPCOS, SCHNEIDER, ABB
12	CABLE GLANDS (DOUBLE COMPRESSION WITH EARTHING LINKS) / CRIMPLING LUGS	DOWELLS, COMET, BRASCO, HMI
13	CABLE JOINTING KITS	RAYCHEM, JAINSONS, 3M, DENSONS, XICON/BIRLA
14	CONTACTORS	SIEMENS, SCHNEIDER, C&S, ABB
15	EARTH LEAKAGE RELAY	ELMEASURE, L & T, SCHNEIDER
16	PUSH BUTTONS	L&T, SIEMENS, BCH, C&S, ESSEN DEINKI, TEKNIC, ABB
17	SELECTOR SWITCHES & ROTARY SWITCHES	KAYCEE, L&T, SIEMENS, GE, VAISHNO, SALZER, BCH, ABB
18	INDICATING LAMPS	SIEMENS, L&T, VAISHNO, RAAS CONTROLS, TEKNIC, C&S, KAYCEE, ABB
19	TERMINALS	ELMEX, WAGO, CONNECTWELL
20	NETWORKING SYSTEM	LEGRAND, SCHNEIDER, NETRACK, NETGARE, REPUTED
21	CCTV SYSTEM	HONEYWELL, HIKVISION,





Schedule number	Reference number	Title
8	7.3	Administrative building – Lighting layout
8	7.4	Administrative building – Power layout
8	7.5	Administrative building – Single line diagram

3. Water works for Administrative Building

3.1 Design Brief

Administrative Block Internal Toilet Layout

The Internal toilet fixtures are provided as per the standards

Toilet Block

- EWC with tank with inlet and outlet controls
- Health faucet with angle valve
- Wash basin with Pillar cock, waste coupling and connection pipes with complete fittings.
- Toilet internal with floor trap and P-trap of PVC connectors and fitting.
- Towel ring and complete fixing.
- Urinals with waste coupling and with inlet and outlet connections.

Pantry Area

- Pantry sink with tap and connectors
- Water waste coupling and connections
- Angle valve with control system.
- Ro water point and provision with control valve.
- Complete internal works

Toilet Internal Water Supply Piping

- For supply of water supply internal pipes proposed with SDR11- CPVC pipes and fittings and complete connectors.
- Concealed stop cork to be provide for internal master control valve
- Standard Pressure to be maintained at every fixture as per standards.

Toilet Internal Waste and Soil Piping

- Internal toilet waste to be provided with PVC pipes of 6kg/cm².
- Internal toilet sewer to be provided with PVC pipes of 6kg/cm².
- Internal floor traps for easy maintenance with all connectors to be provide.
- Standard flow to be maintained at every fixture as per standards.

3.2 Water requirement calculation for Admin Block

Sl.No	Description	OFFICE AREA (in Sq. Ft)	OFFICE AREA (in Sq. Ft)	Total No of persons
1.	Ground floor	6500 (Approx.)	100 sq. Ft per Person	65 Persons
2.	First floor	6500.00	100sqft per Person	65 Persons
3.	Second floor	6500.00	100sqft per Person	65 Persons
			Say	195 Persons

1. Domestic Water Demand

Say = 200 persons

i) For Office users

@ 45 Lit /capita /day = 200 @ 45
= 9000 Ltrs

SAY = 9000 Ltrs

ii) Visitors @ 15 Lit/capita/day = 25 @ 15
(Considering 10% of office users as visitors)

iii) Miscellaneous (servant, Security, Drivers, Wastages) = **1000 Ltrs**
(Considering 10% of office users)

Total Water Required Per Day = **10,000 Ltrs per day**

2. Water Storage

Underground tanks / sumps are proposed for collecting and storing of tanker water before use. It is proposed to construct an underground sump of:

- Sources of Water : From the Centralized Treated UG sump (Palaar River)
- Raw water sump : **10,000 Ltrs / day.**

Raw Water sump : size: 3.00 x 2.50 x 2.0 + 0.3FB.

Note : Treated water from the main source are filtered water, so the admin block filtration is not required. (Only water sump considered for 1.0 Days Storage)

Total population is proposed considered in future upper 2 floors as per the requirement. The water requirement for all the Blocks of the campus has been worked out as per SP-35 and National Building Code (NBC). The requirement is enclosed as ANNEXURE – I. **45lts / capital /day** (35lts for Domestic and 15lts for Flushing/ Floating population) will be the basis for working out the requirement of water.

The water supply and drainage system is designed to provide reliability, easy maintainability and most hygienic conditions for the proposed Building

It is proposed to collect Water from the existing filter water sump, line provided from the

centralized main header line from the proposed OHT, Supply water will be collected in the Underground collection tank (Cap-10,000) and Capacity of water sump is for 1 day storage). Water from this Underground sump is pumped to through a pump to terrace level PVC sintex tank for toilet usage purpose.

The entire Water supply distribution network will be carried out by using CPVC and CPVC pipes.

Internal Cold Water supply : CPVC SDR 13.5 or 11.0

External Cold Water supply : CPVC SDR 13.5 or 11.0

Ball valve at every floor level is being proposed for effective controlling of the distribution system and isolating the particular area at times of maintenance

The quality of water supplied to the building is in accordance with the requirements specified in IS: 10500- 1991- Drinking Water Specifications, depending on the analysis of the water, the treatment scheme shall be worked out.

3. Water Supply Distribution System

Distribution System for Domestic Purpose: Gravity System from terrace level.

The sizing of the entire distribution network is based on the simultaneous use of fixture unit's demand. A shut off valve is provided within the battery limit of each block, which serves for the purpose of maintenance of any utility. Air release valves and water hammer arrestors shall be provided as per requirement of the design.

4. Drainage Collection & Disposal System

Source : From toilets area

Sewage disposal : Centralized STP

- **Sanitary Fixtures, Fittings & Accessories**

Floor mounted / Wall Mounted WCs have been proposed with flush tank for all toilets Rectangular basins have been proposed in Master bedroom & club house area and Rectangular wash basins with pedestal in other toilets with necessary control valves, brackets and supports. Two in one mixers are proposed for in all toilets with low pressure CP fittings to all toilet area.

- **Design Methodology**

Diameter of horizontal pipes and vertical stacks for soil pipes and waste pipes have been arrived at adopting the loading units as recommended in SP 35 – Handbook on Water Supply and drainage. All necessary appurtenances like manholes, drop manholes etc. shall be provided for the efficient functioning of the sewerage system compiling with the relevant authority's requirements.

- **Internal Sewerage System**

Soil and wastewater from water closets and toilets shall be collected by Double -pipe system.

Soil pipes are proposed to be connected to manholes and waste pipes from kitchen are connected to gully trap and then to manholes. Minimum diameter of soil pipe is 110 mm and waste pipe is 75.

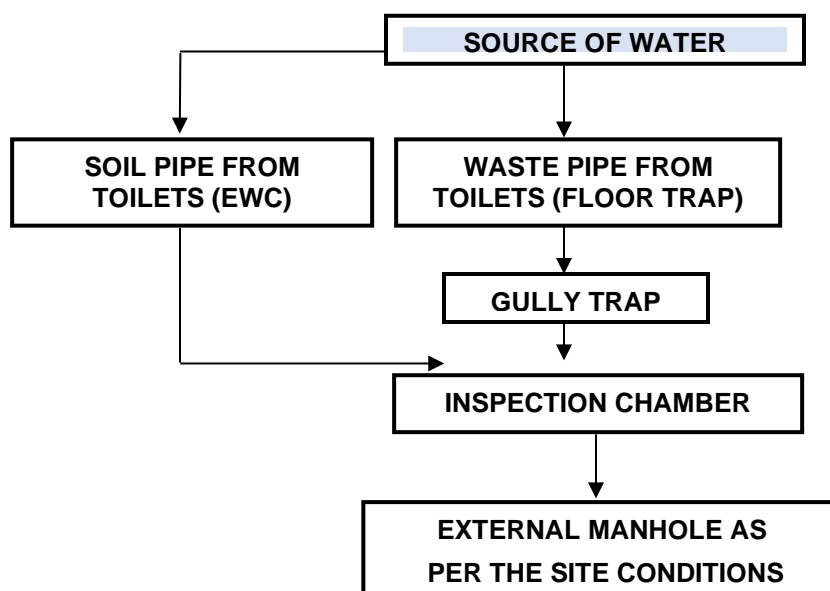
- **External Sewerage System**

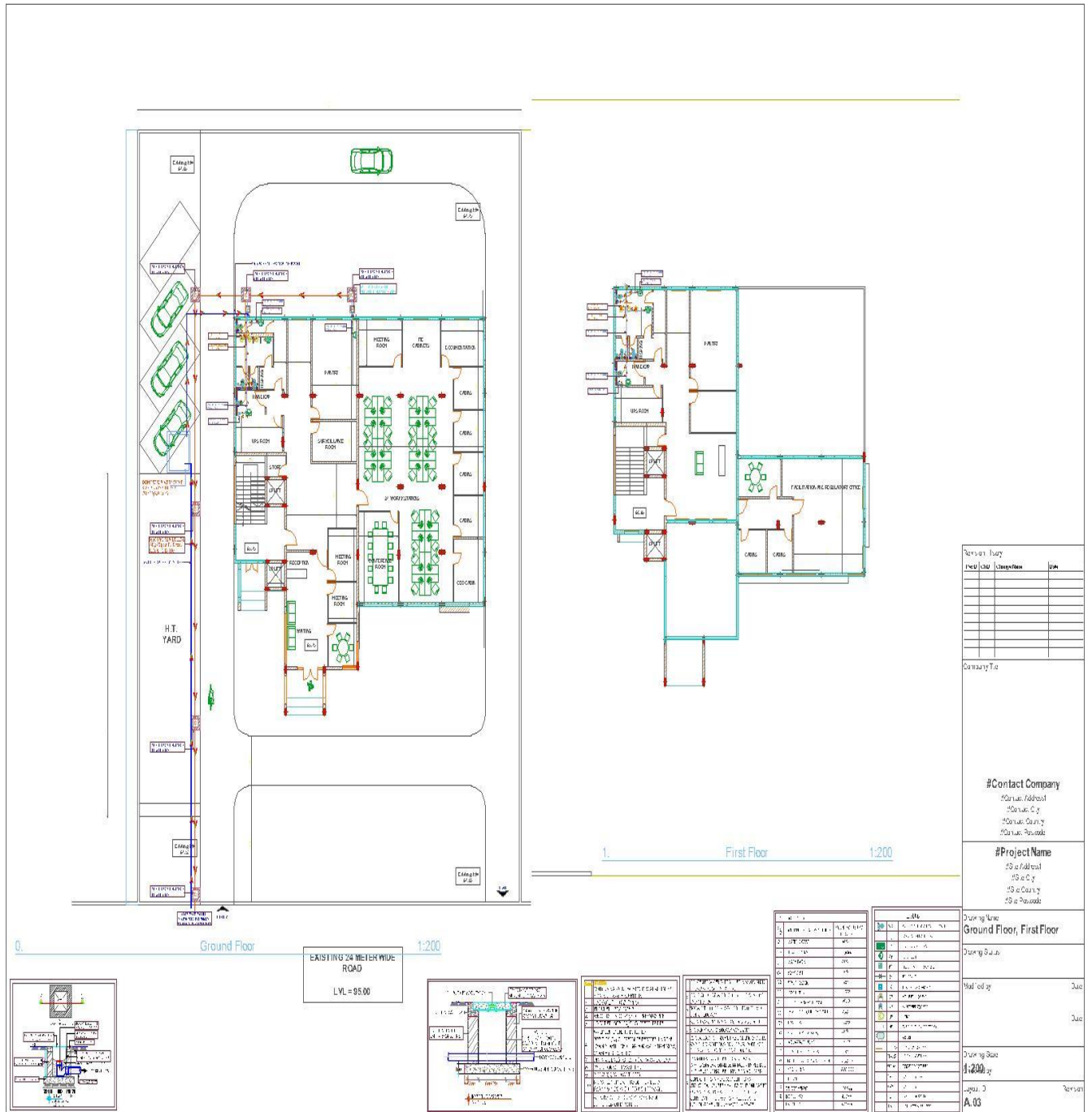
All the soil and waste coming from toilets & kitchen will be collected in the vertical shaft by providing Double stacks for toilets and single waste stacks for kitchen. Waste stacks will be connected to gully trap chambers and soil stacks will be connected to the Inspection Chambers wherever required. All the Inspection chambers are further connected with the pipes of required sizes, which will be laid at necessary gradient. Minimum diameter of external sewer is kept as 110/160 mm

5. Sewage Collection and Disposal

- The sewerage system shall be designed as two pipe system as per IS specifications, with ventilating the soil stack separately.
- The soil and waste stacks also continues till roof level inside the shaft and thus provides for additional venting.
- Deep seal traps i.e. of 75mm water seal shall be provided for floor drains and urinal traps, with nahani traps for kitchens and balconies connected to rainwater pipes.
- The soil stack will be connected to an Inspection chamber located near to the periphery of the building close to the shaft endings.
- The waste pipe will be connected to the inspection chamber through a gully trap to avoid odour nuisance. The combined sewage will be conveyed through a network of pipes to the Sewage Treatment Plants, which are located at the periphery of the site.
- The minimum diameter of the vertical soil stack shall be 110mm. All fixtures and appliances shall be fully trapped to prevent back flow of foul gases and odour into the toilets.
- The sewage from the soil stack shall be connected to the sewer header running below ground level with adequate slope to achieve the smooth flow in the system.

Schematic Diagram of Drainage Disposal System





6. Water supply Fittings

All water supply fittings (including mixer fittings accessories) shall be brass / copper, heavy chromium plated, of the make and design specified. The fittings shall be cast fittings of screw type, machined and threaded properly for fixing to the supply pipes.

The plating shall conform to Indian standard specification IS 4827 –1968 electroplated coating of nickel and chromium on copper alloys.

The fittings shall be supplied complete with chromium plated matching flanges, nuts and extension pieces of required lengths. Metallic washers where required shall also be of chromium plated brass. All bib cocks and stop cocks shall conform to Indian standard specifications IS: 781 – 1984 (second revision) bib taps and stop valves for water services, sand cast brass screw – down (revised) pillar cocks to IS: 8934 – 1978 – pillar taps, mixing fitting to IS: 1701 – 1960 mixing valves for ablutionary and domestic purpose. Both filler, shower arm, rose spout and other fittings shall match the supply fittings in construction, performance and appearance.

All fixing accessories and screws shall be similar to fittings with all exposed parts chromium plated. All washers shall conform to Indian standard specification IS: 4326 – 1967 washers for water taps for cold water services.

- **Floor Traps**

Floor traps shall be of PVC of the size required, of approved design incorporating a deep seal (6cm. minimum) and venting device unless otherwise indicated. All PVC floor traps in general /unless otherwise specified, shall be of molded type only. The traps shall be supplied with cast iron / PVC cap with collar capable of receiving a grating.

- **Ball Float Valves**

The ball valve shall be of high-pressure type and shall be of sizes as specified. The normal size of a ball valve shall be that corresponding to the size of the pipe to which it is fixed. The ball valve shall be of brass or gun metal as specified and the float of copper sheet. The minimum thickness of copper sheet used for making the float shall be 0.45mm for float exceeding 115mm dia. The body of the high pressure ball valve when assembled in working conditions with the float immersed to not more than half of its volume shall remain closed against a test pressure of 3.5kg / sq.cm.

The ball valve shall generally conform to IS specification No.1703: 1977 (Second revision). The weight of ball cock and the size of the ball cock shall be as per IS specification.

Test all plumbing systems in the presence of the site engineer / supervisor and the Architect as herein specified. Provided all equipment, materials and labour necessary for inspection and tests. After repairs are made, repeat test until units / a system is found satisfactory, to the above authorities. Carry out tests prior to concealing, insulating or back filling over any piping. No exceptions will be made.

- **Water Test**

Test entire system or sections of system by closing all openings except the highest opening and filling system with water to the point of overflow. If the system is tested in sections, plug each opening except the highest opening of the section filled with water. Keep the water in system or in portion under test for atleast 45 minutes before inspection starts with test pressure / head of 10 kg / sq. cm lasting for two hours. The system must be tight at all joints.

- **Final Test**

After fixtures are set, test the system with smoke test as follows:

- **Smoke Test**

Fill traps with water, then introduce into system a pungent thick smoke produced by one or more smoke machines. When smoke appears at stacks on the roof, plug stacks and allow pressure of 1 – inch water column to build up in systems. The system shall be tight at all joints.

Test all down spouts or rain headers and their branches within the building by water as described for the above soil, waste and vent system.

- **All Water Piping**

Hydro – static test 10 kg / cm² or twice the working pressure whichever is higher. Without drop in pressure as for a duration of minimum two hours.

All tests on below ground lines shall be continued to backfill on such a line is completed to disclose any damages caused by back filling.

All system shall be tested in section as required to expedite the work of other trades and meet construction schedules and final test on completion.

On completion of the works, the following tests shall be performed to the satisfaction of the Authority's Engineer before issue of virtual completion certificate, if so required.

- ✓ Smoke Test
- ✓ Hydraulic Test
- ✓ Performance Test for fixtures
- ✓ Tests for anti syphonage system
- ✓ Pump rating and output
- ✓ Inspection of all units and fixtures.

The contractor shall arrange for similar tests during the progress of works to ensure that there are no defects in materials / workmanship in portions of work to be concealed or embedded under the floor or walls in ceiling and get this approved by the Authority's Engineer. The under-

floor pipe works shall not be closed without the approval of Authority's Engineer.

- **Stoneware Gully Trap**

Gully traps shall conform to IS: 651 – 1980 (Fourth revision) these shall be sound, free from visible defects such as fire cracks or hair cracks. The glaze of the traps shall be free from crazing. They shall give a sharp clear note when struck with a light hammer. There shall be no broken blisters.

The size of the gully trap shall be as specified, and all dimensions will be as per drawing.

Each gully trap shall have one CI grating of square size corresponding to the dimensions of inlet of gully trap. It will also have a watertight CI cover with frame inside dimensions 300 x 300mm the frame and cover weight not less than 7kg and of sound and good casting and shall have truly square machined seating faces.

- **Inspection Chambers**

Where depth of sewer is less than 1.5m, below outside rectangular made up/ finished level of paving, square inspection chambers shall be used having size as specified. Usual size are 600 x 600 x 900. These shall be constructed in the sewer line at such places and levels and dimensions as indicated on the drawing. Sizes specified shall be clear internal dimensions of the chamber.

- **Laying and jointing**

Pipes shall be cut to length required including the portion to be inserted in the socket with a hacksaw. The pipe shall be cut square. Pipes and sockets shall be clean and dry, and burrs removed both inside and outside with a file. The surface to surfaces to be in contacted shall be roughened with emery paper, and dry fit checked.

A thick coat of solvent cement shall be applied to the outer surface of the pipe and a thin coat on the inside surface of the pipe and a thin coat on the inside surface of the socket by means of a brush. Solvent cement shall be of approved make and quality. The pipe shall then be inserted in the socket and turned for 90 degree to ensure even distribution of solvent cement. Excess solvent cement shall be wiped off. Leak proof adhesives like FRP paste / M – seal to be applied. GI clamps of required size shall be used for clamping the pipes to the walls etc., pipe shall be clamped atleast two inch / 50mm away from the wall surface using GI clamps screwed to the PVC raw plugs, not more than 1 meter apart.

- **Clean Outs**

At every bends, branches and where necessary suitable cleanouts shall be provided into the piping system as per the site requirement.

7. Pumps

Pumps shall be vertical, centrifugal, and multistage directly coupled to motor. Pumps shall be

complete in S.S. impeller shall be hydraulically balanced and keyed to shaft. Pump shall be mounted on a concrete foundation, projecting at least 15 CM above finished floor level. The pumps base shall be set on a vibration elimination pad. The pump shall be lubricated in strict accordance with the manufacturer's instructions and shall be factory aligned prior to shipment. All motors and bases shall be painted with approved finish shop coat of paint. The pump shall be selected for the lowest operating noise level and shall be complete with flexible connections. Valves, and pressure gauges. The pumps shall include cost of foundation channel complete.

The contractor shall supply and install pumps of the type and performance as shown on the drawings, all duties of pumps given in the tender drawings shall be checked and where necessary corrected before ordering. All the parts of the pumps that are in contact with water e.g. shaft, impeller etc. shall be of stainless steel construction.

Pumps shall be so selected that the design duty point is within 5% of the maximum efficiency point. The pump casing so selected shall have ample space to take an impeller one size larger than that capable of performing the design duty.

The pump shall have a speed of not more than 1500 rpm. However, pumps of 2900 rpm with high efficiency and low noise motor can be selected and noise data submitted for approval. All pumps and motors shall be of minimum vibration and noise level during operation. Vibration isolators shall be provided for all pump sets.

Facilities shall be provided to prevent starting of pumps when the water tank is at low water level. An indicator for this low water level alarm shall be provided.

Facilities to select which pump to be duty pump and standby pump shall be provided and be interchangeable.

Leakage from pump gland shall be drained to the nearest floor waste. Pump curves for all pumps offered shall be submitted: all curve indicating excessive shut-off head will not be approved.

Each pump shall be provided with a gate valve at suction and discharge, approved check valve at discharge, approved strainer at suction, flexible connections at pump suction and discharge, eccentric reducer at suction, concentric reducer at discharge, pressure gauges at suction and discharge, circulation relief valve and automatic air relief valve.

3.3 General Conditions and Technical Specification

General technical requirements for electrical works

1. Scope

Design, engineering, supply on for destination site basis, including transportation & insurance, storage, erection, testing and commissioning of the following equipment's/ items complete in all respects.

- The Contractor shall also be responsible for the overall co-ordination with internal/external agencies, project management, training of Authority's manpower, loading, unloading, handling, moving to final destination for successful erection, testing and commissioning of the equipment/works.
- Design of systems includes preparation of single line diagrams and electrical layouts, control and protection schematics, wiring and termination schedules, indoor and outdoor lighting/illumination and other relevant drawings & document required for engineering of all facilities under this contract, are covered under the scope of the Contractor.
- Any other items not specifically mentioned in the specification, but which are required for erection, testing and commissioning and satisfactory operation of the equipment's are deemed to be included in the scope of the specification unless specifically excluded.

2. General requirement

- The Contractor shall furnish catalogues, engineering data, technical information, design documents, drawings etc., fully in conformity with the technical specification.

3. Standards

- The works covered by the specification shall be designed, engineered, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India.
- The Contractor shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IS/IEC.

4. Services to be performed by the equipment being furnished

- All equipment's shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation.

- All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc. for the equipment.

5. Engineering data and drawings

- The engineering data shall be furnished by the Contractor in accordance with the Schedule.

The Contractor shall necessarily submit all the drawings/documents unless anything is waived.

The Contractor shall submit 4 (four) sets hardcopy along with the soft copy of drawings/design documents/data/ test reports as may be required for the approval of the Authority.

6. As built drawings both hard copy and soft copy

At the completion of the works and before issue of the certificate of virtual completion, the Contractor shall submit to the Authority 4 sets of layout drawings (both hard copy and soft copy) drawn at approved scale indicating the complete wiring system as installed. These drawings must provide the following minimum information:

Above indicates the general requirement. However, the Contractor must include all information desired by the Authority in the final as built documents.

7. Pre-commissioning tests

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Authority and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The list of pre-commissioning tests to be performed is given in respective chapters and shall be included in the Contractor's quality assurance programme.

The testing equipment required for testing and commissioning shall be arranged by the Contractor.

8. Packaging & protection

- All the equipment's shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Authority, the Contractor shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Authority to repack any equipment/material at a later date, in case the need

arises. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Authority takes no responsibility of the availability of the wagons.

- All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and pilings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

9. Finishing of metal surfaces

- All metal surfaces shall be subjected to treatment for anti-corrosion protection. All steel conductors including those used for earthing/grounding (above ground level) shall also be galvanized according to IS:2629.
- After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting.
- In case the Contractor proposes to follow his own standard surface finish and protection procedures or any other established painting procedures, like electrostatic painting etc., the procedure shall be submitted for Authority's review & approval.

10. Handling, storing and installation: -

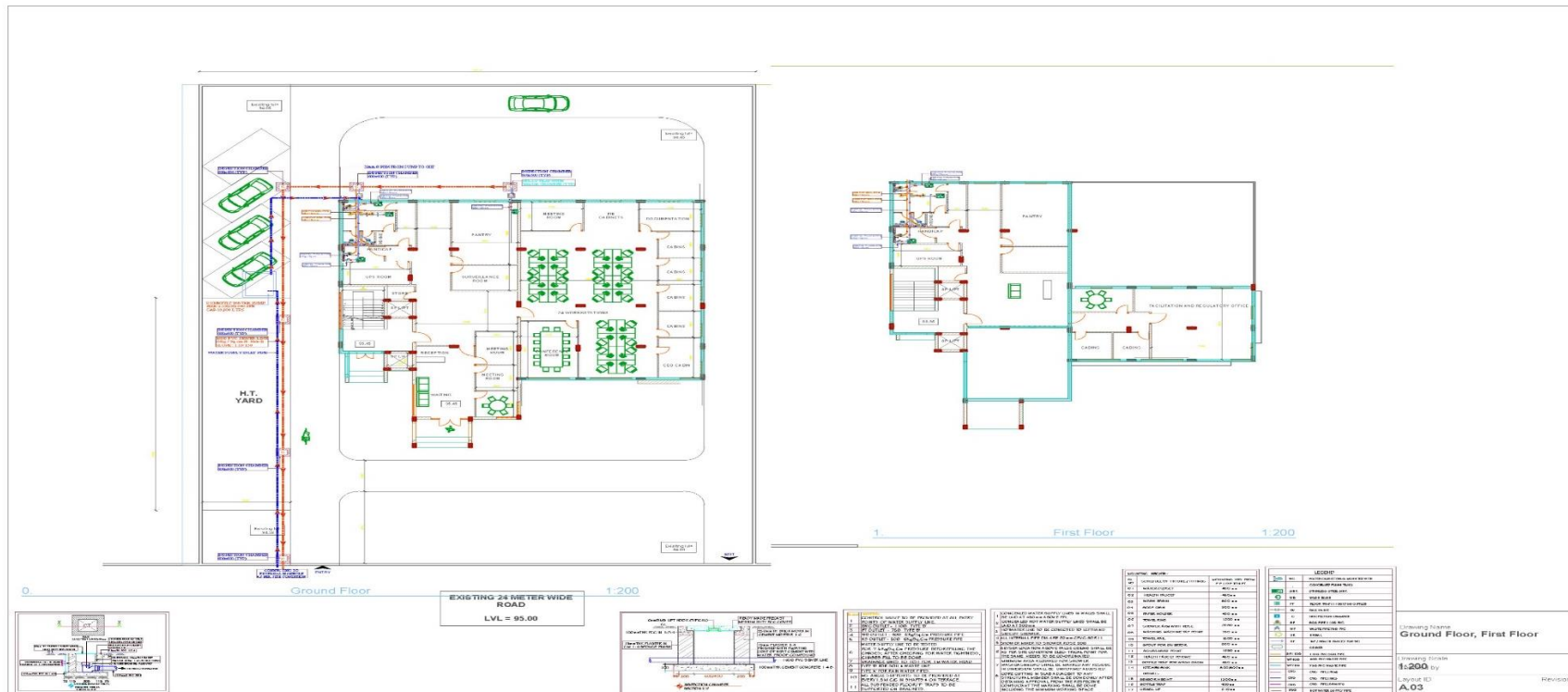
- In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Authority or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment / Panel shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented.
- Contractor may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment / Panel being procured by them separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall full cooperation to them.
- In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Authority. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.

- Where assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of equipment / Panel. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.
- Contractor shall be responsible for examining all the shipment and notify the Authority immediately of any damage, shortage, discrepancy etc. for the purpose of Authority's information only. The Contractor shall submit to the Authority every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.
- The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Authority in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over the Authority, as well as protection of the same against theft, element of nature, corrosion, damages etc.
- The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.
- The words 'erection' and 'installation' used in the specification are synonymous.
- Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.
- The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the minimum clearances as per the statutory requirement, the Contractor shall immediately proceed to correct the discrepancy at his risks and cost.

3.4 Drawings

Please refer to the following for reference to the Intent Diagrams (in A3 size)

Schedule number	Reference number	Title
8	7.2	Administrative building - Water supply



3.5 List of Approved Makes

SN	Details of equipment / material	Make / Manufacturer
1.	GI Pipes	Tata / Jindal- star/Jindal Hissar
2.	GI Fittings	R Brand (ISI) /Unik/NRV/ARV/HB
3.	Gate Valve / Non-Return Valve	Leader/Zoloto/KIRLOSKER/H.SARKER/INTERVALVE
4.	Foot Valve	Leader / Zoloto / NVR/L&T/INTERVALVE/LEHRY
5.	Butterfly Valve	Intervalve/SlimLine/AUDCO/ADVANCE/NVR Zoloto
6.	Pumps	GRUNDFOS/ KIRLOSKAR/ JOHNSON/ KSB
7.	ACB / MCCB / SFU / LBS	MERLIN GERIN / ABB / SIEMENS
8.	Contactors / OLRs	TELE MECHANIQUE / ABB / SIEMENS
9.	MCB / ELCB	MERLIN GERIN / MDS / INDO ASIA
10.	MCB DB	MERLIN GERIN / MDS / INDO ASIA
11.	Digital Meters	AE / MECO / ENERCON
12.	Kwh / MDM / MDC Meters	AE / ENERCON / L&T
13.	LED Indicating Lamps / PBS	TEKNIC / VAISHNO / SIEMENS
14.	Selector Switches	KAYCEE / SALZER/SWITRON
15.	Light Fixtures & Motion Detectors	PHILIPS / WIPRO/BAJAJ
16.	Switches/Sockets(Modular) Outlets in Metal Boxes	Anchor Roma / MDS Mosaic / ABB
17. 17	Diffusers	EDI /SSI
18. 18	Air Blowers	Kay / CVT
19. 19	Filters	ION Exchange / THERMAX / Doshion
20. 20	PE dosing	Asia LMI /GRUNDFOS
21.	Cables / Wires	KEI/Havells/Universal
22.	Centrifuge	ALFA LAVAL / HILLER /Aquarius
23. 19.	UPVC/ CPVC PIPES SCH – 40/80	Astral/Supreme/Prince/Ashirwad
24. 20.	HDPE Pipes PE -8	Supreme/Prince/Rishi/ Ashirvad Pipes

Item No	Description	Alternative1 Make /Model No
	SANITARY FITTINGS	
1	Wall mounted closet	Hindware/Parryware
2	Flush Valve	Jaquar-allied
3	Counter Sunk washbasin	Hindware/Parryware
4	Basin Mixer	Jaquar-Florentine
5	Three in one wall mixer	Jaquar-Florentine
6	CP Shower rose and shower arm	Jaquar-Florentine
7	Angle valve	Jaquar-Florentine
8	Health faucet	Jaquar-allied
9	Telephonic Shower	Jaquar-Florentine
10	Towel rail	Jaquar-Continental
11	Soap dish	Jaquar-Continental
12	Mirror	Saint Gobin
13	Toilet paper holder	Jaquar-Continental
14	Towel ring	Jaquar-Continental
15	Coat hook	Jaquar-Continental

4. Interior Works

4.1 Design Brief

- a) Scope shall include development of the space planning, interior design, material selection, design coordination, design documentation, execution including installation of furniture and fittings to permit ready usage of the Administrative building office.
- b) Provide preliminary design concepts of layout plans/dimensions of the floor including 2D and 3D presentations, working drawings of flooring, false ceiling, partitioning for cabins / cubicles etc., work areas, corridors, special areas such as reception, pantry, meeting rooms etc. This will include suggestions and recommendations on types and quality of materials, colour palettes, and finishing
- c) Design concepts of external areas associated with the Administrative block including entrance, lobbies etc. will be suggested
- d) Provide fully coordinated service plans denoting all AC, Electrical, Lighting, Plumbing, Fire, IT and Telephone points. The plans are to be fully dimensioned on plan and elevation.
- e) Execute works for flooring, false ceiling, electrical fittings & wiring, wall painting, carpeting, networking (WAN & LAN), telephone cabling, plumbing, HVAC, fittings & fixtures including office furniture and other allied works
- f) Supply of office furniture including chairs, tables, sofas, EPBAX system etc.
- g) Installation of Airconditioning VRV/VRF cassette type indoor system with capsule AC units (4-way)
- h) Cleaning of site and handing over of the works
- i) Rectification of works in completed works during Defects Liability Period

5. Testing

Third party testing of material such as Steel, Cement, Cubes, Design Mix, Bricks / Solid Blocks, Electrical Wires / Cables, pipes, and any other item must be facilitated by Contractor as per the directions of Authority's Engineer. Testing will have to be arranged by Contractor for every batch of material (such as cement, steel, electricals wires/cables, pipes etc.) that is brought to the site, and approved by the Authority Engineer before the material can be used.

5.1 Special Conditions for sending the cement concrete cubes for testing

The contractor should make arrangements for getting mould to the site for casting of cubes for testing of concrete strength.

1. **Mould** : The concrete mould' should be as per IS Specification (IS-516-1959) the details of which are as follows:

The mould shall be of metal, preferably steel or cast iron, and stout enough to prevent distortion. It shall be constructed in such a manner as to facilitate the removal of the moulded specimen without damage and shall be so machined that when it is assembled ready for use, the dimensions and internal faces shall be accurate within following limits.

The height of the mould and the distance between opposite faces shall be the specified size $\pm 0.2\text{mm}$. The angle between adjacent internal faces and top and bottom planes of the mould shall be $90^\circ \pm 0.50^\circ$. The interior faces of the mould shall be plane surface with a permissible variation of 0.03 mm. Each mould shall be provided with a metal base plate having a plane surface and to support the mould during the filling without leakage and it shall be preferably attached to the mould by springs for screws.

The interior surfaces of the mould shall be thinly coated with mould oil to prevent adhesion of the concrete.

2. **Compacting**: The concrete shall be filled into the mould in layers approximately 5 cm deep. Each layer shall be compacted either by hand or by vibration as described below (as per ISI).

When compacting by hand, the standard tamping bar shall be used and the strokes of the bar shall be distributed in a uniform manner over the cross section of the mould as prescribed in I.S.I. and for cubical specimen in no case, shall be concrete be subjected to less than 35 strokes per layer for 15 cm cubes (as per I.S.I.).

When compacting by vibration each layer shall be vibrated by means of an electric or pneumatic hammer or vibrator (as per I.S.I.).

3. The concrete cubes shall be cured for 28 days and send on 29th day. If the day falls on a holiday the cubes shall be sent on the next working day.
4. All the charges connected with the cube testing etc. shall be borne by the contractor.
5. If the concrete cube is found to be of lesser strength, then reduction in agreement rates shall be adopted as per the powers delegated to Authority's Engineer.
6. For working out the reduction of rates following procedures will be adopted .

When the strength of cubes tested is between 75% and 100% of the following strength the agreement rates should be reduced proportionately to the allowable strength of concrete (e.g.) concrete mix C.C. 1:2:4 (150 kg/cm²) cube strength achieved during testing - 120 kgs (i.e.) above 75%

When the strength of cube tested falls below 75% of the allowable strength, the R.C. Component from where the cube samples are collected shall be rejected . However, as an additional check, non-destructive test will be conducted through recognized institutions like Anna University etc., where the concrete component can be rejected or reduced rate to be adopted will then be decided. However, for working out the reduced rate, the cubes strength value only should be taken and worked out as given in para (6) above.

5.2 Additional specification for quality of materials and tests to be conducted (as applicable)

S.No.	Material to be Tested	Sampling		Name of test	Permissible Limits	Standards
1	Water	Lab Test: Local Source: Once in three months Outsource: Once in a month				IS 456 - 2000, Clause 5.4
			a)	To neutralize 100 ml of water using Phenolphthalein as an indicator (Acidity)	Not more than 5 ml (or 50 mg/Lit) of 0.02 normal NaOH	
			b)	To neutralize 100 ml of water using mixed indicator (Alkalinity)	Not more than 25 ml (or 250 mg/lit) of 0.02 normal H ₂ SO ₂	
			c)	Solids:		
			(i)	Total dissolved solids	3000 mg/Lit	
			(ii)	Sulphates (as SO ₂)	400 mg/Lit	
			(iii)	Chlorides (as Cl)	2000 mg/Lit for Concrete not containing embedded steel and 500 mg/Lit for Reinforced Concrete work	
			(iv)	Suspended Matter	2000 mg / Lit	
			d)	pH value	Not less than 6	
		Field Test: (Using Litmus Paper) Local Source – Once in Fortnight Outsource – For each Load (Lorry Load)	a)	pH value	Not less than 6	
2	Cement (43	One test for every 300				IS 269 - 2015

S.No.	Material to be Tested	Sampling		Name of test	Permissible Limits	Standards
	Grade)	tonnes of single brand (Test to be done, if there is change in brand)	a)	Initial setting time	Not less than 30 minutes	
			b)	Final setting time	Not more than 600 minutes	
			c)	Fineness of Cement		
				(i) By permeability method	Not less than 225 m ² /kg	
				(Or)		
				(ii) By Standard Sieve Test	Retained not more than 10%	
			d)	Soundness of Cement		
				(i) By Le-Chatelier Method	Expansion not more than 10 mm	
				(Or)		
				(ii) By Auto Clave Test	0.80%	
			e)	Compressive Strength of C.M (1:3) Cube		
				(i) 3 days (72 +/- 1 hr)	Not less than 23 Mpa (or) 230 Kg/Cm ²	
				(ii) 7 days (168 +/- 2 hrs)	Not less than 33 Mpa (or) 330 Kg/Cm ²	
				(iii) 28 days (672 +/- 4 hrs)	Not less than 43 MPA (or) 430 Kg/Cm ²	
3	Steel					
	a) Mild Steel (Grade 1 – Fee 250)	Each Load and Each Diameter (Min. 3 Samples)	a)	Yield Stress	Min 250 N/mm ² (Or) 25 Kg/mm ²	IS 432 (Part-1) 1982
			b)	Elongation	Min 23.0%	
			c)	Ultimate Tensile Stress	Min 410 N/mm ² (Or) 41 Kg/mm ²	
	b) High Strength Deformed Bars (Fe 415)	Each Load and Each Diameter (Min. 3 Samples)	a)	0.20% Proof Stress / Yield Stress	Min. 415 N/mm ² 41.50 Kg/mm ²	IS 1786 - 2008
			b)	Elongation	Min. 14.50%	
			c)	Tensile Stress	10% more than the actual proof stress. But not less than 485 N/mm ² (or) 48.50 Kg/mm ²	
	c) High Strength Deformed Bars (Fe	Each Load and each Diameter (Min. 3 Samples)	a)	0.20% Proof Stress / Yield Stress	Min. 500 N/mm ² (or) 50.0 Kg/mm ²	IS 1786 - 2008
			b)	Elongation	Min. 12.0%	
			c)	Tensile Stress	8% more than the actual 0.2 percent	

S.No.	Material to be Tested	Sampling		Name of test	Permissible Limits	Standards
	500)				proof stress. But not less than 545 N/mm ² (or) 54.50 Kg/mm ²	
4	Sand	Each Load		Clay, Fine Silt and Fine Dust	Not more than 5% by mass	IS 2116 - 1980
5	Coarse Aggregate	Every Quarry				IS 383 - 1970
			a)	Either Crushing Value (or) Impact Value		
				Crushing Value		
				Aggregates used for concrete other than wearing surfaces	Not more than 45%	
				Aggregates used for concrete for wearing surfaces (such as roads, pavements)	Not more than 30%	
				(Or Alternatively)		
				Impact Value		
				Aggregates used for concrete other than wearing surfaces	Not more than 45% by weight	
				Aggregates used for concrete for wearing surfaces (such as roads, pavements)	Not more than 30% by weight	
			b)	Abrasion Value		
				For Aggregates to be used in concrete for wearing surfaces	Not more than 30%	
				For Aggregates to be used in other concrete	Not more than 50%	
6	Bricks	Lot Size – For every one lakh Bricks –		For Class 35		IS 1077 - 1992

S.No.	Material to be Tested	Sampling		Name of test	Permissible Limits	Standards
		(Number of Samples 20 Nos.)	a)	Compressive Strength	Not Less than 35 Kgf/cm ² (or) 3.50 N/mm ²	
			b)	Water Absorption	Not more than 20% by weight	
			c)	Efflorescence	Rating not more than Moderate	
				For Class 50		
			a)	Compressive Strength	Not Less than 50 Kgf/cm ² (or) 5.0 N/mm ²	
			b)	Water Absorption	Not more than 20% by weight	
			c)	Efflorescence	Rating not more than Moderate	
7	Hydraulic pressed tiles	One test for area upto 1999 sq.m and one additional test for every 1000 sq.m and part thereof	a)	Water Absorption	Shall not exceed 15%	IS 2690 - 1993
			b)	Flextural Strength	Shall not be less than 20 Kg/cm ²	
8	Vitrified Tiles	One Test for an area upto 1999 sq.m and one additional test for every 1000 sq.m and part thereof		Deviation percent in length & width (2 or 4 sides)	± 0.10	IS 15622 - 2006
				Deviation percent in thickness	± 4.00	
				Maximum deviation percent in rectangularity	± 0.10	
				Surface Flatness (Warpage)	± 0.20	
				Water absorption percentage by mass	Average <0.08 Individual max 1.0	
				Modulus of rupture in N/mm ²	Average 47, Individual 44 min	
				Breaking Strength in, N	> 7.5 mm thickness, 1500 (Min)	
				Scratch hardness of surface (Mohs)	6 min	
				Bulk density in (g/cc)	2.2 Min	
				Impact Resistance	Required	
				Chemical Properties / Resistance	Required	
9	Electric Cable	One test for each brand, each size		Conductor resistance at 20°C		IS 664-1990
				For 1.5 Sq.mm cable	Max allowable limit 12.10 Ohm/Km	

S.No.	Material to be Tested	Sampling		Name of test	Permissible Limits	Standards
10	Wood	One sample for each work		For 2.5 Sq.mm cable	Max allowable limit 7.40 Ohm/Km	
				For 4.0 Sq.mm cable	Max allowable limit 4.95 Ohm/Km	
				Lab test – Moisture test	Not more than 12%	IS 287 - 1993
				Field test – Visual observation	Free from rotten, unsound knots (or) knots incluster	IS 3629 - 1960
11	Cube test in lab		Compressive strength of 150 mm cube			IS 456 - 2000
		1 to 5 m ² – 1 set	M20 (1:1.5:3)			
		6 – 15 m ² - 2 sets	7 days	Not less than 135 Kg/cm ²		
		16 – 30 m ² – 3 sets	28 days	Not less than 200 Kg/cm		
		31 to 50 m ² – 4 sets	M20 (1:1:2)			
		> 50 m ² – 4 plus one for each add 50 m ²	7 days	Not less than 170 Kg/cm ²		
		(1 set = 3 cubes)	28 days	Not less than 250 Kg/cm		
			M30			
			7 days	Not less than 205 Kg/cm ²		
	28 days	Not less than 300 Kg/cm				
12	Slump Test	Type of work	With vibration		Without vibration	
	Slump test at site for all reinforced concrete at regular intervals (Slump in mm)	Mass concrete, large section, roads and pave	10 to 25		50 to 75	
		RCC foundation, substructures, thick walls and other heavy section	26 to 50		40 to 115	
13	M-Sand	Thin vertical sections such as walls, beams, columns with congested reinforcement	40 to 50		100 to 175	

S.No.	Material to be Tested	Sampling	Name of test	Permissible Limits	Standards
		When using concrete pump	50 to 100		IS 383 – 2016 (3 rd Revision) For Zone-II
13.1	Test for size and grading of aggregate		IS sieve size in mm		IS: 2386 (Part – I) 1963
		a)	10 mm	Shall be 100%	
		b)	4.75 mm	Shall be between 90 & 100%	
		c)	2.36 mm	Shall be between 75 & 100%	
		d)	1.18 mm	Shall be between 55 & 90%	
		e)	600 micron	Shall be between 35 & 59%	
		f)	300 micron	Shall be between 8 & 30%	
		g)	150 micron	Shall be between 0 & 10%	
13.2	Test for Specific Gravity			Shall be between 2.1 and 3.2	
13.3	Test for water absorption, %			Shall not be more than 5%	
13.4	Test for bulk density				IS: 2386 (Part-III) 1963
		a)	Bulk density in KG/1-loose condition	Limit not specified	
		b)	Bulk density in KG/1-compacted condition	Limit not specified	
13.5	Test for deleterious materials				
		a)	Coal and lignite	Shall not be more than 1%	
		b)	Clay lumps	Shall not be more than 1%	
		c)	Material finer than 75 mm IS sieve	Shall not be more than 10%	
		d)	Organic Impurities	Shall pass the test	
		e)	Silt content	Limit not specified	
13.6	Test for soundness of Aggregate		% loss of weight of the material after 5 cycles when tested with sodium sulphate solution	Shall not be more than 10%	
13.7	Test for Total Alkali Content				
			Total alkali content as Na ² O	Shall not be more than 0.3%	

S.No.	Material to be Tested	Sampling	Name of test	Permissible Limits	Standards
13.8	Test for Sulphate content		equivalent percentage		
			Test for sulphate content as SO ₃	Shall not be more than 0.5%	
13.9	Test for Acid Soluble Chloride content		Acid Chloride content percent	Shall not be more than 0.04%	
13.10	Test for Alkali Aggregated reactivity		Acceleration mortar bar method		
			The average expansion of accelerated mortar bar after 16 days of casting percentage	<ol style="list-style-type: none"> 1. Expansions of <0.10% - Indicates Innocuous behaviour of aggregate 2. Expansions between 0.10 and 0.20% includes both Innocuous and deleterious aggregate 3. Expansion >0.20% indicative of Potentially deleterious aggregate 	
13.11	Test for bulking of sand percentage		Bulking of sand percentage	Limit not specified	IS: 2386 (Part-II) 1963