e-TENDER DOCUMENT FOR Proposed construction of G+1 floors Indian Bank INDSETI Building at Settikarai Village, Dharmapuri.

TECHNICAL BID

VOLUME - II

TECHNICAL SPECIFICATION

KINDLY NOTE THAT ONLY ONLINE BIDS WILL BE CONSIDERED AGAINST THIS TENDER. MANUAL SUBMISSION OF BIDS WILL NOT BE ACCEPTED

EMPLOYER/OFFICE INVITING BIDS	ARCHITECT CONSULTANT
Indian Bank, Zonal Office, 1ST FLOOR, 91, DDDC BUILDING, PENNAGARAM ROAD DHARMAPURI-636701. **Tel:** 0434 226 2503	NANDA AND ASSOCIATES ARCHITECTS, No36, Ground Floor, Janakiram Colony Main Road, Arumbakkam, Chennai-600106.

Tender reference No. : ZO:EST:DHARMAPURI:01 Dated 17.08.2024

Cost of Tender : Free of Cost

TABLE OF CONTENT

TECHNICAL SPECIFICATION

FOR

ARCHITECTURAL WORKS

TABLE OF CONTENT

I. TECHNICAL SPECIFICATIONS

GENERAL

PREAMBLE

1.0 GENERAL

These Specifications cover the items of work in structural parts coming under preview of this document. All work shall be carried out in conformation with this. These specifications are not intended to cover the minute details. All codes, standard and good construction practice shall be referred to this specification be the latest thereof.

These specifications shall be read in conjunction with the Technical Specifications for various items of work. The General Contractor shall carefully acquaint himself with the general specifications, coordinate the same with any other specifications forming a part of the Contract Document and determine his contractual obligations for the execution of various items of work in accordance with good engineering practices.

2.0 REFERENCE TO THE STANDARD CODES OF PRACTICE:

2.1 All standards, tentative specifications, specifications, code of practice referred shall be the latest editions including all applicable official amendments and revisions. The contractor shall make available at site all relevant Indian Standard Codes of Practice as applicable.

2.2 In case of discrepancy between standards, codes of practice, tentative specifications, and specifications referred to, the specifications of Indian Standard Codes of practice shall govern.

3.0 SUPREMACY OF TENDER

In case of contradiction between/among two or more clauses given separately in two or more different documents, conditions of acceptance clause will be in following preference:

General Conditions of contract. Shall prevail over Drawings

Drawings shall prevail over BOQ

BOQ shall prevail over shall prevail over technical specification

4.0 DIMENSIONS

4.1 Written dimensions on drawings shall supersede measurement by scale; and drawings to a large scale shall take precedence over those to a smaller scale. Special dimensions or directions in the specifications shall supersede all others. All dimensions shall be checked on site prior to execution.

4.2 The dimensions where stated do not allow for waste, laps, joints, etc. but the General Contractor shall provide at his own cost sufficient labour and materials to cover such waste, laps, joints, etc. and the rate quoted is inclusive of such provision and no separate payment will be made for the same.

4.3 The levels, measurements and other information concerning the existing site as shown on the drawings are believed to be correct, but the Contractor should verify them by himself and also examine the nature of the ground as no claim or allowance whatsoever will be entertained on account of any errors or omissions in the levels or the description of the ground levels or strata turning out different from what was expected or shown on the drawings.

A. WATERPROOFING

1.0 INDIAN STANDARDS:

IS : 702 – 1989 Specifications for Industrial bitumen

IS : 1322 – 1993 Bitumen Felts for Waterproofing and Damp Proofing 3 IS : 3384 – 1986 Specifications for Bitumen primer for use in waterproofing and damp-proofing (first Revision)

The above mentioned IS Codes of Practice have been given for general guidance. However, these IS Codes will be adopted only for those particular items in the contract where the detailed technical specifications are not laid down in the Tender Documents.

All waterproofing work shall be carried out by the main contractor through a specialized Waterproofing agency as specified in the tender. The work shall be carried out strictly in accordance with the instructions of the manufacturer of the waterproofing materials used in waterproofing treatment and the contractor shall be responsible for the proper production of record of ingredients used and the performance of the waterproofing work done.

The entire work shall be covered by a performance guarantee for waterproofing for the period mentioned in the description of item.

The Contractor shall promptly attend to any leakage or dampness see or communicated during the period and satisfy the Dept. that the same has been rectified; if required, by conducting a test by storing 75 mm water over the roof for 10 days. If the Contractor fails to carry out the waterproofing rectification, the dept. will, after giving 10 days notice to the Contractor, get the work carried out by another agency at the Contractor's risk and cost.

2.0 WATERPROOFING PERFORMANCE TEST:

After completion of waterproofing treatment, it shall be tested for waterproofing by storing water for 10 days, to the following depths:

75 mm over exposed horizontal surface. Upto brim in case of water tanks, lift pits

Bone dry surfaces of all underground structures shall have to be demonstrated by the contractor.

The rate for the waterproofing work to be carried out under the contract shall include all labours , materials, tools, plants, equipments, transport and all the operations required for carrying out and completing the work, whether spelt out in detail or not, but including removing all loose materials, loose scales, mortar droppings and oil, grease etc. and removing all debris / rubbish outside AI premises, curing where required and testing to the satisfaction of the EIC.

3.0 WATER PROOFING WITH BITUMEN FELT:

Waterproofing treatment shall be four course or six course as described.

1.1 MATERIALS:

The self finished felt shall be approved brand and manufacture of types 3, Graded, Hessian base felt conforming to IS :1322 -1970.

WEIGHTS:

The total weight of the finished bitumen felt in dry condition with mica dusting powder in the manufactured bitumen felts shall not be less than 22.3 kgs per 10 sqm SAMPLING:

All rolls from the same batch manufactured in one consignment shall constitute a lot.

The number of rolls to be taken from a lot shall depend upon the size of the lot as follows:

NOTE 1: All the rolls taken as per Col.2 shall be inspected for width, length and visible external defects.

These rolls shall be taken at random from the lot. From each of the rolls, one piece 3m long and full width of the felt shall be cut out for preparing test specimens. First 2 m of the roll shall not be selected for this purpose. The length of felt selected shall be free from abnormal defects and shall be truly representative of the whole consignment. In case the material has stuck together no heat shall be applied to separate the layer, but the whole roll shall be sent for testing.

NO OF ROLLS PERMISSIBLE NO. ROLLS	NO. OF ROLLS IN THE LOT	TO BE SELECTED OF DEFECTIVE
Up to 100	0	0
101 to 150	0	0
151 to 300	1	0
301 to 500	2	1
501 to 1000	3	2
1001 to 3000	5	3
3001 & Above	8	5

3.2 CRITERIA FOR CONFORMITY:

The lot shall be considered to be in conformity with the requirements of the standard, if: The number of rolls found defective with respect to width, length and visible external defects, does not exceed the corresponding number given in Col.3 of Sampling.

3.3 BONDING MATERIALS:

This shall be blown type bitumen conforming to IS : 702 – 1988 and IS grade 85/25 of approved quality.

1st Course Kg/sq.m

3rd Course Kg/sq.m

5th Course Kg/sq.m

1 Four Course Treatment 1.45 1.45'—

2 Six Course Treatment 1.45 1.20 1.45

3.4 STONE GRIT AND PEA-SIZED GRAVEL:

Stone Grit shall be 6m and down size. Pea sized gravel shall be hard, round and free from dust, dirt, etc. Grit and gravel shall not be spread over vertical or sloping faces of flashing and at drain mouths. At these places, the surfaces should be painted with two coats of bituminous solution. Stone grit or pea sized gravel for final course of four or six course treatment shall be 0.06 cu.m. per sq.m.

PREPARATION OF SURFACES: The surfaces to be treated shall have a minimum slope of 1:120. This grading shall be carried out with cement concrete or cement plaster with coarse sand as ordered, to the average thickness required and finished smooth. Grading work shall be paid for separately.

The junction between roof and vertical faces of parapet walls, chimneys, etc. shall be cased by running triangular fillets 7.5 cm x 7.5 cm size in cement concrete. At drain mouths, fillets shall be cut back and rounded for all owing for waterproofing treatment. Cement Concrete in fillet shall be 1:2:4 {1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm (nominal size)}.

Where the parapet height is 450 mm or less, the waterproofing treatment shall be carried out over the top of the parapet wall to its full thickness.

For carrying over and tucking in the waterproofing felts into parapet wall of height

more than 450 mm, chimney stack etc. a horizontal groove of 65 mm deep, 75 mm wide, with it slower edge at minimum 150 mm above the graded roof surface shall be cut out nearly and finished smooth inside with cement mortar (1:4).

The triangular fillet 75 mm x 75 mm and the cutting & finishing of the groove shall not be measured or paid for extra. No deduction will be made, however, if the groove has already been provided in an existing building.

Where expansion joints are provided, the construction of dwarf walls and RCC slab, etc., covering the dwarf walls shall be carried out by the same agency and shall be paid separately.

The graded roof surface, concrete fillets, and faces of walls shall be thoroughly cleaned with wire brushes and all scales, mortar droppings, etc. removed. Any cracks in the roof shall be cut into "V" section and filled up flush with cement mortar 1:4 or blown up type petroleum bitumen 82/25 grade. Cleaning of surface or treating the cracks shall not be paid for separately.

4.0 PAINTING OF ROOF SLAB WITH HOT BITUMEN:

4.1 The surface to be painted should be absolutely dry sand shall be cleaned with wire brushes. All scales, mortar droppings, loose materials shall be removed.

4.2 PAINTING WITH BITUMEN:

Surface prepared shall be painted uniformly with bitumen of approved quality of 80/100 etc. after heating it to the required temperature. The cost of bitumen shall be continued at least 15 cms along vertical surface along roof slab and up to drip course in case of parapet wall.

Immediately after painting, dry clean sharp and coarse sand shall be evenly spread at 60 dm3 per 10 sqm of surface to be treated.

4.3 PRIMING COAT:

If directed the priming coat of bitumen shall be applied to the cleaned slab. This shall be paid for separately.

4.4 LAYING:

Blown type petroleum bitumen of IS grade 85/25 shall be heated to 180º C and conveyed to the roof in buckets or pouring can in weighed quantities. The roof surface shall be cleaned dry. Laying shall be commenced at the lowest level and worked up to crest. Each length of the felt laid, shall be rolled half its length.

Hot bitumen shall be poured on the roof across the full width of the rolled felt and the felt rolled out and pressed down. When the first half of felt has been bonded, the other half is rolled up and then unrolled and pressed on the hot bitumen the same way.

Subsequent strips shall be laid similarly with end laps of 10cm and side laps of 7.5 cm.

All over laps shall be firmly bonded with hot bitumen.

The third layer of bitumen in the four course treatment shall be carried out in a similar manner after flashing has been completed, followed by the final course of gravel or grit as specified in above .

4.5 SIX COURSE TREATMENT:

In six course treatment, the third and fourth layers of bitumen and self finished felt shall be laid in manner described above. The laps in fourth layer shall be staggered from those in second layer. The fifth layer of bitumen shall be carried after the flashing is done, followed by the final course of gravel or grit as specified in Waterproofing treatment shall be carried over the drain outlets and 10 cms into drain pipes or outlets.

The flashing shall consist of the same four or six course treatment except that the final course of stone grit or pea sized gravel shall be replaced by an application of additional coat of bitumen on the vertical and sloping faces of the flashing.

The upper edge of the flashing felt shall be well tucked into the flashing grooves in the parapet etc. to a depth of minimum 65 mm. The flashing treatment shall be held in place in grooves with wood edges at intervals and grooves filled up with cement mortar (1:4) and the surface finished smooth with the wall. After curing, when dry, the exposed plaster joints of grooves shall be painted with bitumen and the vertical and sloping surface of the flashing shall be painted with two coats of bitumen.

5.0 FLAT BRICK TERRACOTA TILE WATERPROOFING TREATMENT:

The work is to be carried out on the brick bat lime concrete laid on terrace, measured and paid for separately.

The flat tiles shall be machine pressed flat earthen ware tiles, quality and make approved by EIC.. The tiles shall be 20 mm thick and of the sizes as approved by EIC..

The tiles shall be laid on 12 mm thick cement mortar (1:3) with neat cement slurry. The joints of 3 mm thickness approx. shall be properly pointed in neat cement slurry. The whole surface shall be properly watered and cured. The tiles shall be carried at an angle of 45 º at the joints with vertical walls. Where the treatment consists of two layers, the second layer shall be laid similar to the first with joins in the two layers properly staggered. The terrace shall be tested for waterproofing by keeping 75 mm standing water on completed work for ten days. The soffit of the slab should not show any dampness or leakage.

6.0 CHINA MOSAIC WORK:(if required)

China Mosaic work shall be prepared from broken pieces of while glazed tiles or mixture of white and colour glazed tiles. No piece shall be more than 40 mm and smaller than 10 mm in any direction.

LAYING:

15 mm thick screed consisting of 1 part cement : 4 part sand shall be laid on top of roof slab. Before the screed is about to set, a floating coat, 3mm thick of cement mortar (1 cement : 4 fine sand) shall be laid on the screed. Whilst the floating coat is green, the broken pieces of glazed tiles, thoroughly soaked in water, shall be set flat, as closely as possible. The surface shall then be rolled lightly with a wooden roller to ensure proper setting of the pieces in the floating coat and also squeezing of the mortar into joints.

The surface shall be cleaned with sawdust and kept wet for a minimum of 10 days and thoroughly cleaned on completion. Junctions with the wall shall be curved to 75 mm radium and top edge of curving carried at least 50 mm up the abutting wall. The top edge shall be finished in neat horizontal line and tucked in a groove in the wall 65 mm deep. Bell mouth around rain water pipe inlets etc. wherever required for effective drainage, shall be formed in China Mosaic finish. The surface shall be even and uniform on completion.

7.0 TREATMENT TO CRACKS:

The work shall be carried out by cutting out cracks to V section, minimum 6 mm wide on top, cleaning out with wire brush, filling with cement and sand slurry (1:1) with approved waterproofing compound mixed with cement by weight as specified by the manufacturer and curing as required.

8.0 SHALLOW SUMP FOR RAIN WATER OUTLET:

Shallow sump near rain water outlet shall be constructed before parapet is built and shall be of size specified with cement concrete 1:2:4 mix.

A PVC sheet 1 m x 1 m x 400 microns shall be laid and cement concrete of minimum thickness of 3 cms laid over it with its top surface lower than the level of adjoining roof surface by not less than 20 mm. The concrete shall be of size more than 45 cm x 45 cm to allow for waterproof terracing, to overlap its through edges by min 7.5 cm and shall be sloping towards the outlet. The concrete shall be rendered with 12 mm thick cement plaster 1:3 while cement concrete is still green.

9.0 WATERPROOF TREATMENT WITH ACRYLIC BASED CHEMICAL OR CEMENT BASED WATRPROOF AGENT:

9.1 Preparation of Surface:

The roof surface shall be cleaned with wire brushes and gunny cloth. All scales, mortar falling, loose material etc. shall be removed to base slab surfaces. All cracks shall be made in to “V” grooves 25 mm wide at top and 12 to 20 mm deep and cleaned.

9.2 Laying:

The entire work shall be carried out as per instructions of the manufacturer of the approved waterproofing agent.

A layer of neat cement slurry mixed with waterproof agent shall be laid in convenient lengths and widths. Bricks on edge or broken brick pieces shall be laid in cement mortar1:4 (1 cement : 4 sand) with waterproof agent. The brick pieces / brick on edge shall be wetted thoroughly before use. Cement Mortar 1:4 shall be filled in the joints and a little above. Waterproofing agent of approved make shall be added at 1% weight of cement in case of acrylic based chemical waterproofing agent in slurry and mortar and properly mixed width cement specified by the Manufacturer before mixing the same with sand.

The brick on edge or brick bat work as above shall be laid to proper levels and slopes as required, directed and / or as shown on drawings. Minimum 25 mm thick joint less water proofing layers of cement mortar 1:4 (1 cement : 4 sand) with waterproof agent, shall be laid over the brick bat work and finished smooth with a layer of neat cement slurry mixed with waterproof agent. If directed, string marks showing 300 mm x 300 mm square shall be marked properly. The slope of the finished terrace shall not be less than 1 in 50, unless a flatter slope is expressly permitted by the EIC in writing. The roof surfaces shall slope from all sides towards the rain-water outlets.

The treatment shall be properly rounded at junction of walls, etc. and carried out above 300 mm above the level of waterproofing treatment. The edge of the treatment along parapet shall be tucked into a groove 65 mm deep into the parapet. The treatment shall be continued near rain water outlet etc. The entire treatment shall be properly cured for a period of 2 weeks by ponding method. Normally the proportion of acrylic based chemicals is one percent by weight of OP Cement and for other waterproofing compound 2% by weight of cement. The Contractor shall give complete details of waterproofing treatment proposed by him, including the waterproof compound he proposes to use. These details shall include roof fill materials, waterproofing compound, minimum & maximum thickness of slurry, joints thickness, mortar on top of total treatment.

The Contractor shall ensure that sufficient slope for effective drainage is provided within the average thickness of waterproofing treatment proposed by the Contractor. In case the average thickness has to exceed that specified, the fact shall be specifically brought to the notice of the EIC.

The entire work shall be covered by a guarantee for waterproofing for a period of 10 years as specified in 2.0 above.

10.0 BRICK BAT CONCRETE:

10.1 The work shall be carried out in correct line, level and slope. This shall be carried out When the thickness of cement based waterproofing treatment exceeds the specified thickness or Elsewhere in bathrooms, toilets, etc. to fill up the voids.

11.0 WATERPROOF CEMENT PLASTER:

11.1 The work shall be carried out in correct line and level in CM 1:4 (1 cement:4 sand) minimum 15 mm thick as backing coat with approved waterproofing compound, mixed with cement by weight as specified by manufacturer and finished with 6 mm thick uniform grained sand faced plaster coat including curing with 10 years performance guarantee for terrace parapet or external walls or concrete surfaces.

12.0 INJECTION / PRESSURE GROUTING WATERPROOF TREATMENT:

12.1 Surface Preparation:

The surface to be treated shall be cleaned of all scales, loose materials, and wire brushed clean. All cracks apparent and construction joints shall be made in to V grooves 25 mm at top and above 20 mm deep and treated with cement slurry 1:1 (1 cement : 1 sand) with approved waterproof compound mixed with cement by weight as specified by the manufacturer of the compound.

Holes of about 25 mm dia. to receive funnel or pipe nozzles and 25 to 40 mm deep shall be chiseled at about 1.5 m or less centre to centre as required, in the entire floor and walls to be treated. Nozzles shall then be fixed in these holes and grooves.

After the nozzles are set for minimum 24 hours, neat cement slurry mixed with waterproofing compound by weight of cement, as specified by the manufacturer of the compound, shall be injected through these nozzles, by low pressure, gravity for the slurry to run through the minutest cracks and pores in the entire structure. The process shall be continued till the surface to be treated is bond dry and shall not show any dampness at all.

The nozzles shall then be removed and the holes properly filled up.

13.0 BOX TYPE WATERPROOF TREATMENT WITH STONE SLABS:

13.1 The treatment shall be minimum 75 mm in thickness and shall be carried out entirely as per specialized waterproofing agency's manufacturer's specifications & shall be generally as follows:

13.2 For Bottom of Basement Slabs Etc.

The treatment shall be carried out before laying the raft slab, basement slab, lift pit slab, etc. This shall be laid on 1:3:6 bedding course. The bedding course shall be measured and paid for separately.

A 25 mm thick layer of cement mortar 1:4 (1cement: 4 fine sand) with waterproofing compound mixed with cement by weight as specified by manufacturer shall be evenly laid as backing course. Rough stone slabs of Shahabad Tiles minimum 20 mm thick shall be laid firmly over this with gaps of about 15 mm to 20 mm in between and properly set. The joints thus left are raked out to full depth and cement slurry admixed with waterproofing compound is grouted in these joints. A protective layer of 25 mm thick in CM 1:4 (1cement: 4 fine sand) with waterproofing compound as above is laid over this, with stone chips embedded at random. The total thickness of waterproofing treatment shall be 75 mm. The treatment shall be extended 150 mm beyond the external face of the raft or walls, and shall be properly cured at every stage and after curing is ready to receive the raft and other slabs.

13.3 For Vertical Walls Or Basement Etc.

The surface to be waterproofed shall be properly hacked and roughened. Rough stone slabs about 20 mm thick shall be placed vertically in position with the help of cement paste applied to the internal face of vertical joints leaving a gap of about 20 mm between the external face of RCC wall and internal face of rough stone. The stones are held side by side leaving hardly any gap between the edges. In order to fix the bottom most layer of stones, a groove about 25 mm deep shall be made in the bottom and the stones fixed in it to ensure water tightness at the junction of the walls and the raft.

Maximum 2 or 3 horizontal layers of rough stones are laid at a time. A coat of rough cement plaster 1:4 (1 cement : 4 sand) with water proofing compound is applied to the external face of rough stone. After the plaster layer is set, the gap between wall and stone layer is filled with a grout made up of cement slurry with water proofing compound as per Manufacturer's specifications. The treatment shall be continued up to 300 mm above the final made up ground level.

The proportion of acrylic based waterproofing, chemicals shall be 1% by weight of cement and 2% in case of cement based waterproofing compound. Continuous pumping and bailing out water shall be ensured till RCC raft is laid and till the treatment to walls is completed. The back filling should not contain stones, boulders and such other material which will cause damage to waterproofing treatment. The internal treatment to walls shall be similar for walls and slabs and shall be laid after the raft slab or lift pit slab is laid. This shall be carried out if ordered by the EIC.

The internal treatment shall be finished smooth. The whole work shall be properly cured at every stage.

13.4 Performance Guarantee:

The Contractor shall give 10 years performance guarantee for the waterproofing work carried out by them.

14 .0 WATERPROOFING TREATMENT TO BASE OF WATER STORAGE TANKS, ETC.

Surface preparation is as per 6.0 with double layer of cement based waterproofing treatment

A layer of 25 mm thick cement mortar 1:3 (1 cement : 3 fine sand) shall be then laid with approved waterproofing compound in the proportion as per Manufacturer's specifications, nominal 25 mm size stone aggregates or gravel shall be embedded at random about half depth into the layer, while still green. After this is properly cured, a second layer 25 mm thick cement mortar 1:3 layer with waterproof compound, as above, is laid and finished smooth with neat cement also with waterproofing compound. The whole treatment shall be properly cured.

The entire treatment shall be covered with performance guarantee of 10 years.

14.1 Waterproof Patent Stone for Tank Bottom, Etc.

The patent stone in cement concrete 1:2:4 and 4 mm thick, finished smooth shall be carried out as per the specifications of the item in relevant section, except that the waterproofing compound, by weight, shall be mixed with cement as specified by the manufacturer.

Waterproof cement plaster for interior of water tank. The thickness of plaster shall be min. 20 mm. The specifications shall be same as per plaster finish smooth under relevant section. The work shall cover preparation of surface, waterproofing compound etc.

14.2 Cement Based Waterproofing To Toilet / Bathroom Slabs Etc.

The surface shall be cleaned of all loose scales, mortar, fallings, etc. by wire brushing and gunny cloth. All cracks shall be cut into V form, cleaned and filled in with cement mortar 1:1 slurry with approved waterproofing compound at 2% by weight of cement. A 20mm thick layer of cement mortar 1:3 shall then be laid and gravel or stone aggregate of 12 m nominal size of fairly uniform size hand set in it while the cement mortar is still green with hand pressure. A final layer of 25 mm thick cement mortar 1:3 shall then be laid over it, compacted with trowels, finished smooth. In all cement based waterproofing compound, as specified by the specialized waterproofing agency shall be mixed. The whole work shall be cured properly for 10 days. The joints with walls shall be rounded 150 mm above the waterproofing treatment level. This treatment is used in bathrooms, equipment floor, office buildings, etc.

The waterproofing treatment shall carry performance guarantee of 10 years.

14.3 Expansion Joints - Polysulphide Joints:

The top 12 mm thick and 20 mm deep strip in the horizontal and vertical expansion joints in slabs, beams, columns, walls, etc. shall be filled properly with patented poly sulphide compound as per manufacturer's instructions.

For expansion joints, the joint filled shall be packed firmly to close all gaps or voids.

14.4 Application:

The resin shall be thoroughly mixed with the curing agent and shall be either directly poured or applied with special gun to fill up the joint. The joints are finished flush with the surface.

The expansion joints exposed inside the building at any floor level shall be covered with thin aluminium flat (20 gauge) or asbestos cement strip of min. available thickness or wooden beading etc. as directed by EIC. The width of such covering shall be sufficient to cover the entire joint and allowance for fixing nails / screws. The fixing of such strip shall be at one only to allow for the movement at the joint. Alternatively, the strip can be fixed from both sides but the holes on one side to be oval shape to allow unrestricted movement of structural member and to avoid shearing of the flat. Aluminium angles of suitable size, may also be provided, if the joint is at the corner, but shall be fixed on one side only.

14.5 Grading Roof:

The specification shall be for 1:2:4 cement concrete as covered under relevant section. The concrete shall be laid in level or grade as directed. The measurements shall be in cubic metres.

14.6 Cement Watta:

This is provided at the junction of horizontal and vertical surfaces to prevent entry of water. The surface, about 250 mm to 350 mm wide on both surfaces, shall be cleaned of all grease, oil, etc. The cement watta is triangular in cross section of each side averaging to 250 mm to 350 mm in cement mortar 1:3 (1 cement : 3 sand) finished neat with floating coat of neat cement, cured etc. Approved waterproofing compound shall be mixed with cement as directed by manufacturer by weight all complete as directed by Engineer-in-Charge.

ALTERNATIVE : ISOTHANE - EMB / ISOTHANE – EMA (or approved proven equivalent)

ISOTHANE EMB shall be a very high solid coating so designed to give a high build film with high elasticity, good U.V.stability and high strength. It should adhere permanently into a flexible seamless membrane and maintain high roof integrity on any substrate i.e the hypar shell.

ISOTHANE EMA elastomeric membrane shall be a liquid applied coating based on Urethane Prepolymers which cure by reaction with atmospheric moisture to give a continuous film which is rubbery and elastic. It shall contain leafing aluminium which gives it ultra violet resistance.

ISOTHANE EMA shall cure permanently into flexible seamless membrane, by virtue of its chemical reactivity in the wet state, and shall have a good adhesion to a wide range of substrates. Isothane-EMA should not embrittle with age, exposure to ultra violet radiation or weathering.

APPLICATION SPECIFICATION

All loose materials from roof surface shall be removed by brushing. One coat of Isothane P Primer shall be applied.

Two coats of Isothane - EMB/EMA with suitable interval between two coats shall be applied to achieve a dry film thickness of 1 mm.

PRECAUTION BEFORE APPLICATION / INSPECTION

1. Thoroughly clean the roof surface by brushing (all debris, chippings, moss, etc., must be removed).

2. Inspect total roof area for defect, pay particular attention to:

a) Roof gradient

b) Upstands

c) Expansion joints

d) Dran/gully outlets

e) Roof edges

f) Roof finish

3. Any major cracks or defects noticed on the roof should be individually assessed, but the general treatment is to rake out to a firm base and fill with a non-setting mastic or ISOTHANE-EM. It is generally necessary to re-inforce these areas with scrim.

4. Allow surface to dry thoroughly and any moisture contained in the structure to evaporate.

5. Fill cracks and voids with mastic sealant:

NOTE

a) In the case of two coat application, the first coat should be touch dry in 12-48 hours and the second coat should be applied within 24 hours to ensure good adhesion.

b) Where application extends over more than a working day, an overlap of 150 mm should be done.

c) It is not normally necessary to re-inforce total roof area, but in case of high movement or regular foot traffic this is recommended. Regularly used walkways are also marked out and reinforced with scrim.

d) ISOTHANE - EM can be used for balconies and decks not subject to heavy foot traffic. In such cases at least 1.5 mm coating thickness should be applied and a reinforcing scrim embedded into the first coat is recommended. In order to improve foothold, fine dry aggregate or silica sand should be sprinkled over the last application before it fully cures.

TYPICAL PROPERTIES

S.No.	ISOTHANE - EMA	ISOTHANE - EMB
1. Specific Gravity	1.18	1.20
2. Solid % min	95	92
3. Abel closed cup flush point Deg.C	56	69

4. Application limit Deg.C	0.70	0.70
5. Approx.Dry time (20 C.50% RH)	12.20 hours touch dry - 7 days full cure.	12.20 hours touch dry - 7 days full cure.
6. Elongation %	500	500
7. Tensile Strength	300	400
8. U/V Resistance	Excellent	Excellent
9. Storage stability (Temperature climate)	9 months	9 months

WATER PROOFING ON FLOORS AND WALLS OF SUNKEN AREAS

Preparation of Surface:

This shall be as described for Roof Water Proofing.

Horizontal Surface

Cement slurry admixed with acrylic based chemical @ 0.5 kg/50 kg of cement shall be spread smoothly over the R.C.C roof which has been cleaned and prepared prior to laying the slurry . A 20 mm thick mortar 1:4 (1 cement : 4 coarse sand) admixed with acrylic based chemical as recommended by the manufacturer shall be spread over the bed prepared with cement slury. A

layer of graded stone aggregate shall be embedded at random. After cleaning for about 2 days, another layer of cement shall be spread evenly followed by a 20mm thick mortar 1:4 (1 cement : 4 coarse sand) admixed with acrylic based chemical which is finished smooth and corners rounded off.

Vertical Surface

These shall be 20 mm thickness in two coats. The under coat shall be 10 mm thick 1:4 (1 cement : 4 coarse sand) admixed with acrylic water proofing chemical @ 1 kg per 50 kg of cement and shall be applied on the prepared vertical surface. The top surface shall be brought to a true surface with wooden straight edge. The surface shall be finished smooth. The junction of vertical plastered surface and floor surface shall be rounded of suitable with the same materials as stated hereinbefore.

Curing

The finished surface shall be cured with flooding of water for a period of two weeks before filling sunken areas with concrete.

Precautions

While filling the areas with concrete it is to be ensured that the floor and the walls surface treated with water proofing treatment does not get damaged.

Water proofing of basements, lift pit base and sides and other similar locations shall be done as specified in the schedule and generally comprise of.

A. HORIZONTAL SURFACE:

The prepared surface of P.C.C levelling course shall be treated with three layers of waterproofing course of 20mm thick each, each layer preceded by a spread of proprietary material cement mix slurry for effective bonding of the layer.

The waterproofing course shall be of proprietary material mix cement mortar 1:3 (1 cement : 3 coarse sand) the proportion of mix of cement and proprietary material being as specified by the manufacturer and in no case it shall be less than 1% by weight of cement.

The bottom two layers of waterproofing course shall be provided with embedment of stone aggregate 12mm down by hand pack at random, the time gap between these two layers being not less than 24 hours.

The third and top layer shall be laid after curing for at least two days and top finished smooth, making the total thickness of the treatment to 60 mm.

An additional impervious layer over the waterproofing layers laid shall be formed by injecting, proprietary material cement mix grout, through a net work of nozzles of 25 mm dia M.S pipe of adequate length placed in position, at specified locations (1 to 1.5 m apart) before casting R.C.C base slab (Raft) by securing to the reinforcement of raft in such a manner that they remain in position and free from getting choked during slab casting, not earlier than 7 days of casting, by filling all voids/crevices in the concrete of the raft. The protruding part of the grouting nozzles shall be cut and the space filled with cement sand mortar (1:2) and finished smooth.

All operations of the treatment shall be as per manufacturers directions.

VERTICAL SURFACE

The waterproofing treatment shall be done after the removal of shuttering of vertical walls cast.

The prepared external surface shall be applied with proprietary material cement mix slurry. Then waterproofing plaster shall be done in two layers of 12mm thick each with proprietary cement mix mortar of 1:4 (1 mix : 4 coarse sand).

The cavities and the minutest of cracks in the concrete of the wall is then filled by injecting proprietary material cement mix grout under pressure through nozzles prefixed in a grid pattern on the other side wall surface by cutting holes about 50mm in diameter and 25mm to 40mm deep at 1.0 to 1.5 m apart and grouting nozzles fixed in these holes with cement paste which will be allowed to set for at least 24 hours before actual grouting under pressure. The nozzles are to be removed only after the grout is set. The gaps formed on removal of nozzles shall then be filled with cement sand mortar 1:2 and finished smooth. The position of the nozzles shall cover all construction joints and a continuous groove chiselled out along the joint at the junction of the floor and walls.

All the operations shall be as per manufacturer's specification and directions.

The mix of the proprietary material and cement shall be as per manufacturer's specification and in no case it shall be less than 1% by weight of cement.

The rate for the above treatment shall include drying and cleaning surface free of dust etc.

LIFT PIT

Waterproofing to lift pit, side walls, floor slab, column projected outside and around the pile cap using standard approved chemicals in box method of water proofing prior to construction below the raft and after construction of the RCC bottom and side walls of lift on the outside including necessary materials technique and labour required for effective

and water tight sealing of the entire basement structure all as per IS 6494 and to the following specifications.

At the raft level / bottom of the lift well.

(a) 60mm thick standard box type (injection water proofing treatment shall be provided for all horizontal surface.

(b) At the junction of pile and raft, you shall leave four nozzles, two of which will be grouted after your horizontal surfaces treatment is completed and the balance two grout pipes shall be left in place and grouted after raft concreting is completed.

(c) Grouting nozzles should be left at 1.5 mtr centres in both direction, 2" deep into the raft slab and side walls for grouting after construction.

RAFT / RETAINING WALL

After the excavation the P.C.C for proper bonding with subsequent waterproofing treatment.

Waterproofing course of 20mm thick Chemseal or approved equivalent cement mortar 1:4 in laid over the slurry, Stone aggregate 12mm down is embedded in it by handpack at random.

Not earlier than 24 hours after above operation chemseal cement slurry is spread on the mortar and one more layer of 20mm thick Chemseal or approved equivalent cement mortar 1:4 is laid, Stone aggregate 12mm down is embedded in it by handpack at random. After curing at least for 2 days Chemseal or approved equivalent cement slurry is spread to enable bonding and final layer of 20mm thick chemseal cement mortar 1:4 is laid and finished smooth.

Polysulphide epoxy coating should be given.

The total thickness of the above treatment is about 60mm.

After the reinforcement of raft is placed in position grouting nozzles of adequate length are fixed at the specified locations (1 to 1.5m apart). These nozzles are of 25mm diameter M.S.pipes. The nozzles are placed in such a manner that they remain free from getting choked. The tip of these nozzles protrudes above the raft concrete to allow grouting hose to be connected to them for grouting.

Not earlier than 7 days after the concreting has been done, Chemseal cement grout or approved equivalent is injected through these network of nozzles. This will help to form an additional impervious layer over the waterproofing layers laid at the bottom by filling all voids/crevices in the concrete of the raft.

The protruding part of the grouting nozzles is cut and the space filled with cement sand mortar (1:2) and finished smooth. After the vertical walls have been cast and shuttering removed, the waterproofing treatment is done as follows.

The external surface is prepared and Chemseal or approved equivalent cement, slurry is applied and then waterproofing plaster with Chemseal or approved equivalent cement mortar (1:4) applied in two layers of 12mm each.

Polysulphide epoxy coating will be given.

Holes about 50 mm in diameter and 25 to 40 mm deep are made on the wall surface about 1.00 to 1.5 m apart in a grid pattern, Grouting nozzles are fixed in these holes with cement paste. These nozzles are allowed to set for at least 24 hours. The positioning of the holes is such as to cover all construction joints. The joint at the junction of the floor and walls is chiselled to make a continuous groove and nozzles fixed in this groove.

Chemseal or approved equivalent cement grout is injected through the above nozzles under pressure so as to fill in the minutest of cracks and cavities in the concrete.

After the grout is set, the nozzles are removed and the space filled with cement sand mortar (1:2) and finished smooth.

EXTERNAL IMPREGNATION (BOX) TREATMENT:

FLOOR RAFT: Actual area over which the treatment is laid i.e. total area of raft/floor plus the projections of treatment beyond edge of raft / floor shall be measured and charged accordingly.

WALLS: The external surfaces of the walls actually provided with the treatment shall be measured and charged for.

E. In case of pile Foundations, the treatment shall be laid below pile caps and also to the vertical walls of each pile cap and the same shall be measured and charged for. No deductions shall be made for the piles as grouting shall be done to take care of piles.

GUARANTEE for the watertight performance of the structure for a minimum period of 10 years from the date of completion shall be given in the prescribed form given below. This guarantee shall be in legal paper in an acceptable form. The guarantee shall be enforceable either by the Architects or by clients. If, during the guarantee period, water leaks are noticed in the structure from the portions treated by you, the same shall be rectified when called upon immediately, all at no extra cost to the entire satisfaction of the Architect/Employer.

MODE OF MEASUREMENTS

A. TERRACE

It shall be over all plan area between the walls. The Vattas (Golas) shall be measured separately in Running Meter and as a separate item. Usually the Vattas (Golas) shall be of 300 mm height from the finished surface.

B. TOILET BLOCKS

FLOOR: Area of the Toilet Blocks shall be measured by length x breadth between walls.

VERTICAL SIDES

The actual area treated by us above the finished floor level shall be measured by length x height.

B. BRICK MASONRY

BRICK MASONRY

1.0 DESCRIPTION

This work shall consist of construction of structures with bricks jointed together by cement mortar in accordance with the details shown on drawings or as approved by the Engineer.

2.0 MATERIALS

All materials to be used in the work shall conform to the requirements laid down in chapter Materials under Civil

3.0 PERSONNEL

Only trained personnel shall be employed for construction and supervision.

4.0 CEMENT MORTAR

Cement and sand shall be mixed in specified proportions given in the drawings. Cement shall be proportioned by weight, taking the unit weight of cement as 1.44 tonne per cubic metre. Sand shall be pro-portioned by volume taking into account due allowance for bulking. All mortar shall be mixed with a minimum quantity of water to produce desired workability consistent with maximum density of mortar. The mix shall be clean and free from injurious type of soil/acid/alkali/ organic matter or deleterious substances.

The mixing shall preferably be done in a mechanical mixer operated manually or by power. Hand mixing can be resorted to as long as uniform density of the mix and its strength are assured subject to prior approval of the Engineer. Where permitted, specific permission is to be given by the Engineer. Hand mixing operation shall be carried out on a clean water-tight platform, where cement and sand shall be first mixed dry in the required proportion by being turned over and over, backwards and forwards several times till the mixture is of uniform colour. Thereafter, minimum quantity of water shall be added to bring the mortar to the consistency of a stiff paste. The mortar shall be mixed for at least two minutes after addition of water.

Mortar shall be mixed only in such quantity as required for immediate use. The mix which has developed initial set shall not be used. Initial set of mortar with ordinary Portland Cement shall normally be considered to have taken place in 30 minutes after mixing.

In case the mortar has stiffened during initial setting time because of evaporation of water, the same can be re-tempered by adding water as frequently as needed to restore the requisite consistency, but this re-tempering shall not be permitted after 30 minutes. Mortar unused for more than 30 minutes shall be rejected and removed from site of work.

5.0 SOAKING OF BRICKS

All bricks shall be thoroughly soaked in a tank filled with water for a minimum period of one hour prior to being laid. Soaked bricks shall be removed from the tank sufficiently in advance so that they are skin dry at the time of actual laying. Such soaked bricks shall be stacked on a clean place where they are not contaminated with dirt, earth, etc.

6.0 JOINTS

The thickness of joints shall not exceed 10mm. All joints on exposed faces shall be tooled to give concave finish.

7.0 LAYING

All brickwork shall be laid in an English bond, even and true to line, in accordance with the drawing or as directed by the Engineer, plumb and level and all joints accurately kept. Half and cut bricks shall not be used, except when necessary to complete the bond. Closer in such cases shall be cut to the required size and used near the ends of the walls. The bricks used at the face and also at all angles forming the junction of any two walls shall be selected whole bricks of uniform size, with true and rectangular faces.

All bricks shall be laid with frogs up on a full bed of mortar except in the case of tile bricks. Each brick shall be properly bedded and set in position by slightly pressing while laying, so that the mortar gets into all their surface pores to ensure proper adhesion. All head and side joints shall be completely filled by applying sufficient mortar to brick already placed and on brick to be placed. All joints shall be properly flushed and packed with mortar so that no hollow spaces are left. No bats or cut bricks shall be used except to obtain dimensions of the different courses for specified bonds or wherever a desired shape so requires.

The brick work shall be built in uniform layers, and for this purpose wooden straight edge with graduations indicating thickness of each course including joint shall be used. Corners and other advanced work shall be raked back. Brickwork shall be done true to plumb or in specified batter. All courses shall be laid truly horizontal and vertical joints shall be truly vertical. Vertical joints in alternate courses shall come directly one over the other. During construction, no part of work shall rise more than one metre above the general construction level, to avoid unequal settlement and improper jointing. Where this is not possible in the opinion of the Engineer, the works shall be raked back according to the bond (and not toothed) at an angle not steeper than 45 degrees with prior approval of the Engineer. Toothing may also be permitted where future extension is contemplated. Before laying bricks in foundation, the foundation slab shall be thoroughly hacked, swept clean and wetted. A layer of mortar not less than 12 mm thick shall be spread on the surface of the foundation slab and the first course of bricks shall be laid.

8.0 JOINTING OLD AND NEW WORK

Where fresh masonry is to join with masonry that is partially/entirely set, the exposed jointing surface of the set masonry shall be cleaned, roughened and wetted, so as to effect the best possible bond with the new work. All loose bricks and mortar or other material shall be removed.

In, the case of vertical or inclined joints, it shall be further ensured that proper bond between the old and new masonry is obtained by interlocking the bricks. Any portion of the brickwork that has been completed shall remain undisturbed until thoroughly set.

In case of sharp corners specially in skew bridges, a flat cutback of 100 mm shall be provided so as to have proper and bonded laying of bricks.

9.0 CURING

Green work shall be protected from rain by suitable covering and shall be kept constantly moist on all faces for a minimum period of seven days. Brick work carried out during the day shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period. The top of the masonry work shall be left flooded with water at the close of the day. Watering may be done carefully so as not to disturb or wash out the green mortar.

During hot weather, all finished or partly completed work shall be covered or wetted in such a manner as will prevent rapid drying of the brickwork.

During the period of curing of brick work, it shall be suitably protected from all damages. At the close of day's work or for other period of cessation, watering and curing shall have to be maintained.

Should the mortar perish i.e. become dry, white or powdery through neglect of curing, work shall be pulled down and rebuilt as directed by the Engineer. If any stains appear during watering, the same shall be removed from the face.

10.0 SCAFFOLDING

The scaffolding shall be sound, strong and safe to withstand all loads likely to come upon it. The holes which provide resting space for horizontal members shall not be left in masonry under one metre in width or immediately near the skew backs of arches. The holes left in the masonry work for supporting the scaffolding shall be filled and made good. Scaffolding shall be got approved by the Engineer. However, the Contractor shall be responsible for its safety.

11.0 EQUIPMENT

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

12.0 FINISHING OF SURFACES

12.1 General

All brickwork shall be finished in a workmanlike manner with the thickness of joints, manner of striking or tooling as described in these above specifications.

The surfaces can be finished by “jointing” or “pointing” or by “plastering” as given in the drawings.

For a surface which is to be subsequently plastered or pointed, the joints shall be squarely raked out to a depth of 15 mm. while the mortar is still green. The raked joints shall be well brushed to remove dust and loose particles and the surface shall be thoroughly washed with water, cleaned and wetted.

The mortar for finishing shall be prepared as approved.

12.2 Jointing

In jointing, the face of the mortar shall be worked out while still green to give a finished surface flush with the face of the brick work. The faces of brick work shall be cleaned to remove any splashes of mortar during the course of raising the brick work.

12.3 Pointing

Pointing shall be carried out using mortar not leaner than 1:3 by volume of cement and sand or as shown on the drawing. The mortar shall be -filled and pressed into the raked joints before giving the required finish. The pointing shall be ruled type for which it shall, while still green, be ruled along the centre with half round tools of such width as may be specified by the Engineer. The super flush mortar shall then be taken off from the edges of the lines and the surface of the masonry shall be cleaned of all mortar. The work shall conform to IS:2212.

12.4 Plastering

Plastering shall be done where shown on the drawing.

Plastering shall be started from top and worked down. All putlog holes shall be properly filled in advance of the plastering while the scaffolding is being taken down. Wooden screeds 75 mm wide and of the thickness of the plaster shall be fixed vertically 2.5 to 4 metres apart, to act as gauges and guides in applying the plaster. The mortar shall be laid on the wall between the screeds using the plaster’s float and pressing the mortar so that

the raked joints are properly filled. The plaster shall then be finished off with a wooden straight edge reaching across the screeds. The straight edge shall be worked on the screeds with a small upward and sideways motion 50 mm to 75 mm at a time. Finally, the surface shall be finished off with a plasterer's wooden float. Metal floats shall not be used.

When recommencing the plastering beyond the work suspended earlier, the edges of the old plaster shall be scrapped, cleaned and wetted before plaster is applied to the adjacent areas. No portion of the surface shall be left unfinished for patching up at a later period.

The plaster shall be finished true to plumb surface and to the proper degree of smoothness as directed by the Engineer.

The average thickness of plaster shall not be less than the specified thickness. The minimum thickness over any portion of the surface shall not be less than the specified thickness by more than 3 mm.

Any cracks which appear in the surface and all portions which sound hollow when tapped, or are found to be soft or otherwise defective, shall be cut in rectangular shape and re-done as directed by the Engineer.

12.5 Curing of Finishes

Curing shall be commenced as soon as the mortar used for finishing has hardened sufficiently not to be damaged during curing. It shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages.

12.6 Scaffolding for Finishes

Stage scaffolding shall be provided for the work. This shall be independent of the structure.

13.0 ARCHITECTURAL COPING FOR WING/RETURN / PARAPET WALL

This work shall consist of providing an Architectural coping for wing / retum / parapet walls.

The material used shall be cement mortar 1:3 or as shown on the drawings prepared in accordance as approved.

The cement mortar shall be laid evenly to an average thickness of 15 mm to the full width of the top of the wall and in continuation a band of 15 mm thickness and 150 mm depth shall be made out of the mortar along the top outer face of the walls.

14.0 ACCEPTANCE OF WORK

All work shall be true to the lines and levels as indicated on the drawing or as directed by the Engineer, subject to tolerances as indicated in these specifications.

Mortar cubes shall be tested in accordance with IS:2250 for compressive strength, consistency of mortar and its water retentivity. The frequency of testing shall be one sample for every 2 cubic metres of mortar, subject to a minimum 3 samples for a day's work.

In case of plaster finish, the minimum surface thickness shall not be less than the specified thickness by more than 3mm.

AUTOCLAVED CELLULAR CONCRETE BLOCK MASONRY

SPECIFICATION FOR CONCRETE BLOCK MASONRY

1.0 SCOPE

These specifications cover the use of Autoclaved Cellular Concrete Block Masonry for the structural / non structural purposes.

2.0 GENERAL

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

All relevant Standards as specified elsewhere in this Volume are also applicable.

IS 269	Specification for ordinary and low heat portland cement
IS 383	Specification for coarse and fine aggregates from natural sources for concrete.
IS 455	Specification for portland slag cement
IS 456	Code of Practice for plain and reinforced concrete.
IS: 1200	Measurement for Building works
IS: 1725	Specifications for solid cement blocks used in general building construction.
IS: 1905	Code of practice for structural safety of buildings Masonry walls.
IS:2116	Sand for masonry mortars.
IS:2185 (Part 1)	Specification for concrete masonry units: Hollow and solid concrete blocks.
IS 2185 (Part 3)	Specifications for Autoclaved Cellular concrete Blocks.
IS:2250	Code of practice for preparation and use of masonry mortar.
IS 2572	Code of practice for construction of hollow concrete block masonry.
IS 2645	Specification for integral waterproofing compound.
IS:3115	Specification for lime based blocks.
IS:3414	Code of practice for design and installation of joints in buildings.
IS:3466	Specification for masonry cement.
IS:3952	Specification for burnt clay hollow blocks for walls and partitions.
IS 3809	Fire resistance Test for Structure.
IS:4098	Specification for lime-pozzolana mixture
IS:4441	Code of practice for use of silicate type chemical resistant mortars.
IS:4442	Code of practice for use of sulphur type chemical resistant mortars.
IS 6041	Construction of Autoclaved Cellular Concrete Block Masonry.
IS 6441(Part 1to 8)	Methods of test for autoclaved cellular concrete products. (Determination of unit weight or bulk density & moisture content).
IS 8112	Specification for 43 Grade ordinary Portland cement
IS 9103	Specification for admixtures for concrete.

3.0 MATERIAL

3.1 Cement: Ordinary Portland cement complying with IS 269 shall be used unless specified.

3.2 Aggregates: Aggregates shall conform to IS 383. Grading shall be as indicated in IS 383. Fineness modules of the combined aggregates shall be between 3.6 and 4.

3.3 Water: Water conforming to IS 456 and as approved by the EIC shall be used.

3.4 Admixtures: Additives or admixtures may be added to the cement or concrete mix conforming to the IS specifications. Admixtures shall be chloride free and melamine polymer based. Other additives or admixtures not being governed by Indian Standards shall be tested and checked that the same are not detrimental to durability. However any addition shall only be after approval of the EIC.

4.0 MANUFACTURE:

4.1 Autoclaved Cellular Concrete blocks may be hollow (open or closed cavity) or solid and shall be referred to by its nominal dimension. The term nominal dimension includes the thickness of the mortar joint. All specifications of solid concrete blocks including specifications for actual dimensions, tolerances, sizes, shapes and webs, grades of blocks etc. shall conform to IS : 2185.

4.2 Concreting: Concrete mix used for blocks shall be pre-designed to give a minimum crushing strength of 30 Kg/Cm2. Concrete shall be mixed in the mechanical mixer. Blocks shall be moulded, laid and compacted with automatic machines table vibrator. Care shall be taken to see that the mix mould is properly filled up. Block shall be protected until they are sufficiently hardened to permit handling without damage.

4.3 Curing & Drying: Blocks shall be cured in the curing yard by keeping them continuously moist for at least 14 days. Steam-cured blocks shall be preferred. Cured blocks shall be allowed to dry for a period of 4 weeks before being used. The blocks shall be allowed to complete their initial shrinkage before they are laid in the wall.

4.4 Physical requirements: All blocks shall be sound and free of cracks or other defects. For exposed construction face or faces shall be free of chips or other imperfections, and the overall dimensions of the blocks shall be in accordance to tolerance as specified. Minimum compressive strength shall be 30 Kg/Cm2 or as specified in the Schedule of Quantity, maximum permissible water absorption shall not exceed the limit specified in I.S. : 2185, dimensional variations shall conform to I.S. 2185.

4.5 Testing: Tests as indicated in Appendices A to F of IS 2185 shall be conducted on samples of units selected according to the sampling procedure given here under to ensure conformity with the physical requirements as specified.

4.6 Sampling: A sample of 20 blocks shall be taken from every consignment of 5000 blocks or part thereof of the same size and same batch of manufacture. From these samples, the blocks shall be taken at random for conducting the test. The blocks shall be taken at regular intervals during the course of work, preferably while being loaded or unloaded. In case samples are to be taken from the stacks, blocks shall be taken at random from across the top of the stacks, the sides accessible and from the interior of the stacks.

4.7 The blocks shall be kept under cover and protected from extreme conditions of temperature, relative humidity and wind until they are required for test. The test shall be conducted as soon as the sample has been taken.

4.8 Number of Tests: All the 20 blocks shall be checked for dimensions and inspected for visual defects. Out of the 20 blocks, 3 blocks shall be subjected to the test for block

density, 8 blocks to the test for compressive strength, 3 blocks to the test for water absorption and 3 blocks to the test for drying shrinkage and later to the test for moisture movement. The remaining 3 blocks shall be reserved for retest for drying shrinkage and moisture movement if a need arises.

4.9 Blocks shall be approved if requirements of conditions mentioned in 11.2 to 11.5 of IS 2185 (Part I) (as given below) are satisfied. The number of blocks with dimensions outside the tolerance limit and / or with visual defects, among those inspected shall not be more than two. For Block density and compressive strength, the mean value determined shall be greater than or equal to the minimum limit specified in Table 2 of IS 2185 (Part I).

For drying shrinkage and moisture movement, all the test specimens shall satisfy the requirements of the test. If one or more specimens fail to satisfy the requirements, the remaining 3 blocks shall be subjected to these tests. All blocks shall satisfy the requirements. Drying shrinkage shall not exceed 0.1 percent.

For water absorption, the mean value determined shall not be more than 10 percent by mass.

5.0 PRECAUTIONS:

5.1 ACC blocks should be stacked in dry, well ventilated areas on a level ground. Block should be placed on edges (in direction of 240mm height) not on flat. Different stacks should be maintained for different sizes of blocks.

5.2 Damp-proof course should be provided beneath the ACC block masonry.

5.3 Unsupported height of ACC block masonry should not exceed 18 times the thickness of wall and length 20 times the thickness of wall.

6.0 WORKMANSHIP:

6.1 In total dry climate top and sides may be slightly moistened to avoid absorption of water from mortar. Joints shall not be bigger than 10mm and will be perfectly horizontal and vertical. Joints shall be raked 10mm deep while mortar is wet.

6.3 Cut blocks shall not be used. Special solid / hollow pre-cast blocks at site shall be cast well in advance to be used as spacers and to adjust breaking of vertical joints.

6.4 Cracks in block masonry are due to shrinkage or expansion of blocks or due to settlement, thermal expansion or changes in moisture content in the structural members enclosing the block walls.

The following measures are recommended to prevent formation of cracks.

a) While curing, the block masonry should be lightly sprinkled with water and not made excessively wet.

b) Expansion joints shall be provided in walls exceeding 4.8 m in length.

c) Reinforcement should be provided in the bed joints in block work, one course above and course below windows and above doors in order to distribute the shrinkage/ temperature stresses occurring at the corners of openings, more uniformly throughout the walls.

d) R.C.C. band (Patli) 100 mm thick and width equal to block masonry and having 10mm dia. two bars with 6 mm dia links @ 200 mm c/c shall be provided at every 1000mm interval in the block masonry. The gap between the topmost layer of block and the soffit of the beam shall be packed by lightly hammering flat pieces of approved stone / tiles and then the gaps will be covered by weld mesh before closing them by cement

plaster. The weld mesh will be extended at least 150 mm on the R.C.C. beam and 150 mm on block masonry and nailed to them with strong nails.

e) All block walls abutting concrete columns or walls shall be bonded to the same with approved 6mm dia 250 mm long galvanized M.S. dowels or approved G.I. butterfly ties left from the concrete columns while casting, at every alternate course of block.

7.0 SCAFFOLDING

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

Raking out of joints.Preparation of the tops and sides.

Forming and preparing expansion, contraction or construction joints as detailed above or specified in the BOQ or drawings.

Making holes, openings, outlets, etc. embedding pipes, ends of beams, joints, slabs, trusses, sills, etc. whatever required during construction and neatly finishing the exposed surfaces and opening as per instructions of the EIC.

Curing and protection as specified.

C. PLASTERING & POINTING

1.0 SCOPE

These specifications cover the use of plastering for brick, block masonry and RCC work, pointing for brick, block and stone masonry work.

2.0 APPLICABLE INDIAN STANDARDS

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

IS: 269	Specification for ordinary rapid hardening and low heat Portland cement
IS – 383	Specification for coarse and fine aggregate
IS: 712	Building Limes
IS: 1200 (Part XII)	Method of measurement of building and Civil Engg. Works - Plastering & Pointing
IS: 1542	Specification for sand for plaster

IS: 1630	Mason's Tools for Plaster work and pointing work.
IS: 1661	Code of practice for application of cement lime plaster finishes
IS 2645	Specification for integral waterproofing compound.
IS: 10067	Material Constants for Building Works

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

3.0 GENERAL

3.1 Cement Mortar

Cement mortar shall have the proportion of cement to sand as specified and shall comply with relevant clauses of concrete specifications.

3.2 Scaffolding

Scaffolding independent of masonry / RCC work i.e. double scaffolding shall be erected having two sets of vertical supports with steel sections or pipes of adequate strength so as to be safe for construction operations. The contractor shall take all measures to ensure the safety of the work and working people. Any instructions of the Engineer in this respect shall also be complied with.

The contractor shall be entirely responsible for any damage to properly or injury to persons resulting from ill erected scaffolding, defective ladders and materials or otherwise arising out of his default in this respect. Proper scaffolding shall be provided to allow easy approach to every part of the work. Overhead work shall not be allowed. Making holes of any kind for the purpose of supporting the scaffolding shall not be permitted.

3.3 Tools and Accessories

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

3.4 Programme of work in relation to plastering

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

3.5 General Precaution in plastering

All general precautions as specified in IS.. 1661, Clause 9, shall be taken and preparation of the background shall be done as laid down in IS: 1661, Clause 13. Care shall be taken to see that other parts of the work or adjacent works are not damaged while plastering.

3.6 Preparatory work

All joints in the face work that is to be plastered shall be raked out to depth equal to not less than the width of the joints or as directed by the Engineer. The raking shall be done taking care not to allow by chipping of masonry. In new work the raking out shall be done when the mortar in the joints is still green. Efflorescence if any shall be removed by

brushing and scrapping. Smooth surfaces of concrete, old plaster, etc. must be suitably roughened to provide necessary bond for the plaster. All dirt, soot, oil paint or any other material that might interfere with satisfactory bond shall be removed. In the case of stone masonry, scrubbing on the walls to receive the plaster shall not be more than 12 mm. The surface to be plastered shall be cleaned and scrubbed with fresh water and kept wet for 6 hours prior to plastering. It shall be kept damp during the progress of the work. The plastering shall not be commenced unless the preparatory work is passed in writing by the Engineer.

3.7 Chicken wire Mesh at Junction

All junctions of Masonry wall with R.C. structure e.g. column, beam, etc. which are to be plastered, shall be reinforced by fixing strips of approved G.I. Chicken wire mesh of minimum 300mm wide centrally over the length of junction. G.I. Chicken wire mesh of required width shall also be fixed over chasing for conduits, pipes, etc. on masonry walls before plastering is commenced. The mesh shall be nailed rigidly to the structure / masonry with G.I. nails of suitable type at approx. 400mm centers. The finished mesh shall be straight, rigid and laid without sagging. The payment shall be made for the area covered by wire mesh in Sq. mtrs including overlaps.

3.8 Gauges

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

3.9 Workmanship Plastering:

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

First or Backing Coat: The first coat of the specified thickness shall be applied as described above. The subsequent coat shall be applied after this coat has been allowed to sufficiently set but not dried depending upon weather conditions. The surface shall not be allowed to dry during this period and shall be kept wet.

3.10 Plastering to Ceiling

Ceiling plaster shall be 6to 12 mm thick in 1:3 cement sand mortar (1 cement : 3 sand).

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

4.0 PLASTERING IN TWO COATS

4.1 Base Coat

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

The plaster with this mortar shall be laid as specified above with a thickness of not more than 15 mm for brick work and concrete surfaces. Keys shall be formed on the surface by thoroughly combing it with wavy horizontal lines about 12 mm apart and about 3 mm deep when the mortar is still pastic. The base coat shall be sufficiently cured not allow to dried.

4.2 Final Coat / Finishing Coat

A reasonable time (not more than 48 hours) shall be allowed after the application of the base coat for thorough drying before the application of the second coat. After soaking base coat thoroughly with water the mortar for second coat shall be applied .

The cement mortar for sand faced plaster shall have washed Kharasalis or similar type of approved sand with slightly larger proportion of coarse material. The proportion of cement to sand shall be 1:4. The approved quality of waterproofing compound shall be added as specified by manufacturer and approved by Engineer – In- Charge in external surface plastering. The water is added gradually to make the mixture homogeneous. The thickness of finishing coat shall not exceed 10mm. After application, the surface should be finished with a wooden flat, lined with cork and tapped gently to retain a coarse surface texture. When the finishing coat has hardened, the surface shall be kept moist continuously for 14 days.

The item includes providing rigid P. V. C. pipes of length aprox. 9" and fixing the same at interval of not more than 60cm c/c at the junctions of beam bottom and brick / block masonry work, prior backing coat plaster from outside.

Cement grout shall be poured through the pipes by attaching flexible PVC pipes with minimum head of 3000 mm till the entire gap under the beam is filled up with grout and set. The rigid PVC pipes should be removed the next day of grouting and cavities shall be immediately plugged with 1:3 cement mortar mixed with required water proofing compound.

5.0 POINTING

5.1 General

When the type of pointing is not mentioned in the item, sunk pointing is described below shall be carried out.

5.2 Raking Out Joints

Where the joints have not been raked out when the mortar is green, the joint shall be chipped (without damaging the masonry) to such a depth that the minimum depth of new mortar measured from either the sunk surface of the finished surface of the finished pointing or from the edge of the brick shall not be less than 12 mm, thoroughly cleaned off all loose particles with a stiff brush and thoroughly wetted.

5.3 Pointing

The mortar shall be pressed into the raked out joints with a pointing trowel. The mortar shall not spread over the corners, edges or the surface of the masonry. With a pointing tool, the mortar shall be neatly pressed back to about 3 mm or as directed. The vertical 'joints shall be pressed back similarly to match the horizontal joints. The surface of masonry shall be cleaned of all mortar.

6.0 CURING

Curing shall be started after 24 hours after finishing the plaster. The plaster shall be kept wet for a period of seven days. During this period it shall be suitably protected from all damages as directed by the Engineer-in-Charge. The dates on which the plastering is done shall be legibly marked on the various sections plastered so that curing for the specified period thereafter can be monitored.

Construction Safety

IS:3696 Safety Code For Scaffolds And Ladders. (Part I& II)

Measurement

IS:1200 Method Of Measurement Of Building Works.

IS:3385 Code Of Practice For Measurement Of Civil Engineering Works.

In the event that state, city or other governmental bodies have requirements more stringent than those set forth in this Specification, such requirement shall be considered part of this Specification and shall supersede this Specification where applicable.

6.1 General

The quality of materials and method and control of manufacture and transportation of all concrete work irrespective of mix, whether reinforced or otherwise, shall conform to the applicable portions of this Specification.

Engineer shall have the right to inspect the source(s) of material(s), the layout and operation of procurement and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and Engineer's approval obtained, prior to starting of concrete work.

6.2 Materials

All materials shall conform to the requirements laid in relevant Indian Standard Specification related to them.

6.3 Admixtures:

Admixtures may be used in concrete only with the approval of Engineer based upon evidence that, with the passage of time, neither the compressive strength nor its durability will reduce. Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement, or embedded steel parts. When calcium chloride is permitted to be used, such as in mass-concrete works, it shall be dissolved in water and added to the mixing water in an amount not to exceed 1½ percent of the weight of the cement in each batch of concrete. When admixtures are used, the designed concrete mix shall be corrected accordingly. Admixtures shall be used as per manufacturer's instructions and in the manner and with the control specified by Engineer.

6.4 Water proofing agent

Where specified and approved by Engineer, water proofing agent confirming to IS:2645, shall be added in quantities specified by Engineer.

6.5 Tests

All materials shall satisfy the relevant Indian Standards. It is the Contractor's obligation to carry out the tests at his cost at Laboratories approved by the Engineer and produce the necessary certificates in proof of the compliance of the material with the specification.

- Tests on cement shall include:
- Fineness test
- Test for normal consistency
- Test for setting time
- Test for soundness
- Test for tensile strength
- Test for compressive strength
- Test for heat of hydration (by experiment and by calculations) in accordance with IS:269.
- Tests on sand shall include :
- Sieve test
- Test for organic impurities
- Decantation test for determining clay and silt content
- Specific gravity test
- Test for unit weight and bulkage factor
- Test for sieve analysis and fineness modulus.
- Tests on coarse aggregate shall include
- Sieve analysis
- Specific gravity and unit weight of dry, loose and rodded aggregate
- Soundness and alkali aggregate reactivity
- Petrographic examination
- Deleterious materials and organic impurities
- Test for aggregate crushing value.

The Engineer, if he so desires, may order further tests to be carried out on cement, sand, coarse aggregate, water in accordance with the relevant Indian Standards.

Any or all these tests would normally be ordered to be carried out if Engineer feels the materials are not in accordance with the Specifications or if the specified concrete strengths are not obtained and shall be performed by Contractor at an approved test laboratory.

6.6 Standard Finish for Exposed Concrete

Exposed concrete shall mean any concrete, other than floors or slabs, exposed to view upon completion of the job.

Unless otherwise specified on the Drawings, the standard finish for exposed concrete shall be a smooth finish.

A smooth finish shall be obtained with the use of lined or plywood forms having smooth and even surfaces and edges. Panels and form linings shall be of uniform size and be as

large as practicable and installed with closed joints. Upon removal of forms the joint marks shall be smoothened off and all blemishes, projections, etc. removed leaving the surfaces reasonably smooth and unmarred.

6.7 Integral Cement concrete Finish

When specified on the Drawings an integral cement concrete finish of specified thickness for floors and slabs shall be applied either monolithic or bonded, as specified on the Drawings, as per IS: 2571. The surface shall be compacted and then floated with a wood float or power floating machine. The surface shall be tested with a straight edge and any high and low spots eliminated. Floating or trowelling of the finish shall be permitted only after all surface water has evaporated. Dry cement or a mixture of dry cement and sand shall not be sprinkled directly on the surface of the cement finish to absorb moisture or to stiffen the mix.

6.8 Rubbed Finish

A rubbed finish shall be provided only on exposed concrete surfaces as specified on the Drawings. Upon removal of forms, all fins and other projections on the surfaces shall be carefully removed, offsets leveled and voids and / or damaged sections immediately saturated with water and repaired by filling with a concrete or mortar of the same composition as was used in the surface. The surfaces shall then be thoroughly wetted and rubbed with carborundum or other abrasive. Cement mortar may be used in the rubbing, but the finished surfaces shall not be brush coated with either cement or grout after rubbing. The finished surfaces shall present a uniform and smooth appearance.

6.9 Protection

All concrete shall be protected against damage until final acceptance by Engineer / Owner.

Preparation of concrete surfaces

The preparation of concrete surfaces upon which additional concrete is to be placed later, shall preferably be done by scarifying and cleaning while the concrete is between its initial and final set. This method shall be used wherever practicable and shall consist of cutting the surface with picks and stiff brooms and by use of an approved combination of air and water jet as directed by Engineer. Great care shall be taken in performing this work to avoid removal of too much mortar and the weakening of the surface by loosening of aggregate.

When it is not practicable to follow the above method, it will be necessary to employ air tools to remove laitance and roughen the surface.

The final required result shall be a pitted surface from which all dirt, unsound concrete, laitance and glazed mortar have been removed.

6.10 Bonding Treatment (Mortar)

After rock or concrete surfaces upon which new concrete is to be placed have been scarified, cleaned and wetted as specified herein, they shall receive a bonding treatment, immediately before placement of the concrete.

The bonding medium shall be a coat of cement-sand mortar. The mortar shall have the same cement-sand proportions as the concrete which shall be placed on it. The water-cement ratio shall be determined by placing conditions and as approved by Engineer.

Bonding mortar shall be placed in sufficient quantity to completely cover the surface about 10 mm thick for rock surface and about 5 mm thick for concrete surfaces. It shall be brushed or broomed over the surface and worked thoroughly into all cracks, crevices and depressions. Accumulations or puddles of mortar shall not be allowed to settle in depressions and shall be brushed out to a satisfactory degree, as determined by Engineer.

Mortar shall be placed at such a rate that it can be brushed over the surface just in advance of placement of concrete. Only as much area shall be covered with mortar as can be covered with concrete before initial set in the mortar takes place. The amount of mortar that will be permitted to be placed at any one time, on the area which it is to cover, shall be in accordance with Engineer's directions.

Cleaning and bonding formed construction joints

Vertical construction joints shall be cleaned as specified above or by other methods approved by Engineer. In placing concrete against formed construction joints, the surface of the joints, where accessible, shall be coated thoroughly with the specified bed-joint bonding mortar immediately before they are covered with concrete or by scrubbing with wire brooms dipped into the fresh concrete. Where it is impracticable to apply such a mortar coating, special precautions shall be taken to ensure that the new concrete is brought into intimate contact with the surface of the joint by careful puddling and spading with aid of vibrators and suitable tools.

6.11 Expansion and contraction joints

Provision shall be made for expansion and contraction in concrete by use of special type joints at locations shown on the Drawing. Contraction joint surfaces shall be treated as per the Specifications on the Drawings or as directed by Engineer.

6.12 Preparation of Mortars and Its Grade

Grade of Masonry Mortar

The grade of masonry mortar will be defined by its compressive strength in N/mm2 at the age of 28 days as determined by the standard procedure detailed in IS:2250-1981.

For proportioning the ingredients by volume, the conversion of weight into volume shall be made on the following basis:

Dry hydrated lime 700 kg/cum

Burnt Clay Pozzolana 860 kg/cum

Lime Pozzolana mixture 770 kg/cum

Coarse Sand (dry) 1280 kg/cum

Fine sand (dry) 1600 kg/cum

fly Ash 590 kg/cum

Cement Mortar: This shall be prepared by mixing cement and sand with or without the addition of Pozzolana as specified.

Proportioning: Cement bag weighting 50 kg shall be taken as 0.035 cubic metre. Other ingredients in specified proportion shall be measured using boxes of size 40 X 35 X 25 cm. Sand shall be measured on the basis of its dry volume.

Mixing: The mixing of mortar shall be done in mechanical mixers operated manually or by power as decide by Engineer. The Engineer may, however, permit hand mixing at his discretion taking into account the nature, magnitude and location of the work and practicability of the use of mechanical mixers or where item involving small quantities are to be done or if in his opinion the used of mechanical mixer is not to be used, the Contractor shall take permission of the Engineer in writing before the commencement of the work.

Mechanical Mixing: Cement and sand in the specified proportions shall be mixed dry thoroughly in a mixer. Water shall then be added gradually and wet mixing continued for at least three minutes. Only the required quantity of water shall be added which will produce mortar of workable consistency but not stiff paste. Only the quantity of mortar, which can be used within 30 minutes of its mixing shall be prepared at a time. Mixer shall be cleaned with water each time before suspending the work.

Hand Mixing: The measured quantity of sand shall be leveled on a clean masonry platform and cement bags emptied on top. The cement and sand shall be thoroughly mixed dry by being turned over and over, backwards and forwards, several times till the mixture is of a uniform colour. The quantity of dry mix which can be used within 30 minutes shall then be mixed in a masonry trough with just sufficient quantity of water to bring the mortar to a stiff plaster of necessary working consistency.

Precautions: Mortar shall be used as soon as possible after mixing and before it begins to set, and in any case within half hour, after the water is added to the dry mixture.

Exposed Aggregate Plaster

The base plaster of cement mortar of specified mix and thickness is to be done with surface true to plumb and floated hard. Necessary grooves of 20 mm x 15 mm shall be provided as shown in the drawing or as directed, in the base plaster. The plastered surface shall be properly ranked, cement paste shall be applied on a limited area at a time so that it would not become hard before granite chips are applied. The granite chips to be used shall be 6mm gauge of hard approved variety screened, washed and dried properly and shall be applied by means of floats or trowels, dashing them against the still fresh cement paste already applied. where uniform texture is not obtained chips shall be stuck suitably by hand. care should be taken that application of cement paste shall be done uninterruptedly within one panel so that joints and patches are avoided. precautionary steps should be taken to protect the surface already done during the process of finishing adjoining areas so that the areas completed shall not get stained.

D. STRUCTURAL STEEL (Ornamental)

1.0 SCOPE:

This specification covers Preparation of fabrication drawings, Providing all materials, fabricating, transporting, erection in position to proper lines and levels, fixing, steelwork for various structures and painting / other protection of steelwork for structures including fixtures, fittings, temporary works and supports, and ancillaries. The steelwork may have to be fabricated out of steel shapes, plates, hollow sections, pipes, cast steel, forgings etc and may involve any or combination of two or more of these in sizes, quantity and quality as specified in the drawings or as directed by the Engineer. The steelwork may consist of

all types such as columns, beams, trusses, wall beams, girders, brackets, base-plates, floorings, anchors, stairs bracings or of any other kind as shown in the drawings or as required by the Engineer. Painting would involve cleaning by sand blasting to appropriate degree and specifications as given and painting with various combinations of primary and intermediate and final coats of specified thickness.

The Contractor shall furnish all the materials, skilled staff and labour, transportation, equipment, tools, tackles, temporary work and all other things that may be required for carrying out the work described above as per drawings, specifications and the instructions of the Engineer.

CODES AND STANDARDS:

Codes and standards applicable are given in the list below, which however shall not limit the applicable standards or codes or directions of the Engineer.

Table – Codes of Practice and Standards

Specification	Description
IS: 800	Code of practice for general construction in steel
IS: 808	Dimensions of hot rolled steel beam, column channel and angle sections
IS: 813	Scheme of symbols for welding
IS: 814	Covered electrodes for manual metal arc welding of Carbon and carbon-manganese steel
IS: 816	Code of practice for use of metal arc welding in general mild steel construction
IS: 817	Code of practice for training and testing of metal arc welders
IS: 818	Code of Practice for safety and health requirements in electric and gas welding and cutting operations
IS: 822	Code of procedure for inspection of welds
IS: 823	Code of procedure for manual metal arc welding of mild steel
IS: 1030	Carbon Steel castings for general engineering purposes
IS: 1161	Steel tubes for structural purposes
IS: 1181	Qualifying tests for metal arc welders
IS: 1182	Recommended practice for radiographic examination of fusion welded butt joints in steel plates
IS: 1363 (1&2)	Hexagon head bolts and nuts of product grade C
IS: 1364 (1-5)	Hexagon head bolts and nuts of product grade A and B
IS: 1367 (1-20)	Technical supply conditions for threaded steel fasteners
IS: 1387	General requirements for the supply of metallurgical materials
IS: 1477 (1 & 2)	Code of Practice for painting ferrous metals in buildings

IS: 1599	Method for bent test
IS: 1608	Mechanical testing of metals – tensile testing
IS: 1730	Steel plates, sheets and strips and flats for general engineering purposes – dimensions
IS: 1852	Rolling and cutting tolerances for hot rolled steel products
IS: 2004	Carbon Steel forgings for general engineering purposes
IS: 2016	Plain washers
IS: 2062	Steel for general structural purposes – (supersedes IS: 226)
IS: 2595	Code or practice for radiographic testing
IS: 3502	Steel chequered plates
IS: 3613	Acceptance test for wire flux combination for submerged arc welding
IS: 3640	Hexagon fit bolts
IS: 3658	Code of practice for liquid penetrant flaw detection
IS: 3664	Code of practice for ultrasonic pulse echo testing by contact and immersion methods
IS: 3696	Safety codes for scaffolds and ladders
IS: 3757	High strength structural bolts
IS: 4353	Submerged arc welding of mild steel and low alloy steels – recommendations
IS: 4923	Hollow steel sections for structural use
IS: 5334	Code of practice for magnetic particle flaw detection of welds
IS: 5372	Taper washers for channel
IS: 5624	Foundation bolts
IS: 6610	Heavy washers for steel structures
IS: 6639	Hexagon bolts for steel structures
IS: 7205	Safety code for erection of structural steelwork
IS: 7215	Tolerances for fabrication of steel structures
IS: 7293	Safety code for working with construction machinery
IS: 9595	Metal arc welding of carbon and carbon manganese steels – recommendations
IS: 12843	Tolerances for erection of steel structures
SP: 34	Handbook of concrete reinforcement and detailing

2.0 INSPECTION

It is presumed that the site has been inspected and all site conditions noted that might affect the selection of erection method, plant requirements and such details. The method and units of transportation of structures from fabrication yards to site would also depend on the location of fabrication yards, the dimensions and grades of the connecting roads and the approach to the erection location. It is necessary that during the work the existing structures (where there are some) are not damaged or affected anyway by the present work.

3.0 STRUCTURAL STEEL

3.1 General

3.1.1 General requirements relating to the supply of material shall conform to the specifications of IS: 1387, for the purpose of which the supplier shall be the Contractor and the purchaser shall be the Engineer.

3.1.2 Finished rolled material shall be free from cracks, flaws, injurious seams, laps, blisters, ragged and imperfect edges and other defects. It shall have a smooth and uniform finish, and shall be straightened in the mill before shipment. They shall also be free from loose mill scale, rust, pits or other defects affecting its strength and durability.

The acceptance of any material on inspection at the mill i.e. rolling mills, foundry or fabricating plant where material for the work is manufactured, shall not be a bar to its subsequent rejection, if found defective.

3.1.3 In general, steelwork connections shall be by bolting and welding. Mild steel or high tensile bolts shall be used as indicated in the drawings.

4.0 OTHER MATERIALS

4.1 All materials shall conform to Special requirements as given below:

4.2 Mild steel for bolts and nuts shall conform to IS: 2062 but have a minimum tensile strength of 44 kg/sq. mm. and minimum percentage elongation of 14. High tensile steel for bolts and nuts shall conform to IS: 8500 but with a minimum tensile strength of 58 kg/sq. mm.

4.3 For cast steel, the yield stress shall be determined and shall not be less than 50 percent of the minimum tensile strength.

4.4 Plain washers shall be of steel. Tapered or other specially shaped washers shall be of steel, or malleable cast iron.

4.5 Parallel barrel drifts shall have a tensile strength not less than 55 kg/sq. mm, with elongation of not less than 20 percent measured on a gauge length of 4 So (So = cross sectional area).

4.6 Materials for castings and forgings, fasteners and welding consumables shall be as under:

i) Castings and Forgings: Steel castings and forgings shall comply with the requirements of the following Indian Standards, as appropriate:

IS: 1030 Carbon Steel Castings for General Engineering purposes

IS: 1875 Carbon Steel Billets, blooms, slabs, bars for forgings

IS: 2004 Carbon Steel Forgings for General Engineer purposes

IS: 2644 High Tensile Steel Casings

IS: 4367 Alloy & tool steel forgings for general industrial use

5.0 STEEL PROTECTION SYSTEM

Generally all steelwork shall be sand / shot blasted to SA – 2-1/2 (SIS 055900) and given the following coats of paint.

One coat of zinc anode epoxy primer (or equivalent of similar properties) with a minimum dry film thickness of 75 microns per coat

An intermediate coat of epilux 950 super high build coating (or equivalent of similar properties) with a dry film thickness of 200 microns

Two coats of acrylic polyurethane enamel minimum dry film thickness of 30/35 microns per coat

Unless otherwise specified, paints shall conform to the relevant IS specifications. The paints that have been tested as per specifications only shall be used. Where there are no specifications, manufacturer's recommendation shall be followed.

6.0 FABRICATION

6.1 General

All work shall be in accordance with the drawings approved and released by the Engineer for construction, as per these specifications and as instructed by the Engineer. Care should be exercised by the Contractor to ensure that all parts of an assembly are so well fabricated to fit accurately together. All members shall carry a mark number and an item number and, if required, serial no.

Unless specifically required under the contract, corresponding parts for identical units need not be interchangeable, but the parts shall be match marked.

Templates and other appliances used for ensuring the accuracy of the work shall be of mild steel. All measurements for fabrication shall be made by means of accurate steel tapes or other devices properly calibrated.

All structural steel members and parts shall have straight edges and blunt surfaces. If necessary they shall be straightened or flattened by pressure unless they are required to be of curvilinear forms. They shall also be free from twist. Pressure applied for straightening or flattening shall be such that would not injure the materials. Hammering shall not be permitted. Adjacent surface or edges shall be in close contact or at uniform distance throughout.

The contractor shall submit his program of work to the Engineer for his approval at least 15 days before commencement of fabrication. This program shall include the proposed system of identification and erection marks together with complete details of fabrication and welding procedures.

The Contractor shall prepare shop drawings for fabricating the components of steelwork and obtain approval of the Engineer a week before the start of work on the components. Complete information regarding the location, type, size and extent of all welds shall be clearly shown on the shop drawings. The drawings shall distinguish between shop and field welds.

6.2 Preparation of Edges and Ends

All structural steel parts, where required, shall be sheared, cropped, sawn or flame cut and ground accurately to the required dimension and shape.

End/edge planning and cutting shall be done by any one of the following prescribed methods or left as rolled:

Shearing, cropping, sawing, machining, machine flame cutting.

Hand flame cutting with subsequent grinding to a smooth edge.

Sheared edges of plate not more than 16mm thick with subsequent grinding to smooth profile, which are of secondary use such as stiffeners and gussets.

If the ends of stiffeners are required to be fitted, they shall be ground, so that the maximum gap over 60% of the contact area does not exceed 0.25 mm.

Where the flame cutting or shearing is used, at least one of the following requirements shall be satisfied.

The cut edge is not subject to applied stress.

The edge is incorporated in weld.

The hardness of cut edge does not exceed 350 HV 30.

The material is removed from the edge to the extent of 2 mm or minimum necessary, so that the hardness is less than 350 HV 30.

Edge is suitably heat treated by approved method to the satisfaction of the Engineer and shown that crack had not developed by dye penetrant or magnetic particle test.

Thickness of plate is less than 40 mm for machine flame cutting for materials conforming to IS: 2062. The requirement of hardness below 350 HV 30 of flame cut edges should be specified by the Engineer.

Where machining for edge preparation in butt joint is specified, the end shall be machined after the members have been fabricated. Outside edges of plate and section, which are prone to corrosion shall be smoothed by grinding or filing. In the case of high tensile steel at least 6 mm of the material from the flame cut edge shall be removed by machining. Longitudinal edges of all plate and cover plates in plate girders and built-up members shall be ground to correct dimensions except in the following cases:

Covers to single flange plates may be left un-machined.

Machine flame cutting instead of machining is acceptable for edges of single plates, 25 mm or less thick, in tension.

Edges of single shaped plates over 25 mm thick may be machine flame cut and the end surface ground.

Edges of plates or flats of the same nominal width in tiers may be left un-machined, if so authorised by the Engineer.

All edges of splice and gusset plates may be sheared and ground. The ends of plates and sections forming the main components of plate girders or of built-up members may be machine flame cut, sawn or hand flame cut and ground. Where ends of stiffeners are required to be fitted, they shall be machined, machine flame cut, swan, sheared and ground, or hand flame cut and ground. The ends of lacing bar shall be rounded unless otherwise required. Other edges and ends of mild steel parts may be sheared and any burrs at edges shall be removed.

6.3 Preparation of Holes

6.3.1 Drilling and Punching: Holes for black bolts, high strength bolts and counter sunk bolts (excluding close tolerance and turn fitted bolts) shall be either punched or drilled. The diameter of holes shall be 1.5 mm larger for bolts less than 25 m. dia and 2.0 mm for more than or equal to 25 mm.

All the holes shall be drilled except for secondary members such as, floor plate, handrails etc. Members which do not carry the main load can be punched subject to the thickness of member not exceeding 12 mm for material conforming to IS: 226.

Holes through one thickness of material or when any of the thickness exceeds 20 mm for steel conforming to IS: 2062 or 16 mm for conforming to IS: 8500, shall either be sub-drilled or sub-punched to a diameter of 3 mm less than the required size and then reamed to the required size. The reaming of material more than one thickness shall be done after assembly.

Where several plates or sections form a compound member, they shall where practicable, be firmly connected together by clamps or tacking bolts, and the holes be drilled through the group in one operation. Alternatively, and in the case of repetition work, the plates and sections may be drilled separately from templates that shall be checked periodically. All burrs shall be removed.

Shop erection / assembly shall be done wherever so required by the engineer.

6.3.2 Where block drilling is done, care shall be taken to check that the holes are not out of position or are dimensionally correct

6.3.3 Size of Holes: The sizes of holes in millimeters are given in table 1 below:

Table-1: Diameter of holes for bolts

Nominal dia of Bolts (mm)	Dia of Holes (mm)
12	13.5
14	15.5
16	17.5
18	19.5
20	21.5
24	25.5
27	29.0
30	31.0
31	33.0

Close tolerance bolts and barrel bolts: Holes for close tolerance and turn fitted bolts. The diameter of the holes shall be equal to the nominal diameter of the bolt shank minus 0.15 mm to 0.0 mm. The member to be connected with close tolerance or turn fitted bolts shall be firmly held together by service bolts or clamped and drilled through all thickness in one operation and subsequently reamed to required size within specified limit of accuracy as specified in IS: 919 tolerance grade H8.The holes not drilled through all thickness at one operation shall be drilled to smaller size and reamed after assembly.

Holes for high strength friction grip bolts: All holes shall be drilled after removal of burrs. Where the number of plies in the grip does not exceed three, the diameters of holes shall be 1.6 mm larger than those of bolts and for more than three plies in grip, the diameter of

hole in outer plies shall be as above and dia of holes in inner plies shall not be less than 1.6 mm and not more than 3.2 mm larger than those in bolts, unless otherwise specified by the Engineer.

6.3.4 Removal of Burrs: The work shall be taken apart after drilling and all burs left by drilling and the sharp edges of all rivet holes completely removed.

7.0 BOLTS, NUTS AND WASHERS:

7.1 Black bolts (black all over): Black bolts are forged bolts in which the shanks, heads and nuts do not receive any further treatment except cutting of screw threads. They shall be true to shape and size and shall have the standard dimensions as shown on the drawings.

7.2 Close tolerance bolts: Close tolerance bolts shall be faced under the head and turned on the shank.

7.3 Turned barrel bolts: The diameter of the screwed portion of turned barrel bolts shall be 1.5 mm smaller than the diameter of the barrel unless otherwise specified by the Engineer. The diameter of the bolts as given on the drawing shall be the nominal diameter of the barrel. The length of the barrel shall be such that it bears fully on all the parts connected. The threaded portion of each bolt shall project through the nut by at least one thread. Faces of heads and nuts bearing on steel work shall be machined.

7.4 Washers:

In all cases where the full bearing area of the bolt is to be developed, the bolt shall be provided with a steel washer under the nut of sufficient thickness of the parts bolted together and to prevent the nut when screwed up, from bearing of the bolt.

For close tolerance or turned barrel bolts, steel washers whose faces give a true bearing shall be provided under the nut. The washer shall have a whole diameter not less than 1.5 mm larger than the barrel and a thickness of not less than 6 mm so that the nut when screwed up will not bear on the shoulder of the bolt.

Taper washers with correct angle of taper shall be provided under all heads and nuts bearing on beveled surfaces. Spring washers may be used under nuts to prevent slackening of the nuts when excessive vibrations occur. Where the heads or nuts bear on timber, square washers having a length of each side not less than three times the diameter of bolts or round washers having a diameter of 3½ times the diameter of bolts and with a thickness not less than one quarter of diameter shall be provided.

7.5 Studs

Ordinary studs may be used for holding parts together, the holes in one of the parts being tapped to take the thread of the stud. Counter-sunk studs may be used for making the connections where the surfaces are required to be cleared of all obstruction, such as protruding heads of bolts, studs may also be welded on the steel work in the positions required.

7.6 Service bolts:

Service bolts shall have the same clearance as black bolts and where it is required that there should be no movement prior to final riveting, sufficient drifts or close tolerance bolts shall be used to locate the work.

7.7 Tightening bolts:

Bolted connection joints with black bolts and high strength bolts shall be inspected for compliance of Code requirements.

The Engineer shall observe the installation and tightening of bolts to ensure that correct tightening procedure is used and shall determine that all bolts are tightened. Regardless of tightening method used, tightening of bolts in a joint should commence at the most rigidly fixed or stiffest point and progress towards the free edges, both in initial and in final tightening. The tightness of bolts in connection shall be checked by inspection wrench, which can be torque wrench, power wrench or calibrated wrench.

Tightness of 10% bolts, but not less than two bolts, selected at random in each connection shall be checked by applying inspection torque. If no nut or bolt head is turned by this application, connection can be accepted as properly tightened, but if any nut or head has turned all bolts shall be checked and, if necessary, re-tightened.

7.8 Drifts-

The barrel shall be drawn or machined to the required diameter for a length of not less than one diameter over the combined thickness of the metal through which the drifts have to pass. The diameter of the parallel barrel shall be equal to the nominal diameter of the hole subject to a tolerance of +0 mm and –0.125 mm. Both ends of the drift for a length equal to 1½ times the diameter of the parallel portion of the bar shall be turned down with a taper to a diameter at the end equal to one-half that of parallel portion.

7.9 Pins and pin holes

7.9.1 Pins: The pins shall be parallel throughout and shall have a smooth surface free from flaws. They shall be of sufficient length to ensure that all parts connected thereby shall have a full bearing on them. Where the ends are threaded, they shall be turned to a smaller diameter at the ends for the thread and shall be provided with a pilot nut, where necessary, to protect the thread when being drawn to place. Where the ends are not threaded suitable cotter arrangements shall be made to prevent pin from working loose. Pins more than 175 mm in length or diameter shall be forged and annealed.

Pinholes: Pinholes shall be bored true to gauge, smooth, straight at right angles to the axis of the member and parallel with each other, unless otherwise required. The tolerance in the length of tension members from outside to outside of pinholes and of compression members from inside to inside of pinholes shall be as specified in the drawings. In built up members, the boring shall be done after the members have been riveted or welded. Where specified proper brass / gunmetal bushes shall be provided in the pinholes. The specified diameter of the pinhole shall be its minimum diameter. The resulting clearance between the pin and the hole shall be not less than 0.5 mm and not more than 1.0 mm or otherwise as specified in the drawings.

8.0 SHOP ERECTION AND MATCH MARKING

Sub-sections of the steelwork, if so required by the Engineer, shall be temporarily erected in the fabrication shop before dispatch to site, for the Engineer's inspection. The quality of fabrication, and the alignment and fit of all connections would be checked. For this purpose a sufficient number of parallel drifts and service bolts that tightly screw up, shall be employed. All parts shall fit accurately and be in accordance with drawings and specifications. After the Engineer's approval, any sub-size holes left shall be reamed to size and materials match marked and dispatched to site. The Engineer shall be the sole authority to decide the extent of shop erection required

After the work has been approved by the Engineer and before it is dismantled, each part shall be carefully marked for erection with distinguished marks and stamped with durable markings. Drawings showing these markings correctly shall be supplied to the Engineer.

Unloading, handling and storage of steel work as per these specifications shall be the responsibility of the Contractor. The cost of repairs or rejected material, its removal and the cost of transporting replacement material to the site shall be borne by the Contractor.

9.0 WELDING

All welding shall be done with prior approval of the Engineer and the workmanship shall conform to the specifications of IS: 823 or other relevant Indian Standards as appropriate.

When material thickness is 20 mm or more, special precaution like preheating shall be taken as laid down in IS: 823. Surfaces and edges to be welded shall be welded smooth, uniform and free from fins, tears, cracks and other discontinuities. Surfaces shall also be free from loose or thick scale, slug rust, moisture, oil and other foreign materials. Surfaces within 50 mm of any weld location shall be free from any paint or other material that may prevent proper welding or cause objectionable fumes during welding.

The general welding procedures including particulars of the preparation of fusion faces for metal arc welding shall be carried out in accordance with IS: 9595.

The welding procedures for shop and site welds including edge preparation of fusion faces shall be submitted in writing in accordance with Clause 22 of IS: 9595 for the approval of the Engineer before commencing fabrication and shall also be as per details shown on the drawings. Any deviation from above has to be approved by the Engineer. Preparation of edges shall, wherever practicable done by machine methods.

Machine flame cut edges shall be substantially as smooth and regular as those produced by edge planning and shall be left free of slag. The Engineer shall permit manual flame cutting only where machine cutting is not practicable.

Electrodes to be used for metal arc welding shall comply with relevant IS specifications. Test shall be carried forward as per IS: 8613 to find out suitable wire flux combination for welded joint.

Assembly of parts for welding shall be in accordance with provisions of IS: 9595.

The welded temporary attachments should be avoided as far as possible, otherwise the method of making any temporary attachments shall be removed by cutting, and chipping and surface shall be finished smooth by grinding to the satisfaction of the Engineer.

Welding shall not be done when the air temperature is less than 10 degrees Celsius. Welding shall not be done when the surfaces are moist, during periods of strong winds or snowy weather unless the work and the welding operators are adequately protected.

For welding of any particular type of joint, welders shall qualify to the satisfaction of the Engineer in accordance with appropriate welders qualification tests as prescribed in any of the Indian Standards IS: 817, IS: 1393, IS: 7307(PART I), IS: 7310(PART I) and IS: 7318(PART I) as relevant.

In assembling and joining parts of a structure or of built up members, the procedure and sequence of welding shall be such as to avoid distortion and minimise shrinkage stress.

All requirements regarding pre heating of parent material and inter pass temperature shall be in accordance with provision of IS: 9595

Peening of weld shall be carried out wherever specified by the Engineer:

If specified peening may be employed to be effective on each weld layer except first.

The peening shall be carried out after weld has cooled out by light blows from a power hammer using a round nose tool. Care shall be taken to prevent scaling or flaking of weld and base metal from over peening.

Where the Engineer has specified the butt welds are to be ground flush, the loss of parent metal shall not be greater than that allowed for minor surface defects. The end of butt joints shall be welded so as to provide full throat thickness. This may be done by use of extension pieces, cross runs or other means approved by the Engineer. Extension pieces shall be removed after the joint has cooled and the ends of the welds shall be finished smooth and flush with the faces of the abutting parts.

The joints and welds listed below are prohibited type, which do not perform well under cyclic loading.

i) Butt joints not fully welded throughout their cross section

ii) Groove welds made from one side only without any backing grip

iii) Intermittent groove welds

iv) Bevel grooves and J grooves in butt joints for other than horizontal position

v) Plug and slot welds

The run on and run off plate extension shall be used providing full throat thickness at the end of butt-welded joints. These plates shall comply with the following requirements.

One pair of run on and one pair of run off plates prepared from same thickness and profile as the parent metal shall be attached to start and finish of all butt welds preferably by clamps. When run on and run off plates shall be removed by flame cutting, it should be cut at more than 3 mm from parent metal and remaining metal shall be removed by grinding or by any other method approved by the Engineer.

10.0 TOLERANCES:

The tolerances in fabrications shall be governed by IS: 7215. Tolerances in dimensions of components of fabricated structural steel work shall be specified on the drawings and shall be subject to the approval of the Engineer before fabrication. Unless specified all parts of an assembly shall fit together accurately within tolerances specified in Table –2. A machine bearing surface, where specified by the Engineer, shall be machined with a deviation of 0.25mm for surfaces that can be inscribed within a square of side 0.5 m.

TABLE -2 FABRICATION TOLERANCES

SNO	DESCRIPTION OF WORK / ITEM	TOLERANCE
	INDIVIDUAL COMPONENTS	
1	LENGTH	
	a) Member with both ends finished for contact bearing	± 1mm
	b) individual components of members with end plate connection	+ 0 mm,-2 mm
	c) Other members i) up to and including 12 m	± 2 mm
	Other members ii) over 12 m	± 3.5 mm
2	WIDTH	
	a) width of built-up girders	± 3 mm
	b) Deviation in the width of members required to	+ 0 mm

SNO	DESCRIPTION OF WORK / ITEM	TOLERANCE
	be inserted in other members	- 3 mm
3	DEPTH	
	Deviation in the depth of the solid web and open web girder	+3 mm, -2 mm
4	STRAIGHTNESS	
	a) Deviation from straightness of columns (L – length of member)	L/3000 with max of 15 mm
	i) in elevation	+5 mm,- 0 mm
	ii) in plan	L/1000 with max. of 10 mm
5	Deviation of centre line of web from centre line of flanges in built up members at contact surfaces	3mm
6	Deviation from flatness of plate of webs of built members in a length equal to depth of member (d- depth of member)	0.005 d with max of 2 mm
7	Tilt of flange of plate girders (b – width of the member)	
	i) At splices and stiffeners, at supports, at the top flanges of plate girders and at bearings	0.005 b with a max of 2 mm
	ii) at other places	0.015 b with a max of 4 mm
8	Deviation from square ness of the flange to web of columns and box girders (L is nominal length of the diagonal)	L/1000
9	Deviation from squareness of fixed base plate (not machined) to axis of column. This dimension shall be measured parallel to the longitudinal axis of the column at points where the outer surfaces of the column sections make contact with the base plate (D- the distance from the column axis to the point under consideration on the base plate)	D/500
10	Deviation from square ness of machined ends to axes of columns (D- same as in 9 above)	D/1000
11	Deviation from square ness of machined ends to axes of beams of girder (D- same as in 9 above)	D/1000
12	Ends of member abutting at joints through cleats or end plates, permissible deviation from the square ness of ends	1/600 of depth of member subject to a max of 1.5 mm

11.0 PACKING AND TRANSPORT

All projecting plates and bars and all ends of members at joints shall be stiffened, all straight bars and plates shall be bundled, all screwed ends and machined surfaces shall be suitably packed and all bolts, nuts, washers and small loose parts shall be packed separately in cases, so as to prevent damage or distortion. Care shall be taken during loading and unloading so that no material sustains damage and materials are not mixed up.

The materials shall be carefully transported and unloaded at site of erection, exercising great care not to damage the materials in any manner. They shall be stored as per

erection marks and sizes with small materials being stored in sheds to prevent loss or mixing up.

12.0 ERECTION

12.1 General

The provisions of this item shall apply of erection of steelwork in the various structures either in the roof or elsewhere. The contractor shall transport the fabricated steel to the erection site. This should be done without damaging the steelwork in any manner. Even so the steelwork shall be subject to the Engineer's inspection and minor rectification if needed shall be carried out as directed by the Engineer.

The steelwork shall be erected in position to lines and levels as shown in the drawings with or without enabling works. It will be welded or bolted in final position all as shown in the drawings. The contractor shall take all safety precautions to prevent any damage to the work or any accident. After erection and necessary welding / bolting is approved by the Engineer, the Contractor shall touch up the shop paints as necessary and shall apply the required coats of paint as shown in the drawings. After approval of painting, further work on the structure such as sheeting etc shall be carried and do all the work required to complete the construction included in the contract in accordance with the drawings and the specification and to the entire satisfaction of the Engineer.

12.2 Organization and Equipment

The contractor shall submit a complete erection scheme for the approval of the Engineer showing the equipment that he would be a method and procedure of erection, compatible with details of fabrication. As time is of the very essence, the means to achieve fast and accurate work shall be employed. The approval of the Engineer shall not relieve the contractor of his responsibility for the safety of his method or equipment or from carrying out the work fully in accordance with the drawings of the specifications.

A detailed scheme must be prepared showing stage-wise activities, with complete drawings and phase-wise working instructions. This should be based on detailed stage-wise calculation and take into account specifications and capacity of erection machinery, tools, tackles to be used and temporary working loads as per Code provisions. Temporary work where used shall be supported by design and calculations.

The scheme should be based on site conditions, erection machinery employed, available working space, length and weight of members to be handled. The accent of the scheme shall be safe working and avoidance of any risk of accident.

The scheme should indicate precisely the type of temporary fasteners to be used as also the minimum percentage of permanent fasteners to be fitted during the stage erection. The working drawings should give clearly the temporary, fixtures, clamps, spacer supports, etc.

Unless otherwise provided in the contract, the contractor shall supply and erect all necessary false work and staging and shall supply all labour, tools, erection plant and other materials necessary to carry out the work complete in all aspects.

The contractor shall supply all types, bolts, nuts, washers, etc. required to complete erection at site with allowance for wastage, etc., of 10% of the net number of field bolts, washers required, or a minimum of five number of each item.

Service bolts and nuts, ordinary plate washers and drifts for use in the erection of works shall be supplied at 25% of the number of the permanent bolts in the work.

Prior to actual commencement of erection all equipment, machinery, tools, tackles, ropes, etc. need to be tested to ensure their safe and efficient working. Frequent visual inspection is essential in vulnerable areas to detect displacements, distress etc.

For welded structure, welders' qualifications and skill are to be checked as per standard norms. Safety requirements should conform to IS: 7205, IS: 7273 and IS: 7269 as applicable. Safety shall be the paramount consideration in erection work.

Erection work should start with complete resources mobilized as per latest approved drawings and after a thorough survey of foundations and other related structural work. The structure should be divided into erectable modules as per the scheme.

This should be pre-assembled in a suitable yard/platform and its matching with members of the adjacent module checked by trial assembly before erection.

The structure shall be set out to the required lines and levels. The steelwork should be erected, adjusted and completed in the required position to the specified line and level s with sufficient drifts and bolts. Packing materials are to be available to maintain this condition. Organised "Quality Surveillance" checks need to be exercised frequently.

During the progress of work, the Contractor shall have a competent Engineer and a skilled Foreman in charge of the work, who shall be adequately experienced in steel erection and acceptable to the Engineer.

12.3 Handling and storing Materials

Suitable area for storage of structures and components shall be located near the site of work. The access road should be free from water logging during the working period and the storage area should be on leveled and firm ground.

The store should be provided with adequate handling equipments e.g. road mobile crane, gantries, derricks, chain pulley blocks, winch of capacity as required. Stacking area should be planned and have racks, stands sleeper, access tracks, etc., and properly lighted.

Storage should be planned to suit work sequence and avoid damage or distortion. Rusted, bent or damaged steel shall be rejected. Methods of storage and handling steel, whether fabricated or not shall be subject to the approval of Engineer and should be accessible to handling equipment.

Small fitting hand tools are to be kept in containers in covered stores.

All materials, consumables, including raw steel or fabricated material shall be stored specification-wise and size-wise above the ground upon platforms, skids or other supports. It shall be kept free from dirt and other foreign matter and shall be protected as far as possible from corrosion and distortion. The electrodes shall be stored specification-wise and shall be kept in dry warm condition in properly designed racks. The bolts, nuts, washers and other fasteners shall be stored on racks above the ground with protective oil coating in gunny bags and suitably marked. It is essential to ensure that bolts of different strengths / sizes are not mixed up. The paint shall be stored under cover in airtight containers.

IS: 7293 and IS: 7969 dealing with handling of materials and equipments for safe working should be followed. Safety nuts and bolts as directed are to be used while working. The Contractor shall be held responsible for loss or damage to any material paid for by the Department while in his care or for any damage to such material resulting from his work.

12.4 Straightening Bent Material

The straightening of plates, angles and other shapes shall be done with prior approval of the Engineer by methods not likely to produce fracture or any injury. The metal shall not be heated unless permitted by the Engineer for special cases, when the heating shall not be to a temperature higher than that producing a dark “cherry red” colour, followed by as slow cooling as possible.

Following the straightening of a bend or buckle the surface shall be carefully investigated for evidence of fracture. Sharp kinks and bends may be the cause for rejection of material.

12.5 Assembling Steel

The parts shall be accurately assembled as shown on the drawings and match marks shall be followed. The material shall be carefully handled so that no parts will be bent, broken or otherwise damaged. Hammering which will injure or distort the members shall not be done. Bearing surface or surfaces to be in permanent contact shall be cleaned, given a coat of contact paint before the members are assembled. All joint surface for bolted connections including bolts, nuts, washers shall be free from scale, dirt, burrs, other foreign materials and defects that would prevent solid seating of parts. The slope of surface of bolted parts in contact with bolt head and nut shall not exceed 1 in 20, plane normal to bolt axis, otherwise suitable tapered washer shall be used.

All fasteners shall have a washer under nut or bolt head whichever is turned in tightening. Any connection to be bolted shall be secured in close contact with service bolts or before the connections are finally bolted. Joints shall normally be made by filling not less than 50 percent of holes with service bolts and barrel drifts in the ratio 4:1. The service bolts are to be fully tightened up as soon as the joint is assembled. Connections to be made by close tolerance or barrel bolts shall be completed as soon as practicable after assembly.

Any Connection to be site welded shall be securely held in position by approved methods to ensure accurate alignment, camber and elevation before welding is commenced. The field welding, bolted and pin connection shall conform to the Code requirements. The correction of minor misfits involving harmless amounts of reaming, cutting and chipping will be considered a legitimate part of erection. However, any error in the shop fabrication or deformation resulting from handling and transportation which prevents proper assembling and fitting up of parts by moderate use of drifts or by a moderate amount of reaming and slight chipping or cutting shall be reported immediately to the Engineer and his approval of the method of correction obtained. The correction shall be made in the presence of the Engineer.

Erection tolerance: The unloaded steel structure, as erected shall satisfy the criteria specified in the following table within specified tolerance limits. Each criterion given in the table shall be considered as a separate requirement, to be satisfied independently of any other tolerance criterion.

The erection tolerances specified in the table apply to the following reference points:

- For a column, the actual centre point of the column at each floor level and at the base, excluding any base-plate or cap-plate. The level of the base plate on pedestal shall be so as to avoid contact with the soil and corrosion environment. For a beam the actual centre point of the top surface at each end of the beam, excluding any end plate.

Permissible tolerances after erection

Criterion	Permitted deviation
Deviation of distance between adjacent columns	5 mm
Inclination of a column in a multi-storey building between adjacent floor levels	0.002 h where h is the storey height
Deviation of location of a column in a multi-storey building at any floor level from a vertical line through the intended location of the column base	.0035 □ hb / n 0.5 where □hb is the total height from the base to the floor level concerned and n is the number of storeys from the base to the floor level concerned
Inclination of a column in a single storey building, (not supporting a crane gantry) other than a portal frame	0.0035 h c where h c is the height of the column
Inclination of the column of a portal frame (not supporting a crane gantry)	Mean 0.002 h c Individual 0.010 h c Where h c is the height of the column

A tension member shall not deviate from its correct position relative to the members to which it is connected by more than 3 mm along any setting axis.

Setting Column bases and grouting: Column bases shall be set so that the column load is uniformly transmitted to the foundation with column centre line aligned with the foundation as shown in the drawings. The location and layout of anchor bolts are to be correctly set to ensure that the structures are erected as shown in the drawings.

The Contractor shall be responsible for the correct alignment and leveling of all steelwork at site to ensure that the columns are plumb. Before erection of columns on foundations, the top surface of the base concrete shall be thoroughly cleaned with wire brushes and by chipping to remove all laitance and loose material. The Contractor shall be responsible to provide all packing and shim plates that may be required for the proper erection and bedding of the columns with base plates. No steel structure shall be erected on the foundation unless the foundation has been certified fit for erection of steel, by the Engineer. Adequate number of air releases and inspection holes shall be provided in the base plate.

After the column is erected and alignment is checked and accepted, the column with base shall be held firmly in position by shims and pickings. The space between the column base and the base concrete shall be grouted with non-shrink grout.

The grout shall be of the type Sika grout 214 / Conb extra GP 2 / Shrinkomp 40 or equivalent. The substrate surface must be free of contaminants and all dirt and dust blown clean. The surface shall be thoroughly cleaned with water and all free water removed after cleaning. A containing formwork or other arrangement shall be made to hold the grout without leaks.

The (grout) powder shall be mixed with recommended quantity of water and stirred till a grout of smooth consistency is obtained. It shall be poured as soon as possible in order that the expanding properties are fully availed of. Where a thicker section is encountered, 10 mm chips may be added to the grout. This may slightly affect the flow properties of the grout and additional powder may be needed to restore the same. Bolt holes shall be filled in first and then the gap between the column base and base concrete grouted. It is essential that the grout flow is continuous. For larger grouts suitable pumps shall be

employed. The air must escape and shall not be trapped inside. Grouting shall not be done in extreme hot or cold weather.

13.0 FIELD INSPECTION:

13.1 General

All materials, equipment and work of erection shall be subject to the inspection of the Engineer who shall be provided with all facilities including labour and tools required at all reasonable times. Any work found defective is liable to be rejected.

No protective treatment shall be applied to the work until the appropriate inspection and testing has been carried out. The stage inspection shall be carried out for all operations so as to ensure the correctness of fabrication and good quality. Girder dimensions and camber shall not be finally checked until all welding and heating operations are completed and the member has cooled to a uniform temperature.

14.0 TESTING OF MATERIALS:

Structural steel shall be tested for mechanical and chemical properties as per various IS codes as may be applicable and shall conform to requirements specified in IS: 226, IS: 2062, IS: 11587,IS: 1977, IS: 8500 and IS: 961, etc.

Bolts, nuts, washers, welding consumables, steel forging, casting and stainless steel be tested for mechanical and chemical properties in the appropriate IS Code. Measurements for the plate and rolled sections shall be taken at not less than 15 mm from edge.

Lamination tests for plates shall be carried out by ultra-sonic testing or any other specified methods. Steel work shall be inspected for surface defects and exposed edge laminations during fabrication and cleaning. Significant edge laminations found shall be reported to the Engineer for his decision.

Chipping, grinding, machining or ultrasonic testing shall be used to determine depth of imperfection.

14.1 Bolted connections:

Bolts and bolted connection joints with high strength bolts shall be inspected and tested according to IS: 4000.

The firmness of joint shall be checked by 0.2 mm filler gauge, which shall not go inside under the bolt head by more than 3 mm. The alignment of plates at all bolted splice joints and welded butt joints shall be checked for compliance with Code requirements.

Testing of flame cut and sheared edges is to be done, where the hardness criteria given in the code are adopted. Hardness testing shall be carried out on six specimens.

14.2 Welding and welding consumables:

Welding procedure, welded connection and testing shall be in compliance with Code requirements.

All facilities necessary for stage inspection during welding and on completion shall be provided to the Engineer or their inspecting Authority by manufacturer.

Adequate means of identification either by identification mark or other record shall be provided to enable each weld to be traced to the welder(s) by whom it was carried out.

All metal arc welding shall be in compliance with IS: 9595 provisions.

The method of inspection shall be in accordance with IS: 822 and extent of inspection and testing shall be in accordance with the relevant standards or in the absence of such a standard, as agreed with the Engineer.

Procedure tests -The Destructive and Non-Destructive test of weld shall be carried out according to IS: 7307 (Part I).

14.3 Non-Destructive Testing of Welds

One or more of the following methods may be applied for inspection or testing of weld:

Visual Inspection: All welds shall be visually inspected, which should cover all defects of weld such as size, porosity, crack in the weld or in the HAZ (Heat Affected Zone) etc. Suitable magnifying glass may be used for visual inspection. A weld shall be acceptable by visual inspection if it shows that:

The weld has no cracks.

Through fusion exists between weld and base metal and between adjacent layers of weld metal.

Weld profiles are in accordance with requisite clauses of IS: 9595 or as agreed with the Engineer.

The weld shall be of full cross section, except for the ends of intermittent fillet welds outside their effective length.

When weld is transverse to the primary stress, undercut shall not be more than 0.8 mm deep when the weld is parallel to the primary stress in the part that is undercut.

The fillet weld in any single continuous weld shall be permitted to under run the nominal fillet weld size specified by 1.6 mm without correction provided that undersize portion of the weld does not exceed 10 percent of the length of the weld. On the web-to-flange welds on girders, no under run is permitted at the ends for a length equal to twice the width of the flange.

The piping porosity in fillet welds shall not exceed one in each 100 mm of weld length and the maximum diameter shall not exceed 2.4 mm, except for fillet welds connecting stiffeners to web where the sum of diameters of piping porosity shall not exceed 9.5 mm in any 25 mm length of weld and shall not exceed 19 mm in any 300 mm length of weld.

The full penetration groove weld in butt joints transverse to the direction of computed tensile stress shall have no piping porosity. For all other groove welds, the piping porosity shall not exceed one in 100 mm of length and the maximum diameter shall not exceed 2.4 mm.

Magnetic Particle and Radiographic Inspection:

Welds that are subject to radiographic or magnetic particle testing in addition to visual inspection shall have no crack.

Magnetic particle test shall be carried out for detection of crack and other discontinuity in the weld according to IS: 5334.

Radiographic test shall be carried out for detection of internal flaws in the weld such as crack, piping porosity inclusion, lack of fusion, incomplete penetration, etc. This test may be carried out as per IS: 1182 and IS: 4853.

Acceptance Criteria:

The weld shall be unacceptable if radiographic or magnetic particle testing shows any of the type of discontinuities indicated in the code.

Ultrasonic Inspection:

The Ultrasonic testing in addition to visual inspection shall be carried out for detection of internal flaws in the weld such as cracks, ping porosity inclusion, lack of fusion, incomplete penetration, etc. Acceptance criteria shall be as per IS: 4260 or any other relevant IS Specification and as agreed to by the Engineer.

Liquid Penetration Inspection:

The liquid penetrant test shall be carried out for detection of surface defect in the weld, as per IS: 3658, in addition to visual inspection.

The non-destructive testing of following welds be carried out using one of the method or methods described at (ii), (iii) and (iv) above, as may be agreed to by the Engineer.

All transverse butt welds in tension flange.

10 percent of the length of longitudinal and transverse butt welds in tension flanges.

5 percent of the length of longitudinal and transverse butt welds in compression flanges.

All transverse butt welds in webs adjacent to tension flanges as specified by the Engineer.

The particular length of welds in webs to be tested shall be agreed with the Engineer, in case of (b) or (c).

Where specified by the Engineer, bearing stiffeners or bearing diaphragms adjacent to welds, plates in box girder construction adjacent to plates at cruciform welds, plates in box girder construction adjacent to corner welds or other details shall be ultrasonically tested after fabrication.

Any lamination, lamellar tearing or other defect found shall be recorded and reported to Engineer for his decision.

14.4 Testing of welding for Cast Steel: The testing of weld for cast steel shall be carried out as may be agreed to by the Engineer.

14.5 Stud Shear Connectors (where applicable)

Stud shear connectors shall be subjected to the following tests:

The fixing of studs after being welded in position shall be tested by striking the side of the head of the stud with a 2 kg hammer to the satisfaction of the Engineer.

The selected stud head stroked with 6 kg hammer shall be capable of lateral displacement of approximately 0.25 the height of the stud from its original position. The stud weld shall not show any sign of crack or lack of fusion.

The studs whose welds have failed the tests given in (a) and (b) shall be replaced.

14.6 Inspection requirement:

The fabricated member/component made out of rolled and built-up section shall be checked for compliance of the tolerances given in Table-2. Inspection of

member/components for compliance with tolerances, and the check for deviations shall be made over the full length.

During checking, the inspection requirement shall be placed in such a manner that local surface irregularities do not influence the results.

For plate, out-of-plane deviation shall be checked at right angle to the surface over the full area of plate.

The relative cross frame deviation shall be checked over the middle third of length of the girder or frame between each pair of webs and for cantilever at the end of member.

The web of rolled beam or channel section shall be checked for out-of-plane deviation in longitudinal direction equal to the depth of the section.

During inspection, the component/member shall not have any load or external restraint.

14.7 Inspection Stages:

The inspection to be carried out for compliance of tolerances shall include but not be limited to the following stages:

For completed parts, component/members on completion of fabrication and before any subsequent operation such as surface preparation, painting, transportation, and erection.

For webs of plate and box girder, longitudinal compression flange stiffeners in box girders and orthotropic decks and all web stiffeners at site joints, on completion of site joint.

For girders and frames, cantilevers and other parts in which deviations have apparently increased on completion of site assembly.

Where, on checking member/component for the deviations in respect of out-of-plane or out-of-straightness at right angles to the plate surface, and any other instances, exceed tolerance, the maximum deviation shall be measured any recorded. The recorded measurements shall be submitted to the Engineer who will determine whether the component/member may be accepted without rectification, with rectification or rejected.

15.0 PAINTING

15.1 General Scope

Unless otherwise specified, all steelwork shall be given approved primer and top coats of painting. The work shall include sand / grit blasting of steel to Swedish specification 2-1/2 and other preparation of metal surfaces as required, providing and applying the paint in the specified number of coats and thickness (with repair / touching of the shop / first coat / other coats as necessary) including supply of all materials, equipment, tools and tackles, scaffolding, labour, supervision, thickness testing instruments, all testing, materials and all and other work to complete the painting as per specifications and to the satisfaction of the Engineer.

15.2 Quality of paint

Only the paints which have been tested for the following qualities as per the specification given in the relevant IS codes should be used:

- Weight test (weight per 10 litre of paint thoroughly mixed)
- Drying time
- Flexibility and adhesion
- Consistency
- Dry thickness and rate of consumption

Unless otherwise specified all painting and protective coating work shall be done in accordance with IS: 1477 (Part 1)

15.3 Preparation of Steelwork

The steelwork shall be thoroughly cleaned and all grease, oil and all other surface contaminants shall be removed by application of solvents, wire brushing and other tools. The steelwork shall be grit / sand blasted to degree defined as 2-1/2 as per Swedish Standard SI S 05 5900 with a surface profile not exceeding 65 microns. It must be ensured that the steel is clean and free of all contaminants. The longevity of the coating and protection will depend on the extent to which the steel is clean. All dust is removed and the steelwork.

The steel after grit / sand blast cleaning is very susceptible to atmospheric action and as such within as short a time as possible (not more than 15 to 20 mins) the first coat of primer shall be applied.

15.4 Paint preparation and application procedure

The primer shall be an inorganic Zinc silicate solvent based paint normally of the two pack self curing type. The liquid part is thoroughly stirred to uniform consistency and then the solid part (zinc dust) shall be added with constant mechanical stirring till the powder is thoroughly dispersed. The mixture is strained through a 80 mesh sieve and allowed to mature for 20 minutes with stirring. It is then applied by airless spraying with a pump ratio of 30 : 1, a tip size of 0.40 mm and a pressure of 120 kg / sq.cm The wet film thickness shall be not less than 125 microns and the dry film thickness 75 microns. One coat of primer shall be applied with a DFT of not less than 75 microns.

The intermediate coat shall be of a super high-build epoxy coating with a composition of catalysed epoxy resin suitably pigmented. This is in two packs. The separate packs are stirred properly and mixed in the recommended ratio. The mixture shall be applied to the clean primer surface by airless spray (pump ration 45:1) with a fluid tip of about 0.55 mm and air supply of 100 psi. The pot life of the mixture is an hour. At approximately 4.25 sq.m per litre, a 200 micron DFT should be available.

The topcoats shall be two coats of an acrylic polyurethane enamel for a high gloss coating to provide protection against the atmosphere at site.. The steelwork which has already been primed with one coat and given an intermediate coat shall be carefully cleaned of adhering contaminant without damaging the coats.

The top coat paint also comes in two packs, base is stirred thoroughly and the catalyst is added in the ration of four parts of base to one part of catalyst. The mixture is stirred to uniform consistency and after a maturing period of 30 minutes, the top coats shall be applied by air less spray with pump ratio of 30:1, a tip between 0.40 and 0.45 mm at a tip pressure of 140 kg / esq. There shall be two topcoats each of DFT of 30 microns.

The prime and top coats shall be compatible with each other.

The surface of the steelwork shall be clean dry before the application of any paint.

The painting equipment shall be kept scrupulously clean and for this purpose, a thinner shall be used for cleaning the equipment before and after use.

It must be ensured that all paints are fresh and whenever the contents of two pack paints are mixed the paint must be used up before the time recommended by the manufacturers.

The colour of the topcoats shall be selected by the Engineer. Two slightly different shades may be chosen to ensure that two topcoats are given without missing out any area of the steel work.

15.5 Curing: The painted materials shall not be handled till it is dry. The painted components shall be allowed to air-dry for at least 24 hours after which it should be gradually subjected to working temperature range.

15.6 Ambient conditions and painting: Painting work shall not be done if the ambient temperature is below 10 0 C or if it is above 50 0 C, nor shall it be done if the relative humidity is above 90 %. No painting work shall be done during rain or misty or foggy conditions. As far as possible coated surface shall not be exposed to rain or forest before they are dry.

15.7 Other requirements

The coatings shall be applied to all surfaces excluding inner surfaces of fully sealed hollow sections. Surfaces that would be inaccessible for cleaning and painting after fabrication shall be painted as specified before being assembled.

All bolts, nuts, washers etc. are to be thoroughly cleaned and dipped into boiling linseed oil conforming to IS: 77.

All machined surfaces are to be well coated with a mixture of white lead conforming to IS: 234 and Mutton Tallow conforming IS: 887.

The work shall be done inside a properly covered area by workmen who are properly attired and protected for the work.

All fabricated steel shall be painted in the shops after inspection and acceptance with at least one priming coat, unless the exposed surfaces are subsequently to be cleaned at site or are metal coated. No primer shall be applied to galvanised surfaces.

Field contact surfaces and surfaces to be in contact with cement shall be painted with primer only. No paint shall be applied within 50 mm of designed location of field welds.

E. WOOD WORK & JOINERY INCLUDING DOORS & WINDOWS

1.0 SCOPE

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

2.0 GENERAL

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

IS	205	Specifications for non-ferrous metal butt hinges.
IS	287	Recommendation for maximum permissible moisture content of timber used for different purpose.
IS	303	Specification for plywood for general purpose.
IS	362	Specification for parliamentary hinges
IS	419	Specification for putty for the use on window frames

IS 883	Code of practice for design of structural timber in building.
IS 1003	Specification for Timber panelled and glazed shutters Part II - Window and ventilator shutters.
IS1200	Method of measurement of building and Civil Part XXI Engineering Works – Wood Work and Joinery.
IS:1341	Specification for steel butt hinges
IS:1658	Specification for Fibre Hard Boards
IS: 1761	Specification for transparent sheet glass for glazing and framing purposes.
IS: 3087	Specification for wood particle boards (medium density for structural timber in building)

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

3.0 MATERIALS

3.1 Sawn Timber

Teak wood of good quality and class as specified in the item shall be used. The timber shall be of high quality and well seasoned. It shall have uniform colour free from defects such as cracks, dead knots, shakes, sapwood etc. No individual hard and wound knot shall be more than 6 sq.cm in size and the aggregate area of such knots shall not be more than 1% of the area of the piece. The timber shall be close grained having not less than 2 growth rings per cm. width in cross section.

The maximum permissible percentage of moisture content for well seasoned timber used in building work shall be as specified in the IS : 287.

3.2 Glazing materials - Glass Panels:

Unless otherwise specified, glass panes used in glazed or panelled and glazed shutters, shall be of good quality glass of thickness not less than 4 mm for panes upto 0.1 sq.m in area not less than 5 mm for glass panes of area larger than 0.1 sq.m with a tolerance of 0.2 mm in both cases. The glass shall be free from flaws such as specks, bubbles, smoke waves, air holes, etc. and shall conform to the relevant IS : 1761.

Unless otherwise specified, glass panes used in shutters of bath room and lavatories shall be frosted and of thickness as mentioned above and shall be free from any flaws.

Where so specified, special quality glass such as plate glass, pin heads glass, wired glass, float glass etc. shall be used. They shall conform to relevant IS standards as regards quality. Putty for glazing in wooden frames of doors and windows. Putty shall be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding boiled linseed oil and mixing the whole thing into a homogeneous stiff paste. It shall be free from impurities like dust, grit, etc. and shall conform to IS : 419.

3.3 Fittings

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

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

4.0 WORKMANSHIP

4.1 Wood Work, Wrought, Framed and Fixed

General

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

Note: The work wrought shall mean 'planed'.

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

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

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

Before any surface treatment is applied in the wood work shall be got approved by the Engineer-in-Charge

Fixing in Position:

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

All Carpenter's work shall be accurately set out and framed together and securely fixed in the best possible manner and with properly made joints. All joints must fit accurately without wedging or filling. All nails screws, plugs, pins etc. shall be provided as necessary and as directed and approved. After the woodwork has been erected, if any undue shrinkage or bad workmanship is discovered, the Contractor shall forthwith amend the same without any extra charge.

All expose woodwork in country teak shall be painted with one coat of primer and two coats of paint of type; make and shade as indicated and approved. All woodwork coming in contact or embedded in masonry work shall be treated with two coats of solignum or coal tar as directed by the Engineer prior to installation.

4.2 Panelled, Glazed or Panelled and Glazed Shutters:

General: The work shall be carried out as per detailed drawing. The wooden members shall be planed smooth and accurate. They shall be cut to the exact shape and sizes

without patching or plugging of any kind. Mouldings, rebates, rounding, etc. shall be done, as shown in the drawing, before the pieces are assembled into the shutter.

Joinery work: The thickness of the styles and rails shall be as specified in the item of work. The minimum thickness of panels shall normally be 15 mm where the clear width of panel is not more than 300 mm and 20 mm where the clear width of the panel is more than 300 mm. However, where the Engineer-in-Charge so considers, lesser thickness upto 12 mm and 15 mm respectively may be allowed by him instead of 15 mm and 20 mm specified above. Solid wood panel for door and window shutters shall be made out of one or more strips of timber planks of not less than 125 mm width. it is preferable to use strips of not more than 200 mm width to reduce chances of warping, splitting or other defects. The timber strips shall be joined together with continuous tongued and grooved joints, glued together and reinforced with metal dowels. The grooving of the solid panel shall normally run along the longer dimensions of the panel unless otherwise directed. The corners and edges of panels shall be finished as shown in the drawing and these shall be feather tongued into styles and rails. Sash bars shall have mitres joints with the styles.

Styles and rails of shutters shall be made out of single piece. Lock and intermediate rails exceeding 200 mm in width if permitted by the Engineer-in-charge may be made out of one or more pieces of timber but the width of each piece shall not be less than 125 mm. Where more than one piece of timber is used, they shall be joined with a continuous tongued and grooved joint glued together and reinforced with metal dowels (rust proof) at regular intervals of 20 cm or pinned with not less than three 40 mm rust proof pins of the lost head type.

The tenons shall pass clear through styles. The styles and rails shall have a 12 mm groove to receive the panel.

In case the double shutters the rebate at the closing junction of the two shutters shall be of depth not less than 2 cm.

Shutters shall not be painted or otherwise treated before these are passed by the Engineer-in-Charge and fixed in position.

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

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

5.0 FLUSH DOOR SHUTTERS

5.1 General:

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

5.2 Shutters

The shutters shall be decorative or non-decorative type of the exterior or interior grade as described in the item and as shown in the drawings. It shall conform to the relevant specifications for the type and grade given in I.S. 2202/1983, Specifications for Wooden Flush door shutters (solid core type). The face panel shall be of BWP grade ply conforming to IS-2191 (Part-I).

The finished thickness shall be as mentioned in the item. Face veneers used shall be of the pattern and colour approved by the Engineer. Solid teakwood lipping of thickness not less than 12mm shall be provided on all edges. The lipping shall be fixed using adhesive as specified and shall be factory pressed. Nothing extra shall be payable on this account.

All necessary rebates, recesses, holes etc., if any, for fixtures or otherwise shall also be provided and the visible surface finished with teak veneering to match.

The solid core shall be of wood laminate prepared from battens of well-seasoned and good quality wood, having straight grains. Battens shall be properly glued and machine pressed together.

Edges of the core shall be lipped with good quality teakwood battens of minimum 25mm depth and 35mm width glued and machine pressed along with the core and shall stand 72 hours boiling water test for de-lamination and strength. The flush doors shall be truly plain, well finished and shall be free from detects like warping etc.

Only phenol formaldehyde resin glue shall be used for door manufacture and a certificate to this effect from manufacturers shall be furnished.

5.3 Inspection:

The Contractor shall give intimation to the Engineer-in-Charge who shall arrange for the visual inspection of the samples at the factory premises, accompanied by the Contractor. The samples inspected by the EIC or his representative shall be signed as a mark of identification. These inspected samples of each type will be delivered by Contractor at site.

The final approval of the door and window shutters is subject to testing.

Flush doors shall be tested as per IS-4020.

The cost of sample, packaging, sealing and transportation of samples to the laboratory, shall be borne by the Contractor. Testing charges shall be reimbursed to Contractor, provided that the shutters fulfill the requirement of relevant specification. If the shutters fail to fulfill the requirements, testing charges shall be borne by the Contractor.

5.4 Fixtures and Fastenings

These shall be as shown in a table on the drawings or as indicated in the specifications. Where it is not specified they shall be of oxidised brass and shall be of good workmanship. All fixtures and fastenings shall be sound and strong. They shall be sectional and of the best quality. The size, shape, design and finish shall be as shown on drawings and approved by the Engineer.

Unless otherwise specified each leaf shall be hung with three brass parliamentary hinges for back flap with brass screws. Each door shall be furnished with aldrop and latch, brass flush bolts, etc. The fixtures shall comply with the relevant Indian Standards. Samples of all fixtures and fastening shall be got approved by the Engineer and deposited in his office for reference.

All the fixtures shall be fixed to the joinery in a secure and efficient manner. Metal sockets shall be provided to all bolts where the shoots enter, stone, concrete, etc.

F. FLOORING, SKIRTING, DADO OR CLADDINGWORKS

1.0 SCOPE

These Specifications covers flooring, skirting, dado or cladding works using different types of stone/ slabs/ tiles as detailed hereunder:

2.0 GENERAL

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

IS: 269		Specification for ordinary, rapid hardening and low beat Portland cement.
IS: 383		Specification for coarse and fine aggregate from natural sources for concrete
IS: 657		Specification for material for use in the manufacturer of magnesium oxychloride flooring compositions.
IS: 1130		Specification for marble (Blocks, slabs & Tiles).
IS: 1200	Part XI	Method of measurements for Building and Civil Engg. Works, paving, floor finishes, dado & skirting.
IS: 1237		Specification for cement concrete flooring tiles.
IS: 1443		Code of practice for laying and finishing of cement concrete flooring tiles.
IS. 2541		Code of practice for use of lime concrete' in buildings.
IS: 2571		Code of practice for laying in situ cement concrete flooring
IS: 4082		Recommendation on stacking and storage of construction materials at site.
IS: 4457		Specification for Ceramic unglazed vitreous acid resistant tile.
IS: 8042		Specification for white port land cement
IS 8112		Specification for high strength ordinary portland cement
IS: 10067		Material Constants in Building Work
IS: 13711		Ceramic Tiles : Sampling & basis of acceptance
IS: 13712		Ceramic Tiles : Definitions, classifications, characteristics and making
IS: 13753		Dust Pressed ceramic tiles with water absorption of E > 10% (Group - B III)
IS: 13754		Dust Pressed ceramic tiles with water absorption of 6% < E < 10% (Group - B IIb)
IS: 13755		Dust Pressed ceramic tiles with water absorption of 3% < E < 10% (Group - B IIa)
IS: 13756		Dust Pressed ceramic tiles with water absorption of E < 3% (Group - B I)

Other I.S Codes not specifically mentioned here, but pertaining to Floor Finishes form part of these specifications.

3.0 MATERIAL

3.1 Cement, sand, aggregate, water shall conform to the specifications for Cement concrete of this volume. Stone shall be hard, sound, durable and free from defects like cavities, cracks, sand-holes, flaws, injurious veins, patches of loose or soft materials and weathered portions etc.

4.0 SUB-BASE

4.1 Sub-base for all flooring shall be prepared and kept ready for further applications. All items shall be defined and detailed on the drawing.

Preparation of sub-base may be carried out by excavation or back filling in plinth. Back filling shall be with the selected earth in layer of 150mm to 200mm maximum and

adequately watered and well-compacted to achieve at least 90% compaction at optimum moisture content.

In case of excavation, the base shall be well-dressed to the desired level and inspected. All loose spots shall be excavated till the hard surface is reached and then filled as directed by the Engineer-in-Charge. Surface shall be watered with just sufficient water and rolled and compacted with vibratory compactor.

4.2 Dry Brick Flooring

4.2.1 Spreading Sand:- After the plinth has been prepared as detailed above, 225mm of sand shall be spread, evenly over the surface and well watered and the wet sand brought to a true under surface formation.

4.2.2 Laying bricks:- Over the sand, thoroughly well burnt bricks of uniform shape shall be laid on edge breaking bonds in straight lines. After laying each two or three lines of bricks, they shall be cramped together as tightly as possible. When the last line of bricks has been cramped into position no movement of the bricks should be possible and if any such exists, the flooring must be removed and railed.

4.2.3 Blinding the surface:- After the bricks are satisfactory laid, sand will be spread over the surface so as to fill all joints. This sand will be well watered and more sand and water added as necessary and until all joints are filled flush and solid.

4.2.4 Pointing:- The joints shall thereafter be raked out to a depth of half an inch and level pointed with cement mortar.

4.2.5 Curing:- The complete work shall be kept covered with wet straw for ten days after pointing.

4.3 Rubble soling

Good quality 150mm to 230mm thick rubble soling shall be carried out depending upon the grade of soil. Rubble used shall be at least 100mm for 150mm thick soling and 150mm for 230mm thick soling. Stone shall be hand packed as close as possible and bedded firmly with the broadest face downwards and the greatest length across, voids filled with chips and small stones. These shall be hammered down to achieve packing and the complete filling of interstices. To achieve the desired levels and slopes, pegs at suitable intervals (about 12m) shall be fixed.

Soling shall be watered and again packed with sand or stone dust to fill interstices created by watering. Then it shall be rolled by power driven roller of 10MT capacity wherever possible or with vibratory compactor. Filling sand or stone dust, watering and compaction shall continue till full compactness is achieved to the satisfaction of the Engineer-in-Charge.

4.4 Base floor

This shall be regular reinforced concrete floor or plain cement concrete floor as specified. All specifications of concreting shall be the same as per Plain & Reinforced Concrete section of this volume.

5.0 CEMENT CONCRETE FLOORING

5.1 Materials

Cement concrete: The cement concrete shall generally conform to specifications for ordinary concrete. The coarse aggregates shall be carefully selected, sufficiently tough

and hard stone pieces broken in a manner that will provide particles of approximately cubical shape affording good interlocking. The maximum size of coarse aggregate shall be 12 mm. The fine aggregate shall consist of properly graded particles. The proportion of mix shall not be of the grade below M15 {1: 2: 4 (1 cement: 2 coarse sand: 4 stone aggregate)}. The least amount of mixing water that will produce a workable mix and will allow finishing without excessive trowelling shall be used. Generally a water cement ratio of 0.5 should suffice.

5.2 Workmanship:

The sub-grade in all cases shall be formed to proper levels and slopes, well compacted and cured. The top surface shall be kept slightly rough.

The surface of the sub-grade shall be cleaned off all loose materials and moistened immediately before laying the concrete floor. The concrete flooring shall be laid in alternate bays not exceeding 6.25 sq.m (about 64 sf.ft) each. The edge of each panel into which the floor is divided should be supported by aluminium dividing strips of adequate size to prevent sticking. Their depth shall be the same as that proposed for the finished floor as mentioned in the item. At least 48 hours shall elapse before the concreting in the adjacent bays is commenced.

The concrete shall be laid immediately after mixing. While being placed the concrete shall be vigorously sliced and spaded with suitable tools to prevent formation of voids or honey comb pockets. The concrete shall be brought to the specified levels by means of a heavy straight edge resting on the side forms and drawn ahead with a sawing motion in combination with a series of lifts and drops alternating with small lateral shifts. While concreting the adjacent bays care shall be taken to ensure that the edges of previously laid bays are not broken by careless or hard tamping.

Immediately after laying the concrete, the surface shall be inspected for high or low spots and any needed correction made up by adding or removing the concrete. After striking off the surfaces to the required grade concrete shall be compacted with a wooden float. The blows shall be fairly heavy in the beginning but as consolidation takes place, light rapid strokes shall be given to complete the ramming.

The floating shall be followed by steel trowelling after the concrete has hardened sufficiently to prevent excess of fine material from working to the surface, The finish shall be brought to a smooth and even surface free from defects and blemishes and tested with straight edges. No dry cement or mixture of dry cement and sand shall be sprinkled directly on the surface of the concrete to absorb moisture or to stiffen the mix. After the concrete has been thoroughly rammed and has dried sufficiently to allow rendering to be worked up, surface shall be rendered with a thin coat of 1:1 cement mortar with fine sand and uniformly floated. If so directed by the Engineer-in-Charge, approved mineral colour pigment conforming to appendix-B of IS 657 shall be added to the cement mortar to give the required colour and shade to the flooring. When the cement mortar rendering is sufficiently stiff, lines shall be marked on it with strings or by any other device to give the appearance of tiles 30 x 30 cm or of any other size laid diagonally or square as directed by the Engineer-in-Charge. The junctions of floor and walls shall be rounded off if so directed, without any extra payment.

After the concrete in the bays has set, the joints of the panels shall be filled with cement cream or with suitable bitumastic compound as shown on the drawings or directed by the Engineer-in-Charge. Vertical edge of the bays shall be neatly marked on the surface of the concrete with a pointed trowel after filling the joints.

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

Curing: Curing shall start on the next day after finishing and shall be continued for 14 days. Curing shall not be commenced until the top layer has hardened. Covering with empty gunnies shall be avoided as the colour of the flooring is likely to be bleached due to the remnants of cement dust from the bags.

6.0 GLAZED / ANTISKID CERAMIC / VITRIFIED TILES IN FLOORING

6.1 Material:

The tiles including specials shall be of the approved make and quality and shall conform to BIS Specifications in all respects. Glazed tiles / Ceramic tiles shall conform to IS : 13711-1993, IS : 13712-1993, IS : 13753-1993, IS : 13754-1993, IS : 13755-1993, and IS : 13756-1993. Samples of tiles shall be got approved by the Engineer-in-Charge, who will keep them in his office for verification as to whether the material brought for use conform to the approved samples.

The tiles shall be square or rectangular of size as specified in the item description or as directed by the Engineer-in-charge. The thickness of the tiles shall be as specified. The length of all four sides shall be measured correct to 0.1mm and average length breadth shall not vary more than ± 0.8mm from specified dimension. The variation of individual dimension from average value of length / breadth shall not exceed ± 0.5mm. Tolerance in thickness shall be ± 0.4mm.Cement Mortar 1:4 to be used along with White Cement of approved quality and make.

6.2 Workmanship

6.2.1 Mortar Bedding

The amount of water added while preparing mortar shall be the minimum necessary to give sufficient plasticity for laying. Care shall be taken in the preparation of mortar to ensure that there are no hard lumps that would interfere with even bedding of the tiles. Before spreading the mortar bed, the base shall be cleaned of all dirt, scum or laitance and loose materials and then well wetted without forming any pools of water on the surface. The mortar shall then be evenly and smoothly spread over the base by the use of screed battens to proper level or slope. The thickness of the bedding shall not be less than 12 mm (about ½") or more than 20 mm (about ¾") in any one place. The tiles shall be laid on bedding mortar when it is still plastic but has become sufficiently stiff to offer a fairly firm cushion for the tiles.

6.2.2 Fixing Tiles

The tiles before laying shall be soaked in water for at least 2 hours. Tiles, which are fixed in the floor adjoining the wall, shall be so arranged that the surface of the round edge tiles shall correspond to the skirting or dado. Neat cement grout of honey like consistency shall be spread over the bedding mortar just to cover so many areas as can be tiled within half an hour. The edges of the tiles shall be smeared with neat white cement slurry and fixed in this grout one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. There shall be no hollows in bed or joints. The joints shall be kept as close as possible and in straight lines. The joints between the tiles shall not exceed 1.5 mm (about 1/ 1 6") wide. The joints shall be grouted with a slurry of white cement. When hairline joints are specified the same

shall be followed. After fixing the tiles finally in an even plane, the flooring laid shall be kept moist and allowed to mature undisturbed for 10 days to allow the bedding and flooring to set properly.

6.2.3 Cleaning

After the tiles have been laid in a room or the day's fixing work is completed, the surplus cement grout that may have come out of the joints shall be cleaned off before it sets. Once the floor has set, the floor shall be carefully washed clean and dried. When dry, the floor shall be covered with oil free dry saw dust which shall be removed only after completion of the construction work and just before the floor is occupied.

7.0 GLAZED/CERAMIC TILES IN DADO/ SKIRTING

7.1 Materials

The tiles including specials shall be of the approved make and quality and shall conform to BIS standards in all respects. Samples of tiles shall be got approved by the Engineer-in-Charge. Materials brought for use shall conform to the approved samples.

7.2 Workmanship

7.2.1 Plastering

Cement plaster of about 15 mm thickness shall be applied to the part of the wall where dado or skirting is to be fixed. The proportion of mortar shall be as mentioned in the item.

7.2.2 Fixing of Tiles

Dado or skirting work shall be done only after fixing tiles on the floor is completed. The tiles shall be soaked in water for at least 2 hours before being used for skirting or dado work. Tiles shall be fixed when the cushioning mortar is still plastic and before it gets very stiff. The back of tiles shall be covered with a thin layer of neat cement paste and the tile shall then be pressed in the mortar and gently tapped against the wall with a wooden mallet. The fixing shall be done from the bottom of wall upwards without any hollows in the bed or joints. Each tile shall be fixed as close as possible to the one adjoining. The tiles shall be joined with white cement and matching coloured pigment slurry. Any difference in the thickness of tiles shall be evened out in cushioning mortar so that all tile faces are in one vertical plane. The joints between the tiles shall not exceed 1.5 mm in width and they shall be uniform. After fixing the dado, they shall be kept continuously wet for 14 days.

7.2.3 Cleaning

After the tiles have been fixed the surplus cement grout that may have come out of the joints shall be cleaned off before it sets. After the complete curing, the dado or skirting work shall be washed thoroughly clean.

8.0 CUDDAPAH / KOTA STONE FLOORING (local available sand stone for flooring)

8.1 Cuddapah / Kota Stone Slabs

The slabs 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. They shall be of the colour indicated in the drawings or as instructed by the Engineer-in-Charge.

The slabs shall have the top (exposed) face polished before being brought to site, unless otherwise specified. The slabs shall conform to the size required. Before starting the work the contractor shall get the samples of slabs approved by the Engineer-in-Charge.

8.2 Dressing

Every slab shall be cut to the required size and shape and fine chisel dressed on the sides 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 plane.

The thickness of the slab after it is dressed shall be 20, 25, 30 or 40mm as specified in the description of the item. Tolerance of + 2mm shall be allowed for the thickness. In respect of length and breadth of slabs Tolerance of + 5mm for hand cut slabs and + 2mm for machine cut slabs shall be allowed.

8.3 Laying

Base concrete or the RCC slab on which the slabs are to be laid shall be cleaned, wetted and mopped. The bedding for the slabs shall be with cement mortar 1:6 (1 cement: 6 coarse sand) or with lime mortar (1 lime putty: 1 surkhi: 1 coarse sand) as given in the description of the item.

The average thickness of the bedding mortar under the slab shall be 20mm and the thickness at any place under the slab shall be not less than 12mm.

The slabs shall be laid in the following manner:-

Mortar of the specified mix shall be spread under the area of each slab, roughly to the average thickness specified in the item. The slab shall be washed clean before laying. It shall be laid on top, pressed, tapped with wooden mallet and brought to level with the adjoining slabs. It shall be lifted and laid aside. The top surface of the mortar shall then be corrected by adding fresh mortar at hollows. The mortar is allowed to harden a bit and cement slurry of honey like consistency shall be spread over the same at the rate of 4.4 kg. of cement per sqm. The edges of the slab already paved shall be buttered with grey or white cement with or without admixture of pigment to match the shade of the stone slabs as given in the description of the item.

The slab to be paved shall then be lowered gently back in position and tapped with wooden mallet till it is properly bedded in level with and close to the adjoining slabs with as fine a joint as possible. Subsequent slabs shall be laid in the same manner. After each slab has been laid, surplus cement on the surface of the slabs shall be cleaned off. The flooring shall be cured for a minimum period of seven days. The surface of the flooring as laid shall be true to levels, and, slopes as instructed by the Engineer-in-Charge.

8.4 Curing, Polishing and Finishing:

The day after the tiles are laid all joints shall be cleaned of the grey cement grout with a wire brush or trowel to a depth of 5 mm and all dust and loose mortar removed and cleaned. Joints shall then be grouted with grey or white cement mixed with our without pigment to match the shape of the topping of the wearing layer of the tiles.

The floor shall then be kept wet for a minimum period of 7 days. The surface shall thereafter be grinded evenly with machine fitted with medium grade grit block (No.80). Water shall be used profusely during grinding. After grinding the surface shall be thoroughly washed to remove all grinding mud, cleaned and mopped. It shall then be covered with a thin coat of grey or white cement, mixed with or without pigment to match the colour of the topping of the wearing surface in order to fill any pin hole that appear. The surface shall be again cured. The second grinding shall then be carried out with machine fitted with fine grade grit block (No.120).

The final grinding with machine fitted with the finest grade grit blocks (No.320) shall be carried out the day after the second grinding described in the preceding Para or before handing over the floor, as ordered by the Engineer-in-Charge.

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

First Grinding : Medium grade (No.80)

Final Grinding : Fine grade (No.120)

In all other respects, the process shall be similar as for machine polishing.

After the final polish, oxalic acid shall be dusted over the surface at the rate of 33 gm per square metre sprinkled with water and rubbed hard with a 'namdah' block (pad of woolen rags).

The following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

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

9.0 CUDDAPAH / KOTA STONE IN RISERS OF STEPS, SKIRTING AND DADO

9.1 Kota Stone Slabs and Dressing shall be as specified above, for clause 8.0 for Kota Stone flooring, except that the thickness of the slabs which shall be as specified in the description of the item. The slabs may be of uniform size, as specified.

9.2 Preparation of surface shall be as specified above in clause 8.0 for Kota Stone flooring.

9.3 Laying shall be as specified above in clause 8.0 for Kota Stone flooring for flooring, except that the joints of the slabs shall be set in grey cement mixed with pigment to match the shade of the slabs and the backing coat shall be 15mm thick cement mortar 1: 4 (1 cement : 4 Coarse sand).

9.4 Curing, Polishing and Finishing shall be as specified above in clause 8.0 for Kota Stone flooring.

10.0 MARBLE / GRANITE STONE SLAB FLOORING

10.1 General

The item refers to provision of flooring of Indian Marble / Granite stone slabs of approved colour / pattern and shall conform to the specification as given below :-

10.2 Materials

10.2.1 Stone Slabs

The stone slab specified in the item shall be got approved by the Engineer . At its thinnest part, no stone shall be thinner than the specified thickness. The stone slab shall be hard, sound, durable, resistant to wear, rectangular in shape or square if directed by the Engineer and of the specified width. The stone slab shall be of the type mentioned in the item and of the colour and quality approved by the Engineer. Slabs shall be hard, dense, uniform and homogenous in texture. They shall have even crystalline grain, and free from defects and cracks. The surface shall be machine polished to an even and perfectly plane surface and edges machine cut true and square. The rear face shall be rough enough to

provide a key for the mortar. Uniformity of size shall generally be maintained for the stone slab used in any room. The stone shall be without any soft veins; cracks of floors and shall have a uniform colour. The edges shall be quite straight. The stone in slabs in external and internal wall veneer work shall be mirror polished where required, in the factory with silicon carbide abrasive starting from no. “00” up to no. 5 and then using buff/lead strip rolls with tin oxide for final mirror polish. For flooring and counter top the final tin oxide polish shall not be used. Samples of stone slabs to be used shall be got approved by the Engineer and the slabs to be used shall conform to the approved sample.

The dimensions of the slab shall be as specified in the item.

10.2.2 Bedding

Cement mortar for the bedding shall be of the proportions as specified in the item. The proportions will be by volume on the basis of 50 Kg. bag of cement. The mortar may be hand mixed or machine mixed.

In hand mixed mortar, cement and sand in the specified proportions shall be thoroughly mixed dry on a clean impervious platform by turning over at least 3 times or more till a homogeneous mixture of uniform colour is obtained. Fresh & clean water shall be added gradually and thoroughly mixed to form a stiff plastic mass of uniform colour so that each particle of sand shall be completely covered with a film of wet cement. The mortar so prepared shall be used within 30 minutes of adding water. Only such quantity of mortar shall be prepared as can be used within 30 minutes. The mortar remaining unused after that period or mortar which has partially hardened or is otherwise damaged shall not be re-tempered or remixed. It shall be destroyed or thrown away.

10.3 Construction

10.3.1 Bedding

The base of cement concrete shall be laid and compacted to a reasonably true plain surface and to the required slopes and below the level of the finished floor to the extent of the thickness of the slabs and mortar bedding. Cement concrete bedding if provided shall be paid under a separate item. Cement mortar for bedding may be mixed manually or by a mechanical mixer. The amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and satisfactory bedding. Care shall be taken in preparing the mortar to ensure that there are no hard lumps that would interfere with the even bedding of the stones. Before spreading the mortar, the sub-floor or base shall be cleaned of all dirt, scum or laitance and of loose material and then well wetted without forming any pools of water on the surface. In case of R.C.C. floors, the top shall be left a little rough. All points of level for the finished paving surface shall be marked out. The mortar shall then be evenly and smoothly spread over the base by the use of screed battens only over so much area as will be covered with slabs within half and hour. The thickness of the mortar bedding shall not be less than 12mm, not more than 25mm. The required slope shall be given to the bed.

10.3.2 Fixing stone slab

Before laying, the stone slabs shall be thoroughly wetted with clean water. Neat cement grout of honey like consistency shall be spread on the mortar bed over as much area as could be covered with the slabs within half an hour. The specified type of stone slabs shall be laid on the neat cement float and shall be evenly and firmly bedded to the required level and slope in the mortar bed. Each stone slab shall be gently tapped with a wooden mallet

till it is firmly and properly bedded. There shall be no hollows left. If there is a hollow sound on gentle tapping of the slabs, such slabs shall be removed and reset properly. The Mason shall make the joints of uniform thickness and in straight lines. The joints shall be filled solidly with pigmented grout for their full depth. The stone slabs shall be laid so as to give continuous parallel long joints with cross joints at right angles to them. The edges of the adjoining slabs shall be in one plane. Where the slabs cover open edges, of floor or window sills the edges shall be neatly rounded off. This shall be included in the rate.

When diamond pattern paving is provided in the item, the slabs shall be square and laid to the diamond pattern with triangular shaped slabs to make up the edges. In plain pattern stones on each course shall break joints with those in the next. The pattern joints etc. shall be as per drawings or as directed by Engineer-In-Charge, to the entire satisfaction of Engineer –In- Charge.

10.3.4 Curing

The flooring shall be kept well wetted with damp sand or water for fourteen days. It shall be kept undisturbed for at least seven days.

10.3.5 Cleaning

All flooring shall be thoroughly cleaned and handed over clean and free from any mortar stains etc.

All labour, materials and equipment, cleaning the sub-base, laying mortar bed and cement grout, fixing stone slabs specified above and making up the joints.

Any cutting and waste if required.

Pointing when included in the item.

Cleaning the floor from all stains, etc.

Polishing wherever required.

11.0 MARBLE / GRANITE STONE IN RISERS OF STEPS AND SKIRTING

11.1 Marble Stone Slabs and Dressing of Slabs shall be as specified above in clause 10.0 of Marble / Granite Stone Slab Flooring except that the thickness of slabs shall be as specified in the item description. A tolerance of + 3mm shall be allowed, unless otherwise specified in the description of the item.

11.2 Preparation of Surface

It shall be as specified above in clause 10.0 of Marble / Granite Stone Slab Flooring except where necessary the wall surface shall be cut uniformly to the requisite depth so that the skirting face shall have the projection from the finished face of wall as shown in drawings or as required by the Engineer-in-Charge.

11.3 The risers of steps and skirting shall be in grey or white cement admixed with or without pigment to match the shade of the stone, as specified in the description of the item, with the line of the slab at such a distance from the wall that the average width of the gap shall be 12mm and at no place the width shall be less than 10mm. The skirting or riser face shall be checked for plane and plumb and corrected. The joints shall thus be left to harden then the rear of the skirting or riser slab shall be packed with cement mortar 1:3 (1 cement: 3 coarse sand) or other mix as specified in the description of the item. The fixing hooks shall be removed after the mortar filling the gap has acquired sufficient strength.

The joints shall be as fine as possible. The top line of skirting and risers shall be truly horizontal and joints truly vertical, except where otherwise indicated.The risers and skirting slab shall be matched as shown in drawings or as instructed by the Engineer-in-Charge.

11.4 Curing, Polishing and Finishing

The face shall be kept cured with water for at least seven days.

The face and top of skirting shall be polished. The stone in slabs in external and internal wall veneer work shall be mirror polished where required, in the factory with silicon carbide abrasive starting from no. “00” up to no. 5 and then using buff/lead strip rolls with tin oxide for final mirror polish. For flooring and counter top the final tin oxide polish shall not be used.

12.0 MARBLE / GRANITE STONE SLAB CLADDING

Marble / Granite tiles and slabs shall be mirror polished, eggshell polished, flame finished or given any other surface treatment as specified. All exposed edges shall be similarly treated.The Marble / Granite stone in slabs in external and internal wall veneer work shall be mirror polished where required, in the factory with silicon carbide abrasive starting from no. “00” up to no. 5 and then using buff/lead strip rolls with tin oxide for final mirror polish. For flooring and counter top the final tin oxide polish shall not be used Machine polishing and sizing shall be done with only water as lubricant. Sawing also shall be preferably done with water as lubricant but as a special case, oil or kerosene may be permitted subject to the oil or kerosene being thoroughly dried in ovens. Tiles / slabs with stains or patches due to the use of oil or otherwise shall be rejected. Any tiles / slabs showing patches or stains after installation shall also be rejected and replaced.

Tiles shall be transported to site well-packed in boxes. Slabs will be individually packed in cardboard paper. Tiles / slabs shall not be waxed or touched up with dyes / colours.

The entire supply for each type of marble / granite, unless specifically permitted by the Architect/ EIC, shall be procured from one location in one quarry to keep variations to the minimum. The Contractor shall segregate and sort the tiles / slabs according to colour, texture and size to keep variations in the same in any one floor, wall or isolated area to the minimum. The Contractor shall, before fixing the marble / granite on floors or walls, lay whole areas of marble / granite loose on ground to select and match the marble / granite. Any tiles / slabs with a variation not acceptable to Architect / PMC/ EICof shall not be used, and if used shall be removed and replaced.

Tight tolerances shall be checked and maintained throughout. Maximum variations shall be as follows:-

Sides	±	0.5 mm
Thickness	±	0.5 mm slabs
	±	0.3 mm tiles
Angularity	±	0.2 %
	±	2 mm

Linear items such as treads, skirting, sills etc. shall be of uniform thickness throughout. All visible edges shall be machine polished unless otherwise specified.

Marble / granite shall be laid or fixed to the highest standard by highly trained masons to the entire approval of Architect / PMC/EIC. Any tiles / slabs broken, stained or damaged shall be removed / replaced.

External wall cladding shall be fixed with approved stainless steel 316 grade serrated cramps and dowels. Marble / granite slabs for external cladding shall be minimum 30mm thick. The Contractor shall prepare shop drawings and get them approved by the Architect before proceeding with any work.

The Contractor shall put a mock-up of typical and non-typical panels and get it approved well before he commences fixing on site.

The Contractor shall coordinate his site activities with other contractors working on site through PMC/ EIC and shall take particular care, in coordination with the PMC/ EIC , in ensuring that his methods of fixing do not damage or endanger the building structure, finishes and services in any way.

The Contractor shall get his system of anchorage approved by the Architect/ EIC of . No reinforcement bar in concrete shall be cut through during drilling or anchorage.

The anchorage in solid concrete blockwork shall be specially designed taking into consideration the actual compactness and crushing strength of the blocks. 2 nos. pullout tests in blockwork shall be carried out prior to commencing work to prove the strength of anchorage with ample margin of safety.

Prior to commencing work, the Contractor shall obtain approval of the Architect for material and workmanship after submitting the following details:-

a. 3 representative samples for each type of marble / granite specified.
b. Physical characteristics:- Dimensional tolerances, water absorption (polished or unpolished as applicable) by weight, compression strength, Mohs hardness, unit weight.
c. Source of supply and availability in full quantity and uniformity of colour, tone and texture.
d. Company profiles of suppliers and labour sub contractor if any.
e. Procedure for fixing and samples of fixtures such as cramps, pins, dowels etc.

If required the Contractor shall arrange visits to the quarries and to the works carried out by the proposed Sub Contractor.

Marble / Granite stone slab / tiles delivered on Site, including wastage and breakage, polishing, chamfering, rounding, grooves, drip moulds and other linear works as per drawings and specifications.

Stainless steel cramps, pins and dowels as per approved shop drawings and as specified.

Backing mortar and pigmented cement grout where specified.

Labour in transporting materials on site, fixing, carefully cutting, hand polishing, and touching up where required etc.

Protecting Marble / Granite stone slab / tiles during construction until virtual completion of works.

Temporary supports, templates, straight edges etc.

Alignment and leveling in coordination with EIC / PMC and Main Contractor.

Joints with plastered and other surfaces.

Cleaning on completion.

Scaffolding and safety precautions.

Submissions of Samples.

Mock-up (total area approx. 15 sqm.)

Working to specified tolerances

Shop drawings

Pull out tests – 2 nos. – On anchors in blockwork.

Provisions for adequate anchorage.

13.0 INTERLOCKING BLOCK PAVEMENTS

13.1 Scope

Scope of work consisting of manufacturing of concrete paver blocks of required size, shape and colour, as per the specification given below and providing and fixing of interlocking paver blocks.

13.2 Dimension and Tolerances:

Concrete interlocking paver blocks shall be made in size and shall be as specified in the tender documents.

Maximum variation in dimension of interlocking paver block shall not be more than 2mm.

13.3 Materials

13.3.1 Water

The water used in the manufacture of concrete masonry units shall be free from matter harmful to concrete or reinforcement, or matter likely to cause efflorescence in the units and shall conform to the requirement of IS 456-1978 (Third Revision).

13.3.2 Additives or admixtures

Additives or admixtures may be added as admixtures to the concrete mix. Additives or admixtures used in the manufacture of concrete paver blocks may be:

Accelerating, water reducing and air entraining admixtures conforming to IS-9103 – 1979.

Fly ash conforming to IS-3812 (Part II) 1955.

Waterproofing agents conforming to IS: 2645-1975.

Colouring pigments.

Where no India Standards apply, the additives or admixtures shall be shown by test or experience, to be not detrimental to the durability of the concrete and as approved by the Engineer-In-Charge

13.4.1 Mix

The concrete mix must be prepared and approval of the Engineer-in-charge of should e taken before proceeding with actual manufacturing of the block. Before commencing the manufacturing of blocks the supplier shall submit to the Engineer for approval full details of all preliminary trial mixes and tests.

When the proportions of a concrete mix have been approved by Engineer, the contractor shall not vary the quality or source of materials or the mix without written approval of the Engineer.

In case of blocks, where compaction is done by external vibrator, concrete mix of very low consistency (Zero slump) shall be used in order to vibrate and compact the concrete under pressure.

13.4.2 Mixing

Concrete shall normally be mixed in a mechanical mixer. Mixing shall be continued until there is a uniform distribution of materials and the mass is uniform in colour and consistency.

13.4.3 Placing and Compaction

Concrete placed in the mould will be compacted by means of mechanical compaction the mould shall be filled upto overflow vibrated or mechanically tamped and struck off level.

After demoulding the blocks shall be protected until they are sufficiently hardened to permit handling without damage.

13.4.4 Curing

The block hardened as above shall then be cured in a curing water tank or in a curing yard and shall be kept moist for at least 14 days. When the blocks are cured in immersion tank, the water of the tank shall be changed at least every 4 days.

13.4.5 Drying

After curing the blocks shall be dried for a period of 4 weeks before being used on the work, they shall be stacked with voids horizontal to facilitate through passage of air, the blocks shall be allowed to complete their initial shrinkage before they are laid at site.

13.4.6 Surface Texture and Finish

The finished concrete paver blocks shall have uniform texture and finish. The colour of pigment shall be approved by the Engineer-In-Charge The colour pigment shall be non fading and shall not have any deleterious effect on concrete.

13.5 Physical Requirement

13.5.1 General

All blocks shall be sound and free of cracks or other defects which interfere with the proper placing of the blocks or impair the strength or performance.

The blocks shall be free of chips, cracks or other imperfections.

13.5.2 Dimensions

Overall dimensions of the block shall be in accordance with the specifications and the maximum tolerance in dimension will be + 2mm.

13.5.3 Block Density

The blocks density shall conform to manufacturer's specifications or approved by the Engineer-in-charge .

13.5.4 Compressive Strength

The minimum compressive strength at 28 days shall be 400 kg/cm2 for 100mm thick concrete blocks and 350 kg/cm2 for 60mm thick concrete paver blocks.

13.5.5 Water Absorption

The water absorption shall not be more than 1% of the total mass.

13.5.6 Testing & Sampling

The testing and sampling shall be carried out as specified in IS: 2185 (Part I) 1979, for concrete masonry units.

13.5.7 Manufacturer's Certificate

The manufacturer shall satisfy that the paver blocks conform to the requirement of this specification and shall produce certificate to this effect along with each consignment.

13.5.8 Independent Testing

If the Engineer-In-Charge desires to carry out independent test, same shall be carried out in accordance with the specifications by selecting random sample from any batch. The manufacturer shall supply free of charge required number of paver blocks for testing. Cost of testing shall be borne by the manufacturer.

13.6 Laying & Fixing Paver Blocks

The interlocking Concrete Paver Block is to be fixed as explained. The sub base / ground should be levelled taking into consideration the thickness of the paver block by part excavation and part filling and properly compacting using a plate compactor. Sand bed of 50mm thick should be provided underneath the paver blocks for fixing the interlocking blocks. The interlocking blocks should be placed interlocking them as per the design and shape, as directed by the Engineer-in-charge. After laying the concrete blocks, fine sand should be spread over the paver blocks. The surface should be compacted using plate compactor, so that the fine sand will get filled up in the gaps between blocks and the blocks will be interlocked.

Providing & fixing the interlocking pavement blocks in sand bedding to the required pattern and compacting, including cost of independent testing, leveling of sub base etc. Cleaning the floor.

14. TREMIX FLOORING

Scope: These specifications covers, providing & laying concrete flooring with tremix treatment by dewatering of concrete by vacuum, as detailed hereunder. The tremix treatment shall be carried out by specialized agency only. These specification shall be read in conjunction with the item No.5 Concrete Flooring, above.

14.1 General

The Contractor shall submit the plan of work going to be followed by him, well in advance (at least a week). A sketch shall be accompanied giving details of the construction joint locations, sequence of floor casting, etc. The work shall be planned and executed so that there is no delay between the placement, screeding, de-watering and floating of concrete.

14.2 Screeding:

After poring concrete in place, as detailed in 5.2 above, it shall be compacted, in wet condition, by screed vibrator run over the steel channel shuttering pressing concrete

surface matched with the top of steel channel shuttering spaced not more than 4.0 meters apart. Poker vibrators will be used to vibrate the laid concrete thoroughly with minimum 40 mm dia needles. On completion of laying of approximate 2m to 2.5m length the surface vibrator then be run over the concrete surface to achieve better over all compaction of concrete. Water cement ratio shall be just sufficient to make concrete workable. Screed shall be run at least twice to achieve well compacted & level surface.

Undulations on the concrete surface shall be rectified immediately by local patching, in wet state of concrete.

14.3 Vacuum Dewatering:

After screeding the vacuum mat be placed on this leveled concrete and the excess water from the concrete is sucked off. It should be done in accordance with the manufacturer's recommendation, paying special attention over the edges. A time of approximate 1.5 to 2.0 minutes per centimeter thickness of concrete slab is normally adopted for Vacuum treatment. As a result of which the water cement ratio shall be reduced to in the order of 0.42 to 0.43, thereby reducing the total water content in the concrete by 20 to 25%. Care should be taken at this stage to avoid curling at the ends due to excess use of vacuum mats.

14.4 Floating & Troweling:

The hardened concrete surface after vacuum dewatering shall be leveled to achieve true horizontal surface, with the help of mechanical power floater.

Final smooth finish shall be achieved by mechanical power troweling. To give the surface metallic finish Metallic Dry shake IRONITE No. 3 (non coloured) @ 3.0 kg / sqm sprinkled over green concrete in such a way that 2/3rd of the dry shake shall be broadcasted in first pass and same shall be floated with power floater, remaining 1/3rd of dry shake shall be sprinkled in the next pass to acquire a smooth finish by floating and trowelling.

The floating shall be followed by steel trowelling after the concrete has hardened sufficiently to prevent excess of fine material from working to the surface, The finish shall be brought to a smooth and even surface free from defects and blemishes and tested with straight edges. No dry cement or mixture of dry cement and sand shall be sprinkled directly on the surface of the concrete to absorb moisture or to stiffen the mix. After the concrete has been thoroughly rammed and has dried sufficiently to allow rendering to be worked up, surface shall be rendered with a thin coat of 1:1 cement mortar with fine sand and uniformly floated. If so directed by the Engineer-in-Charge, approved mineral colour pigment conforming to appendix-B of IS 657 shall be added to the cement mortar to give the required colour and shade to the flooring.

After the concrete in the bays has set, the joints of the panels shall be filled with cement cream or with suitable bitumastic compound as shown on the drawings or directed by the Engineer-in-Charge . Vertical edge of the bays shall be neatly marked on the surface of the concrete with a pointed trowel after filling the joints.

14.5 Finishing:

The top shall be polished to give an even & smooth surface. Surface shall be protected from direct sun when it is green.

14.6 Curing:

Curing shall start on the next day after finishing and shall be continued for 14 days. Curing shall not be commenced until the top layer has hardened. Covering with empty gunnies

shall be avoided as the colour of the flooring is likely to be bleached due to the remnants of cement dust from the bags.

15.0 GROOVE CUTTING:

The grooves shall be cut to form the panels of floor as per architectural drawings or as directed by the Engineer-in-charge . The grooves shall be cut 6mm wide & 20mm deep, with mechanical saw and shall be filled upto10 mm deep with joint sealing compound like Polysulphide or (conforming to grade B of IS:1834 or equivalent) of approved make as directed by the Engineer-in-Charge .

15.1 Expansion Joint:

The Expansion joints shall be spaced at approximately 120 sqm. area and/or as specified and shall constitute formation of 12/20/25 mm clear joint between the two concretes. This joint be formed by placing the Shalitex board in position against the old concrete leaving 12/20/25mm x 10mm deep joint at top, which shall be filled in by Polysulphide joint sealant. The 16/20mm dia. MS dowel bars shall be so placed that the half length of bar be bonded in to concrete on one side of the joint and the other half shall be prevented from bonding with concrete. In addition, a recess at its slip end shall be provided to accommodate the movement of the slab during expansion of the concrete. The unbonded portion of the dowel bar shall be covered with an expansion cap using 25mm dia. PVC pipe, 305mm long (unless otherwise specified).

15.2 Construction Joint:

The side construction joints shall be buttered against each other and later on a joint groove shall be cut as specified in ‘a)’ above.

16.0 STEEL REINFORCEMENT:

Reinforcement as specified shall be placed in concrete, 50mm below the top surface of concrete. This mesh shall be for individual panels, formed by side construction joint and expansion joint.

Tie bars, 600 mm long, shall be provided at construction joints using specified dia. and at specified spacing and / or as directed by EIC.

Dowel bars, 600 mm long, shall be provided at expansion joints using specified dia. and at specified spacing and / or as directed by EIC .

G. PAINTING

1.0 SCOPE

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

2.0 GENERAL

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

IS: 63 Whiting for Paint & putty.

IS: 75	Specification for Linseed oil, raw & refined.
IS: 159	Specification for ready mixed paint, brushing, acid resistant.
IS: 345	Specification wood filler, transparent, liquid.
IS: 426	Specification for paste filler for colour coats.
IS: 427	Specification for Distemper, dry colour, as required.
IS: 428	Specification for Distemper, Oil Emulsion, colour as required.
IS: 533	Specification for Gum spirit of Turpentine (Oil of Turpentine)
IS: 710	Marine Plywood
IS: 1200 (Part XIII)	Method of Measurement of Building & Civil Engg Works - White Washing, colour washing, distempering & other finishes.
IS: 1477 (Part 1)	Code of practice for painting of ferrous metals in buildings Pre-treatment
IS: 1477 (Part 11)	Code of practice for finishing of ferrous metals in buildings. Painting
IS: 2338 (Part 1)	Code of practice for finishing of wood and wood based materials Operations and workmanship for finishing.
IS: 2338 (Part 11) :	Code of practice for finishing of wood and wood based materials, Schedule
IS: 2395 (Part 1) :	Code of practice for painting concrete masonry and plaster surfaces. Operation & workmanship
IS: 2395 (Part 11)	Code of practice for painting concrete, masonry and plaster surfaces. Schedule.
IS: 2524 (Part 1)	Code of practice for painting of non-ferrous metal in buildings Pre-treatment
IS: 2524 (Part ll)	Code of practice for painting of non-ferrous metal in buildings Painting
IS: 3140	Code of practice for painting asbestos cement buildings:
IS: 3537	Specification for ready mixed paint, finishing, interior for general purposes to IS colour.
IS: 5410	Specification for cement paints, colour as required.
IS : 6278	Code of practice for white washing & colour washing.

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

3.0 MATERIALS

Materials shall strictly conform to the relevant IS Specifications.

4.0 PAINTING PLASTERED OR CONCRETE SURFACES

4.1 General

Wherever scaffolding is necessary, it shall be erected in such a way that as far as possible no part of scaffolding shall rest against the surface to be painted. A properly secured and well tied suspended platform (“JHOOLA”) may be used for painting. Where ladders are used, pieces of old gunny bags shall be tied at top and bottom to prevent scratches to the walls and floors. For painting of ceilings, proper stage scaffolding shall be erected, where necessary.

4.2 Preparation of surfaces:

The surface shall be thoroughly cleaned off all dirt, dust, mortar dropping and other foreign matter, before paint is to be applied. New plaster surfaces and wet patches shall be allowed to sufficiently dry, before applying paint. All unnecessary nails shall be removed.

Pitting in plaster shall be made good with putty. The surface shall then be rubbed down again with a fine grade sand paper and made smooth.

The surface shall be allowed to dry thoroughly before the regular coat of paint is allowed.

The surface affected by moulds moss, fungi, algaelicnens, efflorescence shall be treated in accordance with IS 2395 (Part 1) before applying paint.

5.0 OIL-BOUND DISTEMPER

5.1 Preparation of Surfaces:

Any unevenness shall be made good by applying putty, made of plaster of Paris mixed with water on the entire surface including filling up the undulation and then sand papering the same after it is dry.

5.2 Primer Coat

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

5.3 Application

Primer shall be applied with a brush on the clean dry and smooth surface. Horizontal strokes shall be given first and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished uniformly leaving no brush marks. It shall be allowed to dry for at least 48 hours, before application of oil bound distemper or any other paint.

5.4 Preparation of oil bound distemper:

The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for days work shall be prepared.

5.5 Application of distemper coat:

After the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. Minimum two coats of distemper shall be applied with brushes in horizontal strokes followed to immediately by vertical which together shall constitute one coat. The subsequent coats shall be applied after a time interval of at least 24 hours between consecutive coats to permit the proper drying of the preceding coat.

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

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

15 cm double bristled distemper brushes shall be used. After each days work, brushes shall be thoroughly washed in hot water with soap solution and hung down to dry. Old brushes, which are dirty and caked with distemper, shall not be used on the work.

6.0 WATER PROOF CEMENT PAINT

6.1 Preparation of Surfaces

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

6.2 Preparation of Paint

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

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

6.3 Application of Paint

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

When weather conditions are such as to cause the paint to dry rapidly, work shall be carried out in the shed as far as possible. This helps the proper hardening of the paint film by keeping the surface moist for a longer period.

To maintain a uniform mixture and to prevent segregation the paint shall be stirred frequently in the bucket. For undecorated surfaces, the surface shall be treated with minimum two coats of water-proof cement paint. Not less than 24 hours shall be allowed between two coats and the second or subsequent coat shall not be started until the preceding coat has become sufficiently hard to resist marking by the brush being used. In hot dry weather the preceding coat shall be slightly moistened before applying the subsequent coat.

The finished surface shall be even and uniform in shade without patches, brush marks, paint drops, etc.

Cement paints shall be applied with a brush with relatively short stiff hog or fibre bristles. The paint shall be brushed in uniform thickness and shall be free of excessively heavy brush marks. The laps shall be well brushed out.

6.4 Curing

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

6.5 Rate

The rate shall include the cost of all labour, materials, equipments, scaffolding necessary in all the above operations (including priming coat) as described above.

7.0 PAINTING WOOD AND METAL SURFACES

7.1 General Requirement

The materials required for the execution of painting work shall be obtained directly from approved manufacturers and brought to the site in maker's drums, with seals unbroken. All paints shall conform to relevant Indian Standards as mentioned under sub-head "Material".

All materials not in actual use shall be kept properly protected. Lids of containers shall be kept closed and surface of paint in open or partially open containers covered with a thin layer of turpentine to prevent formation of skin. Materials which have become stale or fat due to improper and long storage shall not be used. The paint shall be stirred thoroughly in its container before pouring into small containers. While applying also, the paint shall be continuously stirred in the smaller container. No left over paint shall be put back into stock tins. When not in use, the containers shall be kept properly closed.

If for any reason thinning is necessary, in case of ready mixed paint, the brand of thinner recommended by manufacturer shall be used.

Painting except the priming coat shall generally be taken in hand after all other construction work is practically finished. The rooms shall be thoroughly swept out and the entire building cleaned up at least one day in advance of the paint work being started. The surface to be painted shall be thoroughly cleaned and dusted. All rust, dirt scales, smoke and grease shall be thoroughly removed before painting is started.

No painting on exterior or other exposed parts of the work shall be carried out in wet, humid or otherwise unfavourable weather and all the surfaces must be thoroughly dry before painting work is started.

7.2 Brushing of Paint

The brushing operations are to be adjusted to the spreading capacity advised by the manufacturers of the particular paint. The painting shall be applied evenly and smoothly by means of crossing and laying off, the later in the direction of the grain of wood. The crossing and laying off consists of covering the area over with paint, brushing the surface hard for the first time over and then brushing alternatively in the opposite directions two or three times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

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

7.3 Spraying

Where so stipulated, the painting shall be done with spray. Spray machine used may be (a) high pressure (small air aperture) type or (b) a low pressure (large air gap) type, depending on the nature and location of work to be carried out. Skilled and experienced workmen shall be employed for this class of work. Paints used shall be brought to the requisite consistency by adding a suitable thinner.

Spraying should be done only when dry conditions prevail. During spraying the spray gun shall be held perpendicular to the surface to be coated and shall be passed over the surface in a uniform sweeping motion. Different air pressures and fan adjustment shall be tried so as to obtain the best application with the minimum wastage of paint. The air pressure shall not be kept too high as otherwise the paint will clog up and will be wasted.

Spots that are inaccessible to the spray pattern shall be touched up by brush after spraying.

At the end of the job, the spray-gun shall be cleaned thoroughly so as to be free from dirt. Incorrect adjustments shall be set right, as otherwise they will result in variable spray patterns, runs, sags and uneven coats.

Each coat shall be allowed to dry completely and lightly rubbed with very fine grade of sand paper and loose particles brushed off before next coat is applied. Each coat shall vary slightly in shade and shall be got approved 'from the Engineer-in-charge of before next coat is started.

Each coat except the last coat shall be lightly rubbed down with sand paper or fine pumice stone and cleaned off dust before the next coat is applied.

No hair marks from the brush or clogging of paint puddles in the corner panels, angles of moulding, etc. shall be left on the works. In painting doors and windows, the putty round the glass panes shall also be painted but care shall be taken to see that no paint stains etc. are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out in painting.

In painting steel work, special care shall be taken while painting over bolts, nuts, rivets, overlaps etc.

The additional specifications for primer and other coats of paints shall be according to the detailed specifications under the respective headings.

7.4 Brushes and containers

After work, the brushes shall be completely cleaned off paint and linseed oil by rinsing with turpentine. After cleaning, the brushes are wrapped in heavy paper or water proof paper for storage. It is to be used the next day it shall be hung in a thinner or linseed oil in a container. On no account shall brushes to be made to stand on bristles. A brush in which paint has dried up is ruined and shall on no account be used for painting work.

The containers, when not in use, shall be kept closed and free from air so that paint does not thicken and also shall be kept guarded from dust. When the paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, before they can be used again.

7.5 Wood and wood Based Materials

7.5.1 Preparation of Surface

All wood works shall be dry and free from any foreign matter, incidental to building operation. Nails shall be punched well below the surface to provide a firm key for stopping. Moulding shall be carefully smoothened with abrasive paper and projecting fibres shall be removed. Flat portions shall be smoothened off with abrasive paper used across the grain prior to painting. Any knots, resinous, streaks or bluish sap wood that are large not enough to justify cutting out shall be treated with two coats of pure shellac knotting, applied thinly and extended about 25 mm beyond the actual area requiring treatment.

7.5.2 Plywood and Block Board: This shall be treated as for solid wood, described above.

7.5.3 Hard Boards The surface shall be dusted off and painted with a coat of plastic emulsion paint thinned with water or with a coat of shellac varnish as specified. The surface shall then be rubbed down with fine grade abrasive paper and followed with required under coating and finishing coat as for solid wood.

7.5.4 Particle Board: The surface shall be filled with thin brushable filler and finished as for solid wood.

7.5.5 Insulation Boards: Two thin coats of water based paints shall be applied by spraying.

7.6 Priming Coat: The dirt or any other extraneous material shall be removed from the surface to be painted. In case he surface is already finished with printer coat but unsatisfactory, it shall be rubbed down to bare wood and surface reprimed. Primer shall be applied by brushing.

7.7 Application for transparent wood filler: The filler shall be applied with brush or rag in such a way that it fills up all the pores and indentations and levels up the surface. It shall be allowed to dry for 24 hours and it shall then be cut and rubbed with emery paper so that the surface of the wood is laid bare, with, the filler only in the pores and crevices of the wood.

7.8 Stopping: All holes, cracks, crevices, etc. shall be stopped carefully to true and level surface with putty before the main undercoat is applied and after the application of the priming coat, stopping shall be prepared as below:

Bees wax, resin and lac (orange in colour) in the proportion of 1: 1: 16 by weight shall be melted down together in a suitable pot using slow heat, the mix being kept well stirred. Colouring materials to produce the required shade shall be added into molten mixture and stirred. Stopping shall on cooling be rolled into stick forms for use.

7.9 Application of Paints: This shall conform to specifications under Para 7.1

7.10 Applying wood preservatives:

The preservatives of specified quality shall be applied in two coats. On new wood work, it shall be applied liberally with a stout brush and not doubled with rags or cotton waste, The first coat shall be allowed at least 24 hours to soak in before the second coat is applied. The excess of preservative which does not soak into the wood shall be wiped off with a clean dry piece of cloth.

8.0 WHITE WASHING

8.1 General

The item refers to white-washing over old and new concrete, stone masonry brick plastered surfaces and asbestos cement sheets.

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

8.2 Scaffolding

This may be double or single according to requirements. If ladders are used, pieces of old gunny bags or cloth rags shall be tied on their tops to avoid damage or scratches to the

wall. Proper stage scaffolding shall be created when white-washing ceiling. The contractor shall be responsible for accidents if any taken place.

8.3 Preparation of Surface

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

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

8.4 Application of white-wash

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

No portion in the surface shall be left out initially, to be patched up later on.

For new work, the white washed surface shall present a smooth and uniform finish.

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

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

Preparing the surface for white wash including the scaffolding.

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

9.0 PLASTIC EMULSION PAINTING ON WALL & CEILING

9.1 General

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

9.2 Paint

Plastic emulsion paint of approved brand and manufacture and of the required shade shall be used.

9.3 Preparation of Surface

The surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulation and then sand papering the same after it is dry.

9.4 Application: The number of coats shall be as stipulated in the item. The paint will be applied in the usual manner with brush or roller.

The paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surfaces to 2 to 3 hours on non-absorbent surfaces.

The thinning of emulsion is to be done with water and not with turpentine.

Thinning with water will be particularly required for the undercoat which is applied on the absorbent surface. The quantity of thinner to be added shall be as per manufacturer's instructions.

The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

9.5 Precautions

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

Brushes should be quickly washed in water immediately after use and kept immersed in water during break periods to prevent the paint from hardening on the brush.

In the preparation of walls for plastic emulsion painting, no oil base putties shall be used in filling cracks, holes etc.

Splashes on floors etc. shall be cleaned out without delay as they will be difficult to remove after hardening.

Washing of surfaces treated with emulsion paints shall not be done within 3 to 4 weeks of application.

9.6 Other Details: These shall be as per specification for "Painting" as far as they are applicable.

10.0 SYNTHETIC PLASTERING IN PLAIN / STONE OR METALLIC FINISH

10.1 General

Synthetic plaster reinforced by using fibres and shall be based on chemicals having acid and alkally resistant properties. It can be applied to any hard, plain surface both internally and externally. It does not require any further application or treatment once it is applied on the surface.

Synthetic Plaster is available in ready-mixed form in any desired colour and can be applied by using a trowel. The synthetic plaster avoids cracks formation as well as it provides a waterproofing coating on the surface treated.

10.2 Base Coat

An average 20mm thick cement plaster shall be provided as rendering coat which shall be roughened lightly with wire brush so as to form very mild keys on the rendered surface.

The surface shall be allowed for curing for a period of minimum 14 days before the application of synthetic plaster.

10.3 Applications

Synthetic plaster is applied in three coats:

One coat of plaster by trowel and ; Subsequent two coats of chemical overcoat by brush in approved colour and finished as specified (plain/stone or metallic).

10.5 Other Details

The synthetic plaster treatment shall be executed through an approved agency and written performance guarantee shall be submitted by the Contractor for a minimum period of Ten years through the agency. The contractor and the agency shall be jointly responsible for the performance of the treated surface until the expiry of the guarantee period.

11.0 ACRYLIC PAINTING TO EXTERNAL SURFACES

Acrylic weather shield paint of approved brand shall be applied over plastered surfaces as directed by the Engineer.

Other specifications including preparation of surfaces, application of paint etc. shall conform to section 6.3 above and as directed by Engineer-In-Charge . The priming coat, anti-fungal treatment, preparation of paint etc. shall be carried out as per manufacturer's specification / as directed by Engineer-In-Charge .

WAX POLISHING

Wax polish shall either be prepared on site or obtained ready made from market. Polish made on the site shall be prepared from a mixture of pure bees wax, linseed oil, turpentine oil and varnish in the ratio of 2:1 1/2:1 1/2 by weight. The bees wax and the boiled linseed oil shall be heated over a slow fire when the wax is completely dissolved the mixture shall be cooled till it is just warm, and turpentine oil and varnish added to it in the required proportions and the entire mixture is well stirred.

Surface shall be prepared as described under French spirit Polish except that the final rubbing shall be done with sand paper which has been slightly moistured with linseed oil. Mixture of polish shall be applied evenly with a clean cloth pad in such a way that no blank patches are left and rubbed continuously for half an hour. When the surface is quite dry a second coat shall be applied in the same manner, and rubbed continuously for half an hour or until the surface is dry. Final coat shall then be applied and rubbed for 2 hours or more if necessary, until the surface has assumed an uniform Gloss and is quite dry showing no sign of stickiness when touched. Gloss of the polish depends on the amount of rubbing, therefore rubbing must be continuous and with uniform pressure and frequent change in direction.

VARNISHING

Surface shall be prepared as described above. After preparation of surface, two coats of clean boiled linseed oil shall be applied at sufficient interval of time. After the linseed oil has dried two coats of varnish obtained from approved manufacturer shall be applied at sufficient interval of time. If the surface fails to produce the required gloss an additional coat shall be applied without any extra cost.

OIL EMULSION (OIL BOUND) DISTEMPERING

MATERIALS

Oil bound distemper of approved brand and manufacture conforming to latest edition of IS:428 shall be used. The primer shall be cement primer or distemper primer of same brand and manufacturer preferably. Distemper shall be diluted with water or any other prescribed thinner as per manufacturer's instruction. Distemper is to be prepared for the quantity which can be consumed for the day's work.

PREPARATION OF SURFACE

The surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulation and then sand papering the same after it is dry.

Pitting in plaster shall be made good with plaster of paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

Application

The priming coat shall be with distemper primer or cement primer, as required.

Distemper Coat

After the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitute one coat.

The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied over the primer coat to obtain an even shade.

A time interval of at least 24 hours shall be allowed between consecutive coats to permit of the proper drying of the preceding coat.

15 cm double bristled distemper brushes shall be used. After each days work, brushes shall be thoroughly washed in hot water with soap solution and hung down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work.

The specifications in respect of scaffolding, protective measures, measurements etc shall be as described under dry distempering.

PAINTING OIL/ENAMEL/ACRYLIC EMULSION ETC

Ready mixed oil paint, acrylic emulsion paint, ready mixed synthetic enamel paint, Aluminium paint, etc shall be brought in original containers and in sealed tins. If for any reason thinner is necessary the brand and quantity of thinner recommended by the manufacturer or as instructed by the Employer/Architects shall be used.

The surface shall be prepared as specified above and a coat of approved primer shall be applied. After 24 hours drying, approved of specified quality paint shall be applied evenly and smoothly . If required a filler putty coating may be given to give smooth finish. Each coat shall be allowed to dry cut thoroughly and then lightly rubbed down with sand paper and cleaned of dust before, the next coat is applied. Number of coats shall be as specified in the item and if however the finish of the surface is not uniform additional coats as required shall be applied to get good and uniform finish at no extra

cost. After completion no hair marks from the brush or clogging of paint puddles in the corners of panel angles of mouldings shall be left on the work. The glass panes floor etc., shall be cleaned of stains.

When the final coat is applied, if directed, the surface shall be rolled with a roller or if directed it shall be supplied with a stippling brush.

MELAMINE FINISHIES

Apcolite Natural Wood finish clear glossy is a premium quality melaminised coating specially formulated as a protective and decorative finishing clear coating for wood.

TECHNICAL DATA

Method of Application:		Brushing at 25.30 seconds by Ford Cup B4 at 30 Degree C
	:	Spraying at 20.25 seconds by Ford Cup at 30 degree C
Thinner recommended	:	Brushing - Thinner 106
		Spraying - Thinner 124
Thinner intake	:	20.25% by volume
Mixing ratio	:	Base to hardener in 10.1 by volume
Drying Time	:	8 hours
		Surface dry - less than 30 minutes Hard dry 16.20 hours
		Recoating period - Overnight.
Finish	:	25 microns film thickness smooth glossy
Flash point	:	Above 14 degree C (57 degree F)

Sand the surface along the grains with Emery paper No.180 or with a suitable grade sand paper. Brush the surface free of loose dust. Fill the wood using Apcolite Wood Filler. Remove excess filler immediately after applications. Allow 2.3 hours of drying, before sanding with Emery Paper No.240 or 280. If desired, apply Apcolite Natural Wood Finish upto 20% by volume and apply by spraying after Sealer Coat. In application by ragging allow a drying time of 5.10 minutes in between coats and 30.60 minutes before overcoating with finish coats. Apply a coat of Apcolite Natural Wood Finish Clear Sealer, After overnight drying, smooth sand with Emery Paper No.320 and wipe the surface free of loose dust. Apply Apcolite Natural Wood Finish Clear Glossy as follows. Ensure that the surface to be coated is free from loose matter.

Apcolite Natural Wood Finish Clear Glossy is a two component system consisting of base and hardener. These should be mixed in the recommended ratio. The two components should be mixed in a glass, plastic or enamelled container. Allow the mixture to stand for 30 minutes and then apply by brushing or spraying using the recommended thinner for consistency adjustment. The mixture of base and hardener should be used within 8 hours. To enhance gloss and decorative value Apcolite Natural Wood Finish Clear Glossy can be buffed using suitable buffing mops but only after 48 hours of application.

MATT

Apcolite Natural Wood finish clear glossy or approved equivalent is a premium quality melaminised coating specially formulated as a protective and decorative finishing clear coating for wood.

TECHNICAL DATA

Method of Application	:	Brushing at 25.30 seconds by Ford Cup B4 at 30 Degree C
	:	Spraying at 20.25 seconds by Ford Cup at 30 degree C
Thinner recommended	:	Brushing - Thinner 106
		Spraying - Thinner 124
Thinner intake	:	20.25% by volume
Mixing ratio	:	Base to hardener in 10.1 by volume
Drying Time	:	8 hours
		Surface dry - less than 30 minutes Hard dry 16.20 hours
		Recoating period - Overnight.
Finish	:	25 microns film thickness smooth glossy
Flash point	:	Above 14 degree C (57 degree F)

Sand the surface along the grains with Emery paper No.180 or with a suitable grade sand paper. Brush the surface free of loose dust. Fill the wood using Apcolite Wood Filler or approved equivalent. Remove excess filler immediately after applications. Allow 2.3 hours of drying, before sanding with Emery Paper No.240 or 280. If desired, apply Apcolite Natural Wood Finish or approved equivalent upto 20% by volume and apply by spraying after Sealer Coat. In application by ragging allow a drying time of 5.10 minutes in between coats and 30.60 minutes before over-coating with finish coats. Apply a coat of Apcolite Natural Wood Finish Clear Sealer or approved equivalent. After overnight drying, smooth sand with Emery Paper No.320 and wipe the surface free of loose dust. Apply Apcolite Natural Wood Finish Clear Glossy or approved equivalent as follows. Ensure that the surface to be coated is free from loose mater. Apcolite Natural Wood Finish Clear Glossy is a two component system consisting of base and hardener. These should be mixed in the recommended ratio. The two components should be mixed in a glass, plastic or enamelled container. Allow the mixture to stand for 30 minutes and then apply by brushing or spraying using the recommended thinner for consistency adjustment. The mixture of base and hardener should be used within 8 hours.

H. STEEL DOORS

STEEL DOORS & WINDOWS

1.0 APPLICABLE CODES

The provisions of the largest Indian Standards mentioned below shall form a part of these specifications:

IS: 1956	Glossary of terms relating to iron and steel.
IS:814 (Part I)	Specifications for covered electrodes for metal arc welding of structural steel.

IS:814 (Part II)	1) For welding products other than sheets. Specifications for covered electrodes for metal arc welding of structural steel. 2) For welding sheets
IS: 815	Classification and coding of covered electrodes for metal arc welding of structural steel.
IS: 816	Code of practice for use of metal arc welding for general construction in mild steel.
IS: 817	Training of Welders- Code of practice: Part 1 manual metal arc welding
IS: 818	Code of practice for safety and health requirements in electric and gas welding and cutting operations.
IS: 1948	Aluminium doors, windows & ventilators.
IS:1977	Low tensile structural steels – Specifications.
IS: 6227	Code of Practice for use of metal arc welding in tubular structure.
IS: 6248	Specifications for metal rolling shutters and rolling grill.
IS: 1081	Code of Practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators.
IS: 2062	Weldable Structural Steel.
IS: 1361	Specifications for steel windows for Industrial Buildings.
IS:1200 (Part VIII)	Measurements for steel work and iron work.
IS.1038	Specifications for steel doors, windows and ventilators.
IS: 226	Specifications for structural steel (Standard quality).
IS: 823	Code of procedure for manual metal arc welding of metal steel.
IS: 102	Ready mixed paint, brushing, red lead non sitting, priming.
IS: 1363	For black hexagon bolts, nut and lock nuts (dia 6 to 39 mm) and black hexagon screws (dia 6 to 24 mm).
IS: 813	Scheme of symbols for welding.

Other IS Codes not specifically mentioned here but pertaining to Metal Doors, Windows & Ventilators form part of these specifications.

2.0 MATERIALS

2.1 Structural Steel

Standard quality mild steel of various varieties and designations shall be used for different works as mentioned below:

(i) St 42 - S:

This variety of steel (standard quality) shall conform to specifications given in IS: 2062 (latest) and shall be used for

Riveted steel work

Bolted steel work

Steel work where welding is employed for fabrication provided that the thickness of material does not exceed 20 mm. When material conforming to this standard is over 20 mm thick special precautions may be required in case the material is to be welded (see IS: 823 - latest).

(ii) St 30 - 0:

This variety of steel (ordinary quality) shall conform to specifications given in IS: 1977 and is intended for general purposes such as door and window frames, window bars, grills,

steel gates, hand railing , builder's hardware, fencing post, tie bars, etc. All finished steel material shall be properly and neatly rolled to dimensions, sections and weights as specified. The finished material shall be free from visible as well as hidden defects and excessive rusting. The ends of the tubes shall be cut square, unless otherwise specified.

Steel sections and tubes shall be well protected and kept free from excessive rust and scaling. In this regard, decision of Engineer-in-charge shall be final and binding on the contractor.

2.1.1 Black Bolts

Also known as machine bolts, these bolts shall be made from rods and they come from the rolling mills and are not finished to exact size. A lower working stress is taken for these types of bolts than those of rivets and 'turned fitted bolts'.

2.1.2 Welding Equipment:

The welding plant and equipment shall be of modern design and shall be got approved by the Engineer-in-charge.

The electrodes required for metal arc welding shall be 'covered electrodes' and shall conform to IS: 814 (Part I) for welding products other than sheets and IS: 814 (Part II) for welding sheets.

The type of covering shall be as per IS: 815 for classification and coding of covered electrodes for metal are welding of structural sheets.

2.2 Workmanship

2.2.1 Structural Steel Work

The steel sections as specified or required shall be cut, square and to correct lengths, as per drawing and design. The cut ends exposed to view shall be finished smooth. No two pieces shall be welded or otherwise jointed to make up the required length of a member, except as indicated in the drawings or directed by the Engineer-in-charge . All straightening and shaping to form shall be done by application of pressure and not by hammering. Any bending or cutting shall be carried out in such a manner as not to impair the strength of the metal. All operations shall be done in cold state unless otherwise directed / permitted.

All holes shall be generally drilled to the required size and at the required position. Sub-punching shall be permitted, provided it is done 3 mm less in diameter and reamed thereafter to the required size.

Holes for rivets and black bolts shall be larger by 0.4 to 0.6 mm than the nominal diameter of the rivets and black-bolts depending upon the dia of rivets.

Holes for counter-sunk bolts shall be made in such a manner that their heads fit flush with the surface after fixing.

All bolt heads and nuts shall be hexagonal and of equal size, unless specified otherwise. The screwed threads shall conform to IS: 1363 and the threaded surface shall not be tapered. The bolts shall be of such length as to project two clear threads beyond the nuts when fixed in position and these shall fit in the bolts without any shake. The nuts shall fit in the threaded ends of bolts properly. Tapered washers shall be provided for all heads and nuts bearing and levelled surfaces. The threaded portion of the bolt shall not be within the thickness of the parts bolted together. The faces of bolt heads and nuts shutting against steel members shall be machine finished.

Welding shall generally be done by electric process. The electric arc method being economical is usually adopted. Where public electricity is not available a suitable generator shall be arranged. Gas welding shall be resorted to using oxyacetylene flame with specific prior approval of the Engineer-in-charge .

Types of welding: Welds used for joining structural members are generally of the following two types as under:

(i) Fillet weld: The cross section of fillet weld is triangular and it is used to joint two surfaces normally at right angles to each other. This type of weld is used more frequently in structural connections than any other type, and is usually in the form of isosceles triangle. The fillet welds shall be continuous or intermittent as specified in the design.

(ii) Butt welds: These are classified according to the method of grooving or preparing of the base metal. The metal pieces shall be filled or obisolled chiseled to the required shape for butt welding at the throat for which no extra payment shall be made.

Fillet and Butt welds shall conform to IS: 816. Special type of welds as slot-welds shall be used where so specified. Either direct or alternating current (but not both types) may be used throughout the whole work. An ammeter shall be provided to each arc and so situated that the Engineer-in-charge can easily check the current being used by the operator.

Each welder shall be supplied with a portable current regulator to enable him to adjust the welding current within the approved limits without leaving his work. Only qualified operators shall be employed for welding and they shall have been trained and shall be tested after every three months as per provisions of IS: 817 for “Code of Practice for training and testing of Metal Arc Welders”.

In welded structure holes are necessary for service bolts required during erection. These holes shall be made as specified above. The holes in the various sections shall be filled with punches and welded properly to form a composite section.

Surfaces which are to be welded together shall be free from loose mill-scale, rust, paint, grease or other foreign matter. A coating of boiled linseed oil shall be permitted.

Before welding is commenced, the plates shall first be brought together and firmly clamped or spot welded at specified distance. This temporary connection has to be strong enough to hold the parts accurately in place without displacement.

All operators connected with welding and cutting equipment conform to the safety requirement given in IS 818 for “Safety and Health Requirements in Electric and Gas Welding and Cutting Operations”.

The following points shall be borne in mind during the process of welding:

(a) Welds shall be made in the flat position, wherever applicable.

(b) Arc length, voltage and amperage shall be suited to the thickness of material, type of groove and other circumstances of the work.

(c) The sequence of welding shall be such that where possible the members which offer the least resistance to compression are welded first.

Processor Welding

The electrode manipulation during welding shall be such as to ensure that:-

(i) The base metal is in a fused state when the filler metal makes contact with it.

(ii) The filler metal does not overflow upon any unfused based metal.

(iii) The base metal is not under-cut along the weld edges.

(iv) The flowing metal floats the slags, the oxides, and the gas bubbles to the surface behind the advancing pool.

In case any of these requirements is unattainable by manipulation, the current shall be adjusted or the electrode size changed. Each time the arc is started, the electrode shall be moved in such a way that the fusion of base metal at the starting point is assured. At the completion of a run the movement of electrode shall be slowed down to fill the arc crater.

After every interruption of the arc except at completion of a run the arc shall be restarted ahead of the previous deposit and then moved back to fill the crater, or such alternative technique shall be used as will ensure complete filling of the crater or complete fusion between the new and old deposits and the base metal at the point of junction and result in continuity of weld. Before welding operation is completed, all traces of slag shall be removed from the deposit, by chipping if necessary and the deposited and adjoining base metal shall be wire brushed and cleaned at all points. The requirements shall apply not only to successive layers but also to successive beats, and to the overlapping area whatever a junction is made on starting a new electrode:

(v) The welds shall be free from cracks, discontinuity in welding and other defects such as :-

(a) under size

(b) over size

(c) undercutting

(d) over cutting

All defective welds which shall be considered harmful to the structural strength shall be cut out and re-welded.

Finished welds and adjacent parts shall be protected with clean boiled linseed oil and after all slag has been removed, welds and adjacent parts shall be painted after the same are approved by the Engineer-in-charge .

Inspection and testing of welds:

The method of inspection and testing shall be as under:

(a) Visual Inspection: The following factors shall be considered during the visual inspection:

(i) Dimensions of weld deposit. The size of the weld shall be as specified and it may be slightly over but not under.

(ii) Shape of profile: The profile of the weld is affected by the position of the joint, but it shall be uniform. In the case of butt and corner welds, the profile shall be slightly convex and in the case fillet welds it shall be usually slightly concave.

(iii) Uniformity of Surface: The height and spacing of the ripple shall be uniform; these being indicative of workmanship.

(iv) Degree of undercut: Undercutting is undesirable. The weld joint shall be free from undercut but slight intermittent occurrences may be disregarded.

(v) Smoothness of joints: The joints in the weld run where welding has been adopted, shall be as uniform and smooth as possible and shall show no pronounced bump or crater in the weld surface.

(vi) Freedom from surface defects. The surface of the weld shall be free from porosity, cavities and burnt on scale.

(vii) Penetration bead in Butt Welds: A slight penetration bead shall be present and it should be reasonably uniform in width and appearance. Intermittent occurrences of lack of penetration bead may be disregarded.

(viii) Degree of fusion: Fusion shall be complete over the whole area of the joint surface.

(ix) Degree of Root Penetration: These defects are most likely to occur at the root of the weld and in this position they are liable to have the maximum effects in reducing the strength of the weld. A close examination of the root shall, therefore, be made. In butt-welds, the penetration should extend to the underside of the plates producing a penetration bead of the right size. In fillet welds with good root penetration, the weld metal should reach the corner.

Note: 1: In case of fusion welding or non-fusion welding fillet welds will appear in joint, (fillets being at the cretches).

Note: 2: In case of non-fusion welding of cast iron the points shall show satisfactory penetration and adhesion.

(x) Gas Cavities and Flux Entrapments: Unless they are caused by the use of unsuitable material, they are attributable to the quality of workmanship, the desired result being to achieve uniform appearance and freedom from cavities and flux entrapments (where flux is used). In fusion welding of mild steel, cast iron and aluminium where neutral flame is used, and in fusion welding of brass or braze welding of cast iron where oxidizing flame is used, current welding technique may result in rough, porous, discolored and lusterless appearance in the fracture.

Note

(a) In case of fusion welding or non-fusion welding of cast iron isolated blow holes or concentration of pinholes in the weld metal shall be regarded as grounds for rejection but isolated pinholes shall not be so regarded.

(b) Bending Testing (for ductility): The elongation shall be not less than 30 percent for stress relieved welds and not less than 25 percent for non-stress relieved welds.

(c) Tensile Testing: (Reduced Section Tensile Testing): The tensile strength shall be not less than minimum of the specified tensile range of the parent metal.

Radiographic Examination: This shall be done as given in IS: 4853.

3.0 ROLLING SHUTTERS WITH / WITHOUT M. S. GRILL WORK

Rolling shutters shall be motorized gate having motorized operational facility, obtained from manufacturers such as Standard quality and approved make. Shutters up to 12 Sqm. shall be push and pull type.

Shutters exceeding 12 sq.m shall be provided with gears operated by mechanical devices with chain and / or handle or shall have electrically operated arrangement as specified.

Rolling shutters of 8 Sqm or beyond shall be provided with ball bearings. The width and thickness of M.S. lath shall be 80mm and 1.25 mm.

The shutters shall be of length and width as specified. The spring shall be preferably of coiled type and shall be manufactured from high tensile spring steel wire or strip of adequate strength to balance the shutters in all positions. The spring pipe shaft etc. shall be supported on strong mild steel brackets.

Guide channels shall be of mild steel deep channel section and of rolled, pressed or built-up construction. The thickness of sheet shall not be less than 3.175mm (10 gauge). The depth of side channels shall be 60mm for clear shutter with width upto 3.0 m and 75mm for width 3.0m and above. The gap between two legs of guide channel shall be close enough to prevent rattling due to wind and wide enough for free movement of shutters.

Guide channels, each shall have 3 fixing cleats spaced at not more than 0.75m. Cleats shall be fixed to walls or RCC work with bolts or screws.

The guide channels shall be fixed to the jambs either (a) embedded in grooves (b) projecting or (c) overlapping, as directed by the Engineer-in-Charge .

Any cutting to side walls shall be made good after fixing of cleats/lugs.

The cover of shaft etc. shall be of the same gauge materials as laths. M. S. Grill work shall be manufactured with grill made out of 8mm dia. M.S. rounds bent to required shape and connected by means of flat iron 20mm x 6mm as shown on the drawings and fixed in the rolling shutter.

4.0 M.S. WICKET GATE IN ROLLING SHUTTERS

These shall be manufactured with M.S. members of sheet of sizes and as per the details shown on the drawings and fixing in position all fittings required such as hinges, locking arrangements, etc. shall be provided. Painting shall be carried out as per the parent rolling shutters.

5.0 M.S. LADDERS

M.S ladders shall be fabricated out of M.S. rounds, squares, flats etc. as described, as per the drawing or as directed. The work shall include cutting to required sizes, welding, fixing in position, bending and curving the flat iron stringer at top to form handles, embedding the bottom of ladders, providing and casting cement concrete at top and bottom in 1:2:4 (nominal mix) (1 cement: 2 sand: 4 stone aggregate 20mm nominal size) of 60 mm x 30 mm x 150 mm. All the work shall receive one coat of red oxide zinc chromate primer and two coats of synthetic enamel paint of approved make, quality, colour and shade.The width of the ladder shall be 450 mm in between stringers made out of 50mm x 6mm flats as specified and 16mm dia.

M.S. round at maximum 30 cm centres, notched and welded to stringer flats. The ladder shall be fixed at top with welding or with nuts and bolts as required.

6.0 S.S. RAILING

Fabricating stainless steel pipe railing for terraces/ staircase and other areas, up to 1000mm high from finished floor level made out of stainless steel pipe balusters welded to stainless steel pipe top rail and stainless steel pipe intermediate rails (stainless steel pipe shall not be less than 1.5mm thick) including profile cutting, fixing in position, necessary anchor fasteners / approved fixing arrangements, welding using special

electrodes for stainless steel welding, etc. complete as per approved shop drawing and as directed by the Engineer in charge .

The railing pipe shall be of non magnetic type stainless steel and conforming grade 304 of AISI. The item also includes providing and fixing rigid type, high impact, smooth 0.8mm thick Teflon separators (both side) between dissimilar metals (MS & SS) or other non-conducting materials as approved by the Engineer in charge .

Providing and fixing upto 65mm (OD) 12G stainless steel hand rail with 40mm (OD) 14G balustrades at every alternate step fixed/slid on to suitable MS sleeve embedded in stair wall. Each balustrades shall be provided with stainless steel shoe at the wall junction. The joint of the balustrade and the sleeve shall be fixed with lead.

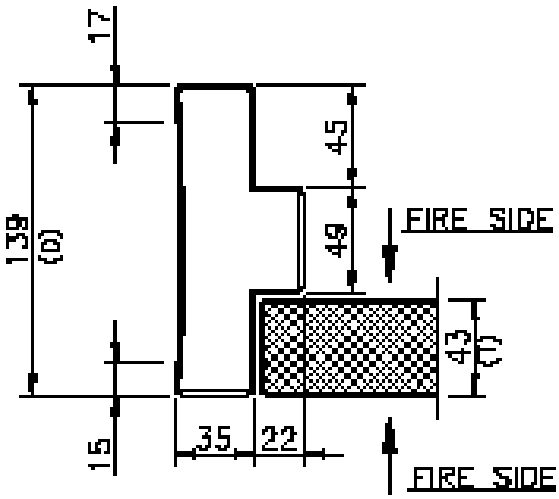
In railing / hand rails at all levels including necessary anchor fasteners, insert plates, scaffolding / staging etc. all complete as directed by the Engineer.

7.0 M.S. PIPE RAILING

The M.S. pipe railing shall be fabricated as per drawings and instructions of EIC , out of specific dia, which indicate nominal bore. Unless otherwise shown on the drawings or as directed, the top horizontal or inclined pipe shall be at a height of 1.0 metre and the middle horizontal or inclined pipe shall be at a height of 0.5 metre. The top pipes will be bent at ends and form into vertical support. The vertical supports shall consist of 40mm to 50mm pipe as shown in the drawing or as directed/ specified, at not more than 1.5 meter centres. All vertical pipes shall be anchored to the structure by approved fixing arrangements. The vertical pipes shall be full from bottom to the top horizontal, which shall be continuous without any break. The middle horizontal pipe shall be continuous between vertical supports. The joints shall be properly made and welded and the welding finished to give a smooth surface. The railing shall be fixed truly vertical and shall have a neat appearance. The railing shall be finished with paint / coating as specified in the item description and as per architectural requirements.

FIRE RATED DOORS

Specifications for 2 Hours 2 Criteria Fire door



2 hours 2 Criteria Fire Rated Door, is fabricated for two hours and two criteria performance in Stability and Integrity as per BS 476 PART 22 AND IS 3614 PART II.

Frame: shall be fabricated from 1.6 mm thick galvanized steel or 2 mm thk. M.S.CRCA sheets depending on the size of the doors. Frames will have a double rebate profile. They will be provided with stiffeners for hardware/ lock mounting and holdfasts for grouting.

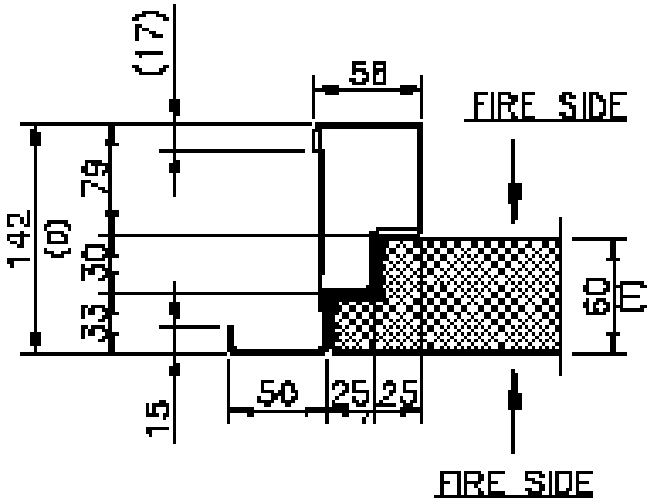
Shutter: of overall thickness 43 mm shall be formed from two outer skin panels of 1.25 mm thick galvanized steel sheets .shutters shall have multibend construction with lock seam joinery for high strength & resistance. Reinforcements shall be provided in the shutter at locking / hardware area. The infill material shall be mineral wool.

Material: The sheet metal used for 1.6 mm thk frame and 1.25 thk shutters panels conform to IS 277 ;1992 . The sheet metal used for 2 mm Thk.CRCA sheet conforms to IS 513: 1994. The doors shall be provided with intumescent seals between frame and shutter at top and two sides for standard and large size doors. The doors shall be provided with 4 “long SS Magnum make hinges. The number of hinges provided shall depend upon door size.

Locking - the doors should be provided with fire resistant three point locking per shutter.

Painting - Both the frames and shutters shall be coated with etch primer, followed by coats of epoxy zinc phosphate primer and final coat of Polyurethane paint.

Specifications for 2 Hours 3 Criteria Fire door.



2 hours 3 Criteria Fire Rated Door, fabricated for two hours and three criteria performance in Stability, Integrity and Insulation as per BS 476 Part 22 and IS 3614 Part II, in both directions .

Frame : shall be fabricated from 1.6 mm thick galvanized steel or 2 mm thk.M.S.CRCA sheets depending on the size of the doors . frames will have a multibend profile . they will be provided with stiffeners for hardware/ lock mounting and holdfasts for grouting .

Shutter: of overall thickness 60 mm shall be formed from two outer skin panels of 1.25 mm thick galvanized steel sheets .shutters shall have multibend construction with lock seam joinery & stepped design for high strength & resistance . Reinforcements shall be provided in the shutter at locking / hardware area . The infill material shall be a Proprietary Ceramic Based Material with internal reinforcements .

Material : The sheet metal used for 1.6 mm thk frame and 1.25 thk shutters panels conform to IS 277 ;1992 . The sheet metal used for 2 mm Thk.CRCA sheet conforms to IS

513 : 1994 . The infill material shall be a Proprietary Ceramic Based Material researched and developed in collaboration with CBRI. the doors shall be provided with intumescent seals between frame and shutter at top and two sides . The doors shall be provided with 4 " long SS Magnum make hinges . The number of hinges provided shall depend upon door size.

Locking - the doors should be provided with fire resistant three point locking per shutter .

Painting - Both the frames and shutters shall be coated with etch primer, followed by coats of epoxy zinc phosphate primer and final coat of Polyurethane paint.

Specifications for Hollow Metal Pressed Sheet Doors (HMPS doors).

HMPS Doors are fabricated using multi bend design and lock seam joinery.

Frame:

shall be fabricated from 1.6 mm thick galvanized steel or 2 mm thk.M.S.CRCA sheets depending on the size of the Doors.

Frames can have a double or a single rebate profile. They will be provided with stiffeners for hardware/ lock mounting and holdfasts for grouting.

Shutter: of overall thickness 43 mm shall be formed from two outer skin panels of 1.25 or 1 mm thick galvanized steel sheets .shutters shall have multi bend construction with lock seam joinery for high strength & resistance. Reinforcements shall be provided in the shutter at locking / hardware area.

The infill material shall be PUF which is injected under a restraining pressure of 1.5 kgs / cm2 .

Material :

The sheet metal used for 1.6 mm thk frame and 1.25 thk shutters panels conform to IS 277:1992 . The sheet metal used for 2 mm Thk.CRCA sheet conforms to IS 513 : 1994 .

PUF shall have a density of approx 0.04 kg/cm3.

The doors shall be provided with 4 " long SS Magnum make hinges . The number of hinges provided shall depend upon door size.

Locking & hardware- the doors shall be provided with standard hardware.

Painting –

Both the frames and shutters shall be coated with etch primer, followed by coats of epoxy zinc phosphate primer and final coat of Polyurethane paint.

Accessories:

vision panel 200x300x6mm as approved.

Dorma PHA 2000 single Panic Bar for Single leaf/active leaf of double leaf door / as approved.

Dorma PHA 2000 3point Panic bar for Double leaf Door/ as approved.

Dorma PHT3905 Outside Access device for Panic Bar / as approved.

Godrej 240 Mortise lock with latch, deadbolt, 2C Cylinder, SS Tubular Handles / as approved.

Godrej Heavy duty door closer:/ as approved.

Hager Door coordinator for double leaf doors/ as approved.

SS D handles: as approved.

SS Tower Bolt: (as approved if required).

Flush Doors Specifications			
TYPE	HONEY COMB	FLAX	TIMBER
A. STILE & RAIL	Mango Treated & Seasoned or Equivalent	Mango Treated & Seasoned or Equivalent	Mango Treated & Seasoned or Equivalent
	Finger Jointed 50 - 60 MM	Finger Jointed 50 - 60 MM	Finger Jointed 50 - 60 MM
B. LOCK RAIL	4" x 15" Height on two sides	4" x 15" Height on two sides	Solid battons
C. FILLER	Honey comb Honicell	Flax Board 400 - 450 Density	Treated Mango or Pine / Meranti / Neem or Equivalent
	BLS 140 15 MM Cell size	Imported Flax Board	
D. CROSS SECTION	Plywood 3.5 MM /3 / 3.5 MM MDF	Plywood 3.5 MM /3 / 3.5 MM MDF	Core Veneer 2.5 MM x 4 Layer Balance Panel 0.5 MM x 2 Face Veneer 0.5 MM x 2 (9 Ply Construction)
E. FACE PANEL	Decorative Veneer / Laminate sheet	Decorative Veneer / Laminate sheet	Decorative Veneer / Laminate sheet
	Commercial Face Veneer	Commercial Face Veneer	Commercial Face Veneer
F. ADHESIVE	AS APPROVED	AS APPROVED	AS APPROVED

I. CEMENT CONCRETE PAVEMENTS

SPECIFICATIONS FOR ROAD WORKS

1.0 SCOPE

1.1 These specifications cover the work of the construction of roads including clearing and grubbing (if required), setting out, embankment / excavation, preparation of sub-grade, laying of sub-base, base, dense bituminous macadam topped by bituminous concrete. The work also involves construction of shoulders, roadside drains medians and all other related works.

1.2 The Contractor shall clear the area (if required) set out the works, provide all the materials, transportation including all leads and lifts, labour, equipment, supervision, and all other incidental temporary and ancillary works required to complete the construction described in the preceding paragraph.

2.0 CODES AND SPECIFICATIONS

The roadwork shall be done as per "Specifications for road and bridge works" published by the Indian Roads Congress on behalf of the Govt. of India, Ministry of Road Transport & Highways (MoRTH) and the various Indian Standards mentioned in the body of these specifications. The following are extracted out of MoRTH specifications.

3.0 SETTING OUT

3.1 The Contractor shall establish working Bench Marks tied with the Reference Bench Mark in the area soon after taking possession of the site. The Reference Bench Mark for the area shall be as indicated in the Contract Documents and the values of the same shall be obtained 'by the Contractor from the Engineer. The working Bench Marks shall be at the rate of four per km and also at or near all drainage structures, over-bridges and underpasses. The working Bench Marks/levels should be got approved from the Engineer. Checks must be made on these Bench Marks once every month and adjustments, if any, got agreed with the Engineer and recorded. An up-to-date record of all Bench Marks including approved adjustments, if any, shall be maintained by the Contractor and also a copy supplied to the Engineer for his record.

3.2 The lines and levels of formation, side slopes, drainage works, carriageways and shoulders shall be carefully set out and frequently checked, care being taken to ensure that correct gradients and cross-sections are obtained everywhere.

3.3. On construction reaching the formation level stage, the centre line shall again be set out by the Contractor and when approved by the Engineer , shall be accurately referenced in a manner satisfactory to the Engineer by marker pegs set at the outer limits of the formation.

3.4. No reference peg or marker shall be moved or withdrawn without the approval of the Engineer and no earthwork or structural work shall be commenced until the centre line has been referenced.

3.5. The Contractor will be sole responsible party for safeguarding all survey monuments, benchmarks, beacons, etc. The Engineer will provide the Contractor with the data necessary for setting out of the centre line. All dimensions and levels shown on the drawings or mentioned in documents forming part of or issued under the Contract shall be verified by the Contractor on the site and he shall immediately inform the Engineer of any apparent errors or discrepancies in such dimensions or levels. The Contractor shall, in connection with the staking out of the centre line, survey the terrain along the road and shall submit to the Engineer for his approval, a profile along the road centre line and cross-sections at intervals as required by the Engineer.

Suitable references for the transverse grid lines should be left in the form of embedded bricks on either ends or by other means so that it is possible to locate the grid points for level measurements after each successive course is laid.

For pavement courses laid only over widening portions, at least one line of levels shall be taken on each strip of widening, or more depending on the width of widening as decided by the Engineer in charge .

Notwithstanding the above, the measurements may be taken at closer intervals also, if so desired by the Engineer, the need for which may arise particularly in the case of estimation of the volume of the material for profile corrective course (leveling course). The average thickness of the pavement course in any area shall be the arithmetic mean of the difference of levels before and after construction at all the grid points falling in that area,

provided that the thickness of finished work shall be limited to those shown on the drawings or approved by the Engineer in writing.

As supplement to level measurements, the Engineer shall have the 3 ption to take cores/make holes to check the depth of construction. The holes made and the portions cut for taking cores shall be made good by the Contractor by laying fresh mix/material including compacting as required at no extra cost immediately after the measurements are recorded.

3.6 The lump sum rate quoted by the Contractor shall, unless otherwise specified, also include compliance with/supply of the following:

(i) General works such as setting out, clearance of site before setting out and clearance of works after completion;

(ii) A detailed programme for the construction and completion of the work (using CPM/PERT techniques) giving, in addition to construction activities, detailed network activities for the submission and approval of materials, procurement of critical materials and equipment, fabrication of special products/equipment and their installation and testing, and for all activities of the Employer that are likely to affect the progress of work, etc., including updating of all such activities on the basis of the decisions taken at the periodic site review meetings or as directed by the Engineer;

(iii) Samples of various-materials proposed to be used on the Work for conducting all tests thereon as required as per the provisions of the Contract;

(iv) Testing of various materials including soil / coarse and fine aggregates / cement, design of concrete mixes and all testing for the same, drilling of cores from finished work and testing the same and all other work tests as required under these Specifications and furnishing lest reports/certificates;

(v) Inspection Reports in respect various items of work as per the relevant Specifications;

(vi) Any other data, which may be required as per these. Specifications or the Conditions of Contract or any other annexure / schedules forming pan of the Contract;

(vii) Any other item of work which is not specifically provided in the Bill of Quantities but which is necessary for complying with the provisions of the Contract;

(viii) All temporary works

(ix) Establishing and running a laboratory with facilities for testing for various items of works as specified hereafter.

(x) Cost of in-built provisions for Quality Assurance:

(xi) Cost of safeguarding the environment; and

(xii) Cost of providing “as-built drawings” in original and two sets of prints.

4.0 EXCAVATION FOR ROADWAY AND DRAINS

4.1 Scope

This work shall consist of excavation, removal and satisfactory disposal of all materials necessary for the construction of roadway, side drains and waterways in accordance with requirements of these Specifications and the lines, grades and cross-sections shown in

the drawings or as indicated by the Engineer. It shall include the hauling and stacking of or hauling to sites of embankment and sub-grade construction, suitable cut materials as required, as also the disposal of unsuitable cut materials in specified manner, trimming and finishing of the road to specified dimensions or as directed by the Engineer.

4.2 Classification of Excavated Material

The rate for excavation is for all soils and hence there will be no need for classification.

4.3 Construction Operations

4.3.1 Setting out: After the site has been cleared, the limits of excavation shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer. The Contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboos, stones, lime, mortar, concrete, etc., required in connection with the setting out of works and the establishment of bench marks. The Contractor shall be responsible for the maintenance of benchmarks and other marks and stakes as long as in the opinion of the Engineer, they are required for the work.

4.3.2 Excavation - General: All excavations shall be carried out in conformity with the directions given herein under and in a manner approved by the Engineer. The work shall be so done that the suitable materials available from excavation are satisfactorily utilized as decided upon beforehand.

While planning or executing excavations, the Contractor shall take all adequate precautions against soil erosion, water pollution etc., and take appropriate drainage measures to keep the site free of water .

The excavations shall conform to the lines, grades, side slopes and levels shown on the drawings or as directed by the Engineer. The Contractor shall not excavate outside the limits of excavation. Subject to the permitted tolerances, any excess depth/ width excavated beyond the specified levels/dimensions on the drawings shall be made good at the cost of the Contractor with suitable material of characteristics similar to that removed and compacted to the requirements of Clause 6.0.

All debris and loose material on the slopes of cuttings shall be removed. No backfilling shall be allowed to obtain required slopes excepting that when boulders or soft materials are encountered in cut slopes, these shall be excavated to approved depth on instructions of the Engineer and the resulting cavities filled with suitable material and thoroughly compacted in an approved manner.

After excavation, the sides of excavated area shall be trimmed and the area contoured to minimise erosion and ponding, allowing for natural drainage to take place. If trees were removed, new trees shall be planted, as directed by the Engineer. The cost of planting new trees shall be deemed to be incidental to the work.

4.3.3 Methods, tools and equipment: Only such methods, tools and equipment as approved by the Engineer shall be adopted / used in the work. If so desired by the Engineer, the Contractor shall demonstrate the efficacy of the type of equipment to be used before the commencement of work.

4.3.4 Marsh excavation (if encountered): The excavation of soils from marshes/ swamps shall be carried out as per the programme approved by the Engineer.

Excavation of marshes shall begin at one end and proceed in one direction across the entire marsh immediately ahead of backfilling. The method and sequence of excavating and backfilling shall be such as to ensure, to the extent practicable, the complete removal

or displacement of all muck from within the lateral limits called for on the drawings or as staked by the Engineer, and to the bottom of the marsh, firm support or levels indicated.

4.3.5 Excavation for surface/sub-surface drains: Where the Contract provides for construction of surface/sub-surface drains, excavation for these shall be carried out in proper sequence with other works as approved by the Engineer.

4.3.6 Slides: If slips, slides, over-breaks or subsidence occur in cuttings during the process of construction, they shall be removed at the cost of the Contractor as ordered by the Engineer. Adequate precautions shall be taken to ensure that during construction, the slopes are not rendered unstable or give rise to recurrent slides after construction. If finished slopes slide into the roadway subsequently, such slides shall be removed and paid for at the Contract rate for the class of excavation involved, provided the slides are not due to any negligence on the part of the Contractor. The classification of the debris material from the slips, slides etc. shall conform to its condition at the time of removal and payment made accordingly regardless of its condition earlier.

4.3.7 Dewatering: If water is met with in the excavations due to springs, seepage, rain or other causes, it shall be removed by suitable diversions, pumping or bailing out and the excavation kept dry whenever so required or directed by the Engineer. Care shall be taken to discharge the drained water into suitable outlets as not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair/restore to the original condition at his own cost or compensate for the damage.

4.3.8 Disposal of excavated materials: All the excavated materials shall be the property of the Employer. The material obtained from the excavation of roadway, shoulders, verges, drains, cross-drainage works etc., shall be used for filling up of (i) roadway embankment, (ii) the existing pits in the right-of-way and (iii) for landscaping of the road as directed by the Engineer, including leveling and spreading with all lifts and lead up to 3000 m and no extra payment shall be made for the same.

Unsuitable and surplus material not intended for use within the lead specified above shall also, if necessary, be transported with all lifts and lead beyond initial 3000 m, disposed of or used as directed by the Engineer.

4.4 Plying of Construction Traffic: Construction traffic shall not use the cut formation and finished sub-grade without the prior permission of the Engineer. Any damage arising out of such use shall be made good by the Contractor at his own expense.

4.5 Preparation of Cut Formation: The cut formation, which serves as a sub-grade, shall be prepared to receive the sub-base/base course as directed by the Engineer.

Where the material in the sub-grade (that is within 500 mm from the lowest level of the pavement) has a density less than specified in Table 6-2, the same shall be loosened to a depth of 500 mm and compacted in layers in accordance with the requirements of Clause 6.0.

Any unsuitable material encountered in the sub-grade level shall be removed as directed by the Engineer and replaced with suitable material compacted in accordance with Clause 6.0.

6.6 Finishing Operations

Finishing operations shall include the work of properly shaping and dressing all excavated surfaces.

When completed, no point on the slopes shall vary from the designated slopes by more than 150 mm measured at right angles to the slope, except where excavation is in rock (hard or soft) where no point shall vary more than 300 mm from the designated slope. In no case shall any portion of the slope encroach on the roadway.

The finished cut formation shall satisfy the surface tolerances described in Quality control of road works clause 900 of MoRTH specifications.

5.0 EMBANKMENT CONSTRUCTION

5.1 General

5.1.1 Description: These Specifications shall apply to the construction of embankments including sub-grades, earthen shoulders and miscellaneous backfills with approved material obtained from roadway and drain excavation, borrow pits or other sources. All embankments, sub-grades, earthen shoulders and miscellaneous backfills shall be constructed in accordance with the requirements of these Specifications and in conformity with the lines, grades, and cross-sections shown on the drawings or as directed by the Engineer.

5.1.2 Materials and General Requirements

51.3 Physical requirements:

5.1.4 The materials used in embankments, sub-grades, earthen shoulders and miscellaneous backfills shall be soil, moorum, gravel, a mixture of these or any other material approved by the Engineer. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment/ sub-grade.

The following types of material shall be considered unsuitable for embankment:

(a) Materials from swamps, marshes and bogs;

(b) Peat, log, stump and perishable material; any soil that classifies as OL, OI, OH or Pt -in accordance with IS: 1498;

(c) Materials susceptible to spontaneous combustion;

(d) Materials in a frozen condition;

(e) Clay having liquid limit exceeding 70 and plasticity index exceeding 45; and

(f) Materials with salts resulting in leaching in the embankment.

5.1.5 Expansive clay exhibiting marked swell and shrinkage properties (“free swelling index” exceeding 50 per cent when tested as per IS: 2720 - Part 40) shall not be used as a fill material. Where expansive clay with acceptable “free swelling index” value is used as a fill material, sub-grade and top 500 mm portion of the embankment just below sub-grade shall be non-expansive in nature.

5.1.6 Any fill material with a soluble sulphate content exceeding 1.9 grams of sulphate (expressed as SO3) per litre when tested in accordance with BS: 1377 Test 10, but using a 2:1 water-soil ratio shall ‘not be deposited within 500 mm or other distance described in the Contract, of concrete, cement bound materials or other cementitious materials forming part of the Permanent Works.

Materials with a total sulphate content (expressed as SO3) exceeding 0.5 per cent by mass, when tested in accordance with BS: 1377 Test 9 shall not be deposited within 500 mm, or other distances described in the Contract, of metallic items forming part of the Permanent Works.

5.1.7 The size of the coarse material in the mixture of earth shall ordinarily not exceed 75 mm when being placed in the embankment and 50 mm when placed in the sub-grade. However, the Engineer may at his discretion permit the use of material coarser than this also if he is satisfied that the same will not present any difficulty as regards the placement of fill material and its compaction to the requirements of these Specifications. The maximum particle, size shall not be more than two-thirds of the compacted layer thickness.

5.1.8 Ordinarily, only the materials satisfying the density requirements given in Table 6-1 shall be employed for the construction of the embankment and the sub-grade.

TABLE 6.1. DENSITY REQUIREMENTS OF EMBANKMENT AND SUB-GRADE MATERIALS

S.No.	Type of Work	Maximum laboratory dry unit weight when tested as per IS: 2720 (Part 8)
1.	Embankments up to 3 metres	Not less than 15.2 kN/cu.m.
	height, not subjected to extensive flooding.	
2.	Embankments exceeding 3 metres	Not less than 16.0 kN/cu. m.
	height or embankments of any height	
	subject to long periods of inundation	
3.	Sub-grade and earthen shoulders/ verges/ backfill	Not less than 17.5 kN/cu. m.

Notes: (1) This Table is not applicable for lightweight fill material e.g. cinder, fly ash etc.

(2) The Engineer may relax these requirements at his discretion taking into account the availability of materials for construction and other relevant factors.

(3) The material to be used in sub-grade should also satisfy design CBR at the dry unit weight applicable as per Table 6-2.

6.0 General requirements

6.1. The materials for embankment shall be obtained from approved sources with preference given to materials becoming available from nearby roadway excavation or any other excavation under the same Contract.

The work shall be so planned and executed that the best available materials are saved for the sub-grade and the embankment portion just below the sub-grade.

6.2. Borrow materials: Where the materials are to be obtained from designated borrow areas, the location, size and shape of these areas shall be as indicated by the Engineer and the same shall not be opened without his written permission. Where specific borrow areas are not designated by the Employer/the Engineer, arrangement for locating the source of supply of material for embankment and sub-grade as well as compliance to environmental requirements in respect of excavation and borrow areas as stipulated, from time to time by the Ministry of Environment and Forests, Government of India and the local bodies, as applicable, shall be the sole responsibility of the Contractor.

Haulage of material to embankments or other areas of fill shall proceed only when sufficient spreading and compaction plant is operating at the place of deposition.

No excavated acceptable material other than surplus to requirements of the Contract shall be removed from the site. Should the Contractor be permitted to remove acceptable material from the site to suit his operational procedure, then he shall make good any consequent deficit of material arising there from.

Where the excavation reveals a combination of acceptable and un-acceptable materials, the Contractor shall, unless otherwise agreed by the Engineer in charge , carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the permanent works without contamination by the unacceptable materials. The acceptable materials shall be stockpiled separately.

The Contractor shall obtain representative samples from each of the identified borrow areas and have these tested at the site laboratory following a testing programme approved by the Engineer. It shall be ensured that the sub-grade material when compacted to the density requirements as in Table 6-2 shall yield the design CBR value of the sub-grade.

TABLE 6-2. COMPACTION REQUIREMENTS FOR EMBANKMENT AND SUB-GRADE

Type of work/ material		Relative compaction as percentage of max. laboratory dry density as per IS: 2720 (Part 8)
1.	Sub-grade and earthen shoulders	Not less than 97
2.	Embankment	Not less than 95

The Contractor shall at least 7 working days before commencement of compaction submit the following to the Engineer for approval:

(i) The values of maximum dry density and optimum moisture content obtained in accordance with IS: 2720 (Part 7) or (Part 8), as the case may be, appropriate for each of the fill materials he intends to use.

(ii) A graph of density plotted against moisture content from which each of the values in (i) above of maximum dry density and optimum moisture content were determined.

(iii) The Dry density-moisture content -CBR relationships for light, intermediate and heavy compactive efforts (light corresponding to IS: 2720 (Part 7), heavy corresponding to IS: 2720 (Part 8) and intermediate in-between the two) for each of the fill materials he intends to use in the sub-grade.

Once the above information has been approved by the Engineer, it shall form the basis for compaction.

6.3 Construction Operation

6.3.1. Setting out: After the site has been cleared, the work shall be set out to Clause 5.3.1. The limits of embankment/sub-grade shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. The embankment/sub-grade shall be built sufficiently wider than the design dimension so that surplus material may be trimmed, ensuring that the remaining material is to the desired density and in position specified and conforms to the specified side slopes.

6.3.2 Dewatering: If the foundation of the embankment is in an area with stagnant water, and in the opinion of the Engineer it is feasible to remove it, the same shall be removed by bailing

out or pumping, as directed by the Engineer and the area of the embankment foundation shall be kept dry. Care shall be taken to discharge the drained water so as not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair/restore it to original condition or compensate the damage at his own cost.

6.3.3 Compacting ground supporting embankment/sub-grade: Where necessary, the original ground shall be leveled to facilitate placement of first layer of embankment, scarified, mixed with water and then compacted by rolling so as to achieve minimum dry density as given in Table 6-2.

In case where me difference between the sub-grade level (top of the sub-grade on which pavement rests) and ground level is less than 0.5 m and the ground does not have 97 per cent relative compaction with respect to the dry density as given in Table 6-2, the ground shall be loosened up to a level 0.5 m below the sub-grade level, watered and compacted in layers in accordance with Clauses 6.3.4 and 6.3.5 to not less than 97 per cent of dry density as given in Table 6-2.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced by approved materials laid in layers to the required degree of compaction.

Embankment or sub-grade work shall not proceed until the foundations for embankment/sub-grade have been inspected by the Engineer for satisfactory condition and approved.

Any foundation treatment specified for embankments especially high embankments, resting on suspect foundations as revealed by borehole logs shall be carried out in a manner and to the depth as desired by the Engineer. Where the ground on which an embankment is to be built has any of the material types (a) to (f) in Clause 6.1.4 at least 500 mm of such material must be removed and replaced by acceptable fill material before embankment construction commences.

6.3.4 Spreading material in layers and bringing to appropriate moisture content

6.3.4.1 The embankment and sub-grade material shall be spread in layers of uniform thickness not exceeding 200 mm compacted thickness over the entire width of embankment by mechanical means, finished by a motor, grader and compacted as per Clause 6.3.5. The motor grader blade shall have hydraulic control suitable for initial adjustment and maintain the same so as to achieve the specific slope and grade. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as in Table 6-2 and got approved by the Engineer. Each compacted layer shall be finished parallel to the final cross-section of the embankment.

6.3.4.2 Moisture content of the material shall be checked at the site of placement prior to commencement of compaction; if found to be out of agreed limits, the same shall be made good. Where water is required to be added in such constructions, water shall be sprinkled from a water tanker fitted with sprinkler capable of applying water uniformly with a controllable rate of flow to variable widths of surface but without any flooding. The water shall be added uniformly and thoroughly mixed in soil by blading, discing or harrowing until a uniform moisture content is obtained throughout the depth of the layer.

If the material delivered to the roadbed is too wet, it shall be dried, by aeration and exposure to the sun, till the moisture content is acceptable for compaction. Should circumstances arise, where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, compaction work shall be suspended.

Moisture content of each layer of soil shall be checked in accordance with IS: 2720 (Part 2), and unless otherwise mentioned, shall be so adjusted, making due allowance for evaporation losses, that at the time of compaction it is in the range of 1 per cent above to 2 per cent below the optimum moisture content determined in accordance with IS: 2720 (Part 7) or IS: 2720 (Part 8) as the case may be. Expansive clays shall, however, be compacted at moisture content corresponding to the specified dry density, but on the wet side of the optimum moisture content obtained from the laboratory compaction curve.

After adding the required amount of water, the soil shall be processed by means of graders, harrows, rotary mixers or as otherwise approved by the Engineer until the layer is uniformly wet.

Clods or hard lumps of earth shall be broken to have a maximum size of 75 mm when being placed in the embankment and a maximum size of 50 mm when being placed in the sub-grade.

6.3.4.3 Embankment and other areas of fill shall, unless otherwise required in the Contract or permitted by the Engineer, be constructed evenly over their full width and their fullest possible extent and the Contractor shall control and direct construction plant and other vehicular traffic uniformly over them. Damage by construction plant and other vehicular traffic shall be made good by the Contractor with material having the same characteristics and strength as the material had before it was damaged.

Embankments and other areas of unsupported fills shall not be constructed with steeper side slopes, or to greater widths than those shown in the Contract, except to permit adequate compaction at the edges before trimming back, or to obtain the final profile following any settlement of the fill and the underlying material.

Whenever fill is to be deposited against the face of a natural slope, or sloping earthworks face including embankments, cuttings, other fills and excavations steeper than 1 vertical on 4 horizontal, such faces shall be benched immediately before placing the subsequent fill.

All permanent faces of side slopes of embankments and other areas of fill formed shall, subsequent to any trimming operations, be reworked and sealed to the satisfaction of the Engineer by tracking a tracked vehicle, considered suitable by the Engineer, on the slope or any other method approved by the Engineer.

6.3.5 Compaction

Only the compaction equipment approved by the Engineer shall be employed to compact the different material types encountered during construction. Smooth wheeled, vibratory, pneumatic tyred rollers, etc. of suitable size and capacity as approved by the Engineer shall be used for the different types and grades of materials required to be compacted either individually or in suitable combinations.

The compaction shall be done with the help of vibratory roller of 80 to 100 kN static weight with plain or pad foot drum or heavy pneumatic tyred roller of adequate capacity capable of achieving required compaction.

The Contractor shall demonstrate the efficacy of the equipment he intends to use by carrying out compaction trials. The procedure to be adopted for these site trials shall first be submitted to the Engineer for approval.

Earthmoving plant shall not be accepted as compaction equipment nor shall the use of a lighter category of plant to provide any preliminary compaction to assist the use of heavier plant be taken into account.

Each layer of the material shall be thoroughly compacted to the densities specified in Table 6-2. Subsequent layers shall be placed only after the finished layer has been tested according to Section 900 of Quality Control of Road Works of MoRTH specifications and accepted by the Engineer. The Engineer may permit measurement of field dry density by a nuclear moisture/density gauge used in accordance with agreed procedure and the gauge is calibrated to provide results identical to that obtained from tests in accordance with IS: 2720 (Part 28). A record of the same shall be maintained by the Contractor.

When density measurements reveal any soft areas in the embankment /sub-grade/ earthen shoulders, further compaction shall be carried out as directed by the Engineer. If in spite of that the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, compacted to the density requirements and satisfaction of the Engineer.

6.3.6 Drainage

The surface of the embankment/sub-grade at all times during construction shall be maintained at such a cross fall (not flatter than that required for effective drainage of an earthen surface) as will shed water and prevent ponding.

6.3.7 Repairing of damages caused by rain/spillage of water

The soil in the affected portion shall be removed in such areas as directed by the Engineer before next layer is laid and refilled in layers and compacted using appropriate mechanical means such as small vibratory roller, plate compactor or power rammer to achieve the required density . If the cut is not sufficiently wide for use of required mechanical means for compaction. the same shall be widened suitably to permit their use for proper compaction. Tests shall be carried out as directed by the Engineer to ascertain the density requirements of the repaired area. The work of repairing the damages including widening of the cut, if any, shall be carried out by the Contractor at his own cost, including the arranging of machinery/equipment for the purpose.

6.3.8 Finishing operations

Finishing operations shall include the work of shaping and dressing the shoulders/verge/roadbed and side slopes to conform to the alignment, levels, cross-sections and dimensions shown on the drawings or as directed by the Engineer subject to the surface tolerance as per Quality Control of Roadworks Section 900 of MoRTH Specifications. Both the upper and lower ends of the side slopes shall be rounded off to improve appearance and to merge the embankment with the adjacent terrain.

When earthwork operations have been substantially completed, the road area shall be cleared of all debris, and ugly scars in the construction area responsible for objectionable appearance eliminated.

6.4 Construction of Embankment and Sub-grade under Special Condition

6.4.1 Construction of embankment over ground incapable of supporting construction equipment

Where embankment is to be constructed across ground which will not support the weight of repeated heavy loads of construction equipment, the first layer of the fill may be constructed by placing successive loads of material in a uniformly distributed layer of a minimum thickness required to support the construction equipment as permitted by the Engineer. The Contractor, if so desired by him, may also use suitable geo-synthetic material to increase the bearing capacity of the foundation. This exception to normal procedure will not be permitted where, in the opinion of the Engineer, the embankments could be constructed in the approved manner over such ground by the use-of lighter or modified equipment after proper ditching and drainage have been provided. Where this

exception is permitted, the selection of the material and the construction procedure to obtain an acceptable layer shall be the responsibility of the Contractor. The cost of providing suitable traffic conditions for construction equipment over any area of the Contract will be the responsibility of the Contractor and no extra payment will be made to him. The remainder of the embankment shall be constructed as specified in Clause 6.3.

6.4.2 Embankment construction under water

Where filling or backfilling is to be placed under water, only acceptable granular material or rock shall be used unless otherwise approved by the Engineer. Acceptable granular material shall consist of graded, hard durable particles with maximum particle size not exceeding 75 mm. The material should be non-plastic having uniformity coefficient of not less than 10. The material placed in open water shall be deposited by end tipping without compaction.

6.5 Surface Finish and Quality Control of Work

The surface finish of construction of sub-grade shall conform to the requirements of Clause 902 of as per Quality Control of Road works Section 900 of MoRTH specifications. Control on the quality of materials and works shall be exercised in accordance with Clause 903.of the same.

6.6 Sub-grade Strength

6.6.1 It shall be ensured prior to actual execution that the borrow area material to be used in the sub-grade satisfies the requirements of design CBR.

6.6.2 Sub-grade shall be compacted and finished to the design strength consistent with other physical requirements. The actual laboratory CBR values of constructed sub-grade shall be determined on undisturbed samples cut out from the compacted sub-grade in CBR mould fitted with cutting shoe or on re-moulded samples, compacted to the field density at the field moisture content.

7.0 SURFACE/SUB-SURFACE DRAINS

7.1 Scope

This work shall consist of constructing surface and/or sub-surface drains in accordance with the requirements of these Specifications and to the lines, grades, dimensions and other particulars shown on the drawings or as directed by the Engineer.

Schedule of work shall be so arranged that the drains are completed in proper sequence with road works to ensure that no excavation of the completed road works is necessary subsequently or any damage is caused to these works due to lack of drainage.

7.2 Surface Drains

Surface drains shall be excavated to the specified lines, grades, levels and dimensions to the requirements of Clause 5. The excavated material shall be removed from the area adjoining the drains and if found suitable, utilised in embankment/sub-grade construction. All unsuitable material shall be disposed of as directed.

The excavated bed and sides of the drains shall be dressed to bring these in close conformity with the specified dimensions, levels and slopes.

Where so indicated, drains shall be lined or turfed with suitable materials in accordance with details shown on the drawings.

All works on drain construction shall be planned and executed in proper sequence with other works as approved by the Engineer, with a view to ensuring adequate drainage for the area and minimising erosion/ sedimentation.

8.0 PREPARATION AND SURFACE TREATMENT OF FORMATION

Preparation and surface treatment of the formation, that is top of the sub-grade, shall be carried out only after completion of any specified sub-grade drainage and unless otherwise agreed by the Engineer, immediately prior to laying the sub-base or the road base where no sub-base is required. The sequence of operations shall be as follows:

(a) All surfaces below carriageway, lay-byes, footways and hard shoulders shall, after reinstatement of any soft areas to the required Specifications be well cleaned and freed of mud and slurry.

(b) The surface shall be compacted by 4 passes of a smooth wheeled roller of 80 to 100 kN weight after spraying requisite amount of water, if required, before the commencement of rolling.

(c) The formation shall, wherever necessary, be regulated and trimmed to the requirements of Clause 6.3.8 with motor grader.

(d) The trimmed formation shall be rolled by one pass of smooth wheeled roller of 80 to 100 kN weight after spraying requisite amount of water, if required, before the commencement of rolling.

Where the completed formation is not immediately covered with sub-base or road base material, its moisture content shall be maintained to prevent cracking in the formation by suitable measures as approved by the Engineer. The entire work of surface treatment of formation shall be deemed as incidental to the work of sub-base/base course to be provided on the sub-grade and as such no extra payment shall be made for the same.

9.0 WORKS TO BE KEPT FREE OF WATER

9.1 The Contractor shall arrange for the rapid dispersal of water collected/accumulated on the earthwork or completed formation during construction or on the existing roadway or which enters the earthwork or any other item of work from any source, and where practicable, the water shall be discharged into the permanent outfall of the drainage system. The arrangements shall be made in respect of all earth work including excavation for pipe trenches, foundations or cuttings.

9.2. The Contractor shall provide, where, necessary, temporary water courses, ditches, drains, pumping or other means for maintaining the earthwork free from water. Such provisions shall include carrying out the work of forming the cut sections and embankments in such manner that their surfaces have at all times a sufficient minimum cross fall and, where practicable, a sufficient longitudinal gradient to enable them to shed water and prevent ponding.

The works involved in keeping the earthwork or any other item of works free of water shall be deemed as incidental to the respective item of work and as such no separate payment shall be made for the same.

10.0 GRANULAR SUB-BASE

10.1 Scope

This work shall consist of laying and compacting well-graded material on prepared sub-grade in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as

sub-base hereinafter) as necessary according to lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

10.2 Materials

10.2.1 The material to be used for the work shall be natural sand, moorum, gravel, crushed stone, or combination thereof depending upon the grading required. Materials like crushed slag, crushed concrete, brick metal and kankar may be allowed only with the specific approval of the Engineer.

The material shall be free from organic or other deleterious constituents and conform to one of the three gradings given in Table 10-1.

While the gradings in Table 10-1 are in respect of close-graded granular sub-base materials, one each for maximum particle size of 75 mm, 53 mm and 26.5 mm, the corresponding gradings for the coarse-graded materials for each of the three maximum particle sizes are given at Table 10-2.

The grading to be adopted for a project shall be as specified in the Contract.

10.2.2 Physical requirements

The material shall have a 10 per cent fines value of 50 kN or more (for sample in soaked condition) when tested in compliance with BS:812 (Pan 111). The water absorption value of the coarse aggregate shall be determined as per IS : 2386 (Pan 3); if this value is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS : 3.83. For Grading II and III materials, the CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions which shall be taken as being the density relating to a uniform air voids content of 5 per cent.

TABLE 10-1. GRADING FOR CLOSE-GRADED GRANULAR SUB-BASE MATERIALS

IS Sieve Designation	Per cent by weight passing the IS sieve		
	Grading I	Grading II	Grading III
75.0 mm	100	–	–
53.0 mm	80–100	100	–
26.5 mm	55–90	70–100	100
9.50 mm	35–65	50–80	65–95
4.75 mm	25–55	40–65	50–80
2.36 mm	20–40	30–50	40–65
0.425 mm	10–25	15–25	20–35
0.075 mm	3–10	3–10	3–10
CBR Value (Minimum)	30	25	20

TABLE 10.2. GRADING FOR COARSE GRADED GRANULAR SUB-BASE MATERIALS

IS Sieve Designation	Per cent by weight passing the IS sieve		
	Grading I	Grading II	Grading III

75.0 mm	100	–	–
53.0 mm		100	
26.5 mm	55–90	50–80	100
9.50 mm			
4.75 mm	10–30	15–35	25–45
2.36 mm			
0.425 mm			
0.075 mm	< 10	< 10	< 10
CBR Value (Minimum)	30	25	20

Note : The material passing 425 micron (0.425 mm) sieve for all the three gradings when tested according to IS : 2720 (Pan 5) shall have liquid limit and plasticity index not more than 25 and 6 per cent respectively.

10.3 Strength of sub-base

It shall be ensured prior to actual execution that the material to be used in the sub-base satisfies the requirements of CBR and other physical requirements when compacted and finished.

When directed by the Engineer, this shall be verified by performing CBR tests in the laboratory as required on specimens remoulded at field dry density and moisture content and any other tests for the “quality” of materials, as may be necessary.

10.4 Construction Operations

10.4.1 Preparation of sub-grade : Immediately prior to the laying of sub-base, the sub-grade already finished to Clause 5 or 6 as applicable shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water if necessary and rolled with two passes of 80 -100 KN smooth wheeled roller.

10.4.2. Spreading and compacting: The sub-base material of grading specified in the Contract shall be spread on the prepared sub-grade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation or other means as approved by the Engineer.

When the sub-base material consists of combination of materials mentioned in Clause 10.2.1, mixing shall be done mechanically by the mix-in-place method.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small-sized jobs. The equipment used for mix-in-place construction shall be a rotavator or similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS:2720 (Part 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that, at the time of compaction, it is from 1 per cent above to 2 per cent below the optimum moisture

content corresponding to IS:2720 (Part 8). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means like disc harrows, rotavators until the layer is uniformly wet.

Immediately thereafter, rolling shall start. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 KN weight may be used. For a compacted single layer upto 225 mm the compaction shall be done with the help of a vibratory roller of minimum 80 to 100 kN static weight with plain drum or pad foot-drum or heavy pneumatic tyred roller of minimum 200 to 300 kN weight having a minimum tyre pressure of 0.7 MN/m2 or equivalent capacity roller capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional cross fall and super-elevation and shall commence at the edges and progress towards the centre for portions having cross fall on both sides.

Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. During rolling, the grade and cross fall (camber) shall be checked and any high spots or depressions, which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 km per hour.

Rolling shall be continued till the density achieved is at least 98 per cent of the maximum dry density for the material determined as per IS:2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

10.4.3 Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of Clause 902 of Quality Control of Road works Section 900 of MoRTH Specfications.

Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900 of MoRTH specifications.

10.4.4 Arrangements for Traffic

During the period of construction, no traffic shall be allowed over the area.

10.5 Materials

Cement concrete: The cement concrete shall generally conform to specifications for ordinary concrete. The coarse aggregates shall be carefully selected, sufficiently tough and hard stone pieces broken in a manner that will provide particles of approximately cubical shape affording good interlocking. The maximum size of coarse aggregate shall be 12 mm. The fine aggregate shall consist of properly graded particles. The proportion of mix shall not be of the grade below M20 {1: 1.5: 3 (1 cement: 1.5 coarse sand: 3 stone aggregate)}. The least amount of mixing water that will produce a workable mix and will allow finishing without excessive trowelling shall be used. Generally a water cement ratio of 0.5 should suffice.

10.6 Workmanship

The sub-grade in all cases shall be formed to proper levels and slopes, well compacted and cured. The top surface shall be kept slightly rough.

The surface of the sub-grade shall be cleaned off all loose materials and moistened immediately before laying the concrete floor. The concrete paving shall be laid in alternate

bays not exceeding 6.25 sq.m (about 64 sf.ft) each. At least 48 hours shall elapse before the concreting in the adjacent bays is commenced.

The concrete shall be laid immediately after mixing. While being placed the concrete shall be vigorously sliced and spaded with suitable tools to prevent formation of voids or honey comb pockets. The concrete shall be brought to the specified levels by means of a heavy straight edge resting on the side forms and drawn ahead with a sawing motion in combination with a series of lifts and drops alternating with small lateral shifts. While concreting the adjacent bays care shall be taken to ensure that the edges of previously laid bays are not broken by careless or hard tamping.

10.7 Screeding

After poring concrete in place, it shall be compacted, in wet condition, by screed vibrator run over the steel channel shuttering pressing concrete surface matched with the top of steel channel shuttering spaced not more than 4.0 meters apart. Poker vibrators will be used to vibrate the laid concrete thoroughly with minimum 40 mm dia needles. On completion of laying of approximate 2m to 2.5m length the surface vibrator then be run over the concrete surface to achieve better overall compaction of concrete. Water cement ratio shall be just sufficient to make concrete workable. Screed shall be run at least twice to achieve well compacted & level surface.

Undulations on the concrete surface shall be rectified immediately by local patching, in wet state of concrete.

After striking off the surfaces to the required grade concrete shall be compacted with a wooden float. The blows shall be fairly heavy in the beginning but as consolidation takes place, light rapid strokes shall be given to complete the ramming.

No dry cement or mixture of dry cement and sand shall be sprinkled directly on the surface of the concrete to absorb moisture or to stiffen the mix.

After the concrete in the bays has set, the joints of the panels shall be filled with cement cream or with suitable bitumastic compound as shown on the drawings or directed by the Engineer-in-Charge.

Vertical edge of the bays shall be neatly marked on the surface of the concrete with a pointed trowel after filling the joints.

Brooming: When concrete is in final stage of plastic state, the pavement shall be given broom finish with approved steel / fibre broom. The broom shall be pulled gently over the pavement surface from edge to edge (perpendicular to centre line of the road). Brooming shall be completed before concrete passes plastic state.

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

Curing shall not be commenced until the top layer has hardened. Covering with empty gunnies shall be avoided as the colour of the flooring is likely to be bleached due to the remanents of cement dust from the bags.

J. LANDSCAPING ENGINEERING

1.0 SCOPE

1.1 General Scope of Work

The scope of work of this package is shown on the drawings, tech. Specifications, the Planting Schedule (given at the end of this specification section) and any other instructions defined in this document.

The scope of work comprises but is not limited to the following;

Supply all of plants associated with landscape, water feature and related mechanical works, special lighting, other related structures.

1.2 Detailed Scope of Work

1.2.1 Construction

1.2.1.1 Planting for landscape, backfilling and leveling, refilling

2.0 SUBMISSIONS:

(To be provided by Contractor)

- Construction method statement
- Shop drawings
- Site organization chart
- Detail work schedule
- Site progress schedule report
- Site safety organization chart
- Site photos
- Construction records. QA/AC records
- Purchase orders, delivery orders
- As built drawings and documentation
- One CD containing soft copies of all the drawings produced

3.0 TECHNICAL SPECIFICATIONS

3.1 Garden Works

3.1.1 Scope of Work

This section includes execution of landscape (softscape) work as per the design drawings and the planting schedule included herein. It includes all labors, materials, tools, power supply, transportation, handle, follow-up care, direct or indirect works (supplementary or replacement included) indicated on the Contract drawings, which are necessary to complete all the newly planted avenue trees in all the streets ,shrubs, ground covers, accent plants(specimen plants) at the entrance ,four rain gardens behind administration buildings, shrub plantations & tree plantations at traffic island / medians ,flower beds at guard house.(.All the associated expense has been covered in the unit price of the Contract.

3.2 Planting Materials

3.2.1 Select Young Trees in Nursery Garden

3.2.1 The Contractor shall submit in writing to client the supply sources on plants and visit the nursery garden for selection young trees together with client.. If plants are not grown by the planter himself, the Contractor shall visit the original planting region in company with client for selection as the case may be. The plantings in jobsite neighborhood or in

conservation zone, defined by the legislation in force, cannot be taken as the supply sources for this project. The Contractor shall submit the planting inspection record to client for approval and proceed after permission is given.

3.2.2 Inspection shall be performed on species, specification and quality. It shall be deemed as unqualified if any case is found like: wrong species, not in accordance with specification, improper visual proportion, partly withered, over weak, poor growth in the crowded garden, lots of pruning to be applied to suit the specification, root seriously damaged resulted from small root ball.

3.2.3 The arbor of trunk diameter of 5cm above (5cm included) shall be selected individually. Labels shall be lead-sealed and hung on the plant for showing the approval by the Owner. Standard plants shall be selected for those arbors (diameter below 5cm) and shrubs, and photos shall be taken as the inspection standard for planting.

3.2.4 Trees for replanting shall be inspected by client in accordance with the above-mentioned regulations.

3.2.5 The Contractor shall protect well the qualified plantings after inspection. No planting of the trees failed in inspection even if with an approved label.

3.3 Precaution for planting inspection

3.3.1 Ten trees for each kind of trees shall be ready for inspection and selection as the standard trees to be followed.

3.3.2 The plantings to be selected as the standard trees shall be in good shape and healthy conditions besides complying with the diameters and ranges specified in the Contract. The following specifications are to be satisfied or exceeded:

3.3.2.1 Arbor

Openness / Spread
- min. 3 limbs with branching height above ½ of its whole height
- upright trunk
- minor pruning
- no plant disease and insects, no wound

Cutting Layer
- upright trunk without any limb
- no broken sprout on the growing points
- over high or excessive growth (like: weak and spindling branches)

Erection:
- upright trunk
- clear cutting layer
- no excessive growth or branching
- no broken sprout

Erect tower-shape trees, such as Cypress Trees
- upright trunk
- no air or sunlight perpetration
- no over spread or excessive growth of branches
- no broken sprout

3.3.2.2 Shrubs

- min. 3 limbs, varies depending on species (different growing forms)
- upright trunk in healthy condition
- minor pruning
- limbs not on one supporting point
- no plant disease and insects, no wounds

To select plantings depending on their purpose:

- For show: 3-5 branches at lower position
- For others: 3-5 branches may at higher position

Ground covers and flowering plants

- healthy, no disease and insects
- branching varies depending on species, general 5 branches
- dense and rich branches and leaves, no spread or excessive growth resulted from lacking of growing sunlight. Ground cover suit to geographic region and characteristics.
- shade tolerance
- drought-enduring
- sufficient sunlight
- growth speed
- growth mode

Flowers

- avoid over flourishing
- aging
- protruding
- weak

3.3.2.3 Palms: classified as erect and fascicled

- upright
- trunk
- bare trunk
- no diseases and insects, healthy

3.3.3 Preparation for plantings to be selected:

- Pruning
- Cut the burlap away from the root (soil balled for bare rooted plants)
- natural growing, upright trunk, healthy
- after root cut, heel in pot to prevent any seasonal effect and increase the survive percentage
- good tree & crown shapes, no excessive growth (over-high or imbalance)

3.3.4 The Contractor shall provide the statement on plant sources, certificate for selected nursery garden and agreement to supply trees.

3.4 Inspection for Planting Construction

3.4.1 All the planting shall grow vigorously in good shape without diseases or insects (sterilization may be applied before transplanting to site if necessary). When the area of base of planting changes or roots needed to be cut, dig out the healthy and strong roots

together with perennial soil ball, well wrapped, no falling over or departed during landscaping. Soil ball size to drawings.

3.4.2 During transplanting, well protection shall be carried out for roots, leaves and barks to avoid any damage or exposed directly under strong sunlight.

3.4.3 All the activities shall be finished within 2 days from digging plantings in the garden to the final transplantation.

3.5 Variety, Specification and Quality for Plants

3.5.1 Unless otherwise stated, the plant specified as one number shall be of the same species, variety, specification and color and high quality.

3.5.2 Species ranks the plants with same term both on genus and type in botanical terminology, while Variety groups the plants with same terms on genus, type or breed in botany. At the mean time, there may be many different cultivars for one Species. Same variety shall be applied in case the variety is specified. If not, plantings from species shall be selected.

3.5.3 Planting with same specification shall be of same tree height, crown width, crown thickness, trunk diameter, root ball, leaves density and so on. Dimensions shall only be taken after the pruning all the excessive branches and leaves.

- Tree Height (H): the height from treetop to ground
- Crown Width (W): average diameter of tree crowns in horizontal level
- Crown Thickness (T): tree crown thickness
- Diameter (ϕ): the average diameter of tree trunks 1m above the ground
- Ball root (Br): soil ball around the root before the specified transplanting. The average diameter shall be taken as reference.
- Density branch (1): nos for plant branches or density for leaves

For plant group of same specification, follow the difference indicated, otherwise the height difference between the highest and lowest plants shall not be exceeds 10% of the standard one. The width of branches and leaves shall be controlled neither smaller than the specification (its difference shall be within 5%) nor bigger than the specified standard. All the above-mentioned width and height shall only measure after plant pruning.

3.5.4 High-quality plantings are free of:

- Serious diseases or insects, broken or twisted branches, fertilizer or medical hazards, aging, wound barks.
- Dry root, withered leaves and spouts resulted from long time laying after digging out
- Small ball root, broken or deflected
- Big tree in signal trunk (unless otherwise stated) with bent trunk, sparse tree crown, deflected or abnormal growth
- Too less branches for shrubs or herbs, not flourishing branches or leaves
- No turf grassroots, no original soil or its thickness is less than 2cm, fall apart or scattered, mixed with weeds

3.6 Alternatives

Alternatives can be applied after the written approval by the Owner if the Contractor has difficulty to supply the plants in accordance with the specifications, which may be from same Species with small sizes or other Species with same characteristics and sizes. Price

shall be deducted after discussion for the plants from same species but in small size. No additional costs to be claimed by the Contractor for that from different species.

The Contractor shall apply, at no additional cost, alternative plants in big size from the same or different species after the permission of client.

3.7 Flowering beds

The plotting area has been indicated on the drawings. The Contractor shall submit his planting proposal regarding construction and follow-up care to client after the Contract is awarded, showing clearly the species and planting arrangement for each area. During follow-up care other than the construction period, transplantation shall be carried out at least twice to ensure there are grass flowers in bloom at one place all the time. The plantings shall cover the whole planting areas. The Contractor shall perform the activities as soon as his proposal is confirmed. No changes or additional cost, unless otherwise approved by client

3.8 Rain gardens

The plotting area has been indicated on the drawings. The Contractor shall submit his planting proposal regarding construction and follow-up care to client after the Contract is awarded, showing clearly the species and planting arrangement for each area. During follow-up care other than the construction period.

The plantings shall cover the whole planting areas. The Contractor shall perform the activities as soon as his proposal is confirmed. No changes or additional cost, unless otherwise approved by client.

4.0 SOIL, FERTILIZER, PESTICIDE, PROTECTION AND OTHERS

4.1 Soil

4.1.1 The items of “backfilling of the imported soil” specified in the drawings, if not stated otherwise, refer to the soil imported from the farmland outside the Site. The soil shall be neutral black loamy soil, or the rich soil of three quarters’ loamy soil and one quarter’s organic fertilizer. The imported soil can only be excavated and filled with the permission from client soil test and analysis shall be made, if necessary, at the expense of Contractor.

The backfilling soil specified in the drawing cannot contain stone, concrete, brick or other foreign matters to the detriment of root growth.

4.1.2 Judgment of Imported soil

4.1.2.1 Difference in color

Color: yellow＜grey＜brown＜dark brown＜black brown
Quality: poor-excellent
Ordinary soil + compost (vegetation type)

4.1.2.2 Soil holding quality (squeezes the soil into a ball with water, flick it to see if it holds together).

The Judgment can be made on:

- no crack (clay, poorly drained)
- 3-5 pieces (good)
- crisp (sand, no water contained)

4.2 Fertilizer

4.2.1 The type of fertilizer, applying frequency and time shall be in accordance with the drawings. If not specified in drawings or for any other reasons that Contractor needs to change the type, applying frequency and time, the change can only be made with the permission of client.

4.2.2 “Base fertilizer” is the organic fertilizer applied in the soil during planting. The organic fertilizer shall be compost, animal manure, or organic garbage compost certified by research institute.

4.2.3 “Amendment” is the fertilizer applied after the planting to promote the growth and blooming of the plants. Its type shall depend on the plants and its growth. For example, the flowering bud needs to be applied with the phosphate fertilizer, the leave sprout needs to be applied with the nitrate fertilizer.

4.3 Pesticide

During the period of construction and maintenance the pest or weed, if found, shall be removed immediately. The types and amount of pesticide or herbicide will be at the Contractor’s decision. For any injury to plants, animals, or human beings caused by the wrong operation the Contractor shall be liable.

4.4 Protection measures

Protection shall be made against the destruction from animal and human and bad weather.

4.4.1 Rail shall be erected against the damage by animal and humans.

4.4.2 Firm staking or supporting rope shall be erected according to design drawing to support the seedlings. Staking shall depend on the size of young trees and the local wind. The staking shall be antiseptic treated timber made of fir, cassia tree or other timbers that are approved by client and be 5-10cm in diameter. The staking or rope can support the plant with proper size. At the contact point with the plant the timber shall be applied with soft material to avoid any injury to the trees. The appearance of staking shall be clean and proper, and can be painted black or dark green for a better appearance.

4.4.3 Straw or other measures shall be used to wrap trunk to protect against harsh weather.

4.4.4 Once the perennial soil ball is digged, burlap, rope or other packing material shall be used to wrap the ball in case the root ball will fall apart in transportation, disturbance, and transplantation. Root cutting shall be done with sharp saw. In transportation of big tree its bark and leaves cannot be injured.

4.4.5 All the protection expense is deemed to be included in the unit rates, the Contractor cannot charge for any extra expenses.

4.5 Watering

Water in the works shall be at the Contractor’s decision on its sources, quality, and watering time. The water, however, cannot be the industrial wastewater, sewage water containing poisonous substances. The responsibilities of any harm to plants for the wrong operation shall be borne by the Contractor.

4.6 Others

Any application of the chemicals like evaporation inhibitor, soil chemicals by Contractor shall

be permitted by client and the Contractor shall be responsible for the result.

5.0 PLANTING

Unless otherwise stated, the planting schedule shall be followed as: arbor, shrub, rain garden, ground covers, flowers..

5.1 Planting of arbor, shrub, and Rain garden

5.1.1 Application of planting hole and base fertilizer

- As per design drawing, mark the planting location at site, dig the hole after inspection by client..
- In accordance with the drawing specification the size of hole, unless otherwise specified, shall be two times than the root ball diameter. The depth shall be the number of root diameter plus 30cm.
- The debris, concrete block or any other foreign matters that will prevent the root growth shall be removed from the Site.
- For the filling work of imported soil as specified in the design drawings, the earth excavated from the hole shall be leveled if it is little amount, or removed from the Site if it is large amount for the purpose of a better drainage of the area.
- Lay compost or other appropriate mixture of organic fertilizer and soil at the bottom of the digged hole. The applied amount refers to the design drawings. If not specified, the proportion of organic fertilizer and soil shall be 1:4.

5.1.2 Transplantation

- Root Cutting shall be more than 2 months.
- Bare-root is forbidden. Root ball shall be big (diameter shall be specified).
- Over-pruning is forbidden (pruning method will depend on the trees species)
- Black cotton mesh or canvas shall be used to wrap the ball in transportation to avoid water evaporation.
- Prune the injured twig after delivery at site. Planting shall be done in 24 hours. If not, watering shall be followed to protect the plant, but cannot exceed 48 hours.
- Locate the transplantation place. Cotton or straw rope shall be used to wrap the trunk at the fixed staking for protection.
- Regular watering to trees, trunk, leaves.
- Before planting into the holes, the wrapping shall be removed if the wrapping cannot resolve into soil like straw rope, etc.
- After the planting into the holes, the wrapping or rope shall be removed 1/3 at the top.
- Soil backfill shall be imported soil or the excavated soil and to be packed for the support of trees.
- Soil backfill mould can be 2cm above the ground. The edge of the hole shall be compacted

with the neighboring soil. The surface of planting hole shall be a saucer shape to retain water.

5.1.3 Staking

After the planting the staking or protection measures shall be made to support the plant.

5.1.4 Pruning

After the proper planting the Contractor shall prune the plant to reduce the water evaporation. At the expiry of maintenance period the plant shall comply with the requirement in specification.

5.1.5 Watering and fertilizing

Water the plants after planting. The Contractor shall be responsible for applying the "amendment" in the 90th day and the 150th day after the maintenance period. The fertilizer resolved in water shall be applied to the plant by watering. But attention shall be paid not to injure the plant.

5.2 Ground covers and flowers

5.2.1 Ground Leveling

5.2.1.1 As per design drawings, delineate the plot to be planted with ground covers and flowers. The planting work can be started after inspection by client.

5.2.1.2 Loosen the surface soil to 15cm depth of the ground, remove the debris, concrete, grass root, and other substances that will prevent the plant growth. Besides, keep the ground surface sloped to drain the water.

5.2.1.3 Application of "Base fertilizer"
Apply the mixture of 10cm thickness of compost and soil with the proportion of 1:4.

5.2.2 Planting

Plant the ground covers and grass flowers as per the Specification, but the spacing of plants can be negotiated with client. Without the permission of client and the quantity of the plants cannot be reduced.

5.2.3 Watering and fertilizing

Watering shall be done immediately after the planting. "Amendment" shall be applied on the 7th day after the planting, the beginning day and the 90th and 150th day of the maintenance period. The application amount shall be 0.02kg for every square meter. The fertilizer resolved in water can be applied in watering.
In the grass planting area, add 10cm thick mix soil with the proportion of organic fertilizer and imported soil as 1:4.

5.3 Rain gardens

5.3.1 Planting method

Excavating & Loosen the surface soil to 0.4M - 0.5M depth of the ground, remove the debris, concrete, grass root, and other substances that will prevent the plant growth

spacing, location and other details are mentioned in the drawings.

5.3.2 The primary media in each pond consists of dug up in situ soil horizon of about 0.4m depth.

5.3.3 The dug up soil from the each circular or oval pond can be used for landscaping the rain garden provided the soil should be fertile if not garden soil with soil amendments should be used.

5.3.4 Application of "Base fertilizer" Apply the mixture of 10cm thickness of compost and soil with the proportion of 1:4.

6.0 Planting

Plant the WATER TOLERANT plants as per the Specification, but the spacing of plants can be negotiated with client. Without the permission of client and the quantity of the plants cannot be reduced.

6.1 Watering and fertilizing

Watering shall be done immediately after the planting. "Amendment" shall be applied on the 7th day after the planting, the beginning day and the 90th and 150th day of the maintenance period. The application amount shall be 0.02kg for every square meter. The fertilizer resolved in water can be applied in watering.
In the grass planting area, add 10cm thick mix soil with the proportion of organic fertilizer and imported soil as 1:4.

The gap between circular ponds/oval ponds should be filled with pebbles/in situ stones in the rain garden of thickness 6"-8" which reduces the velocity of surface runoff as well as helps obtain sediment free water entering the ponds which enhances infiltration all avoid the flow path of storm water flows.

Maintenance work shall begin on the day the planting is finished. It shall be 1 year started from the next day of the final acceptance of the whole planting works.

6.2 Primary acceptance, final acceptance and inspection

6.2.1 Primary acceptance by client after the finishing of the whole planting and the whole works stipulated in the Contract.

6.2.2 In the maintenance period the inspection shall be made every two months. The inspection result made at the end of the maintenances period shall be taken as the reference data for the settlement of planting price. The substandard planting in the expiry inspection of maintenance period shall be deducted from the price.

6.2.3 The Contractor shall apply for the expiry inspection of maintenance period by the Owner at 4th months started from the inspection made at the end of the 8th month.

6.2.4 Primary inspection, acceptance and every check and check made in maintenance period shall be in accordance with the Contract, the pruning or mowing shall be permitted from client before inspection.

6.3 Expiry of maintenance period

6.3.1 The Contractor shall be responsible to maintain the living state of plant, including watering in dry weather, drainage in rainy season, and to prevent against any injuries caused by animals, humans, wind, pest, weed, etc. If the tree is on loose ground to stand or slanted, it shall be established upright and the firming rope should be tightened.

6.3.2 Under the following conditions the Contractor shall be liable for the rework of following at his own expenses: the top withered, the living plants cannot reach to 80% of the total area, serious pest hazard and broken limb. The above shall be replaced with new planting. The flower withering shall also be replaced under the instruction of client

6.3.3 At the expiry of maintenance period, the following requirement to be approved as the standard garden.

- All the planting shall be in accordance with the Contract
- All the planting is living, well grown, no pest hazard or withering.
- The specification of planting cannot be less than that stated in the Contract.
- Ground covers shall be well grown, no pest hazard or withering, and its coverage rate shall be more than 90%. No rain washing exists.
- The weed in the area of ground cover cannot exceed 10%, and comply with the appearance effect stated in the design drawings.

6.4 Back charge at the expiry of maintenance period
At the expiry of maintenance period, the substandard planting exceeding 10% of the total planting works shall not be charged in the lump sum for the planting works. Besides, the Contractor shall reimburse client for the expenses of the substandard part planting.

7.0 Planting Schedule

Type of plantations	Screening Trees / Avenue Trees (2m) Height
Planting Time	June 3rd week –December 1st week
Methodology	1. Excavating pits of size 0.75m x 0.75m x 0.75m filling them with supplied garden soil mixture of well rotten farmyard manure or leaf mould , red earth, river sand in appropriate ratios with folidal dust/bavistine. the spacing, location and other details as per the drawings and specifications. 2. While placing the sapling /tree in the pit the tap roots should not be folded back and fibrous roots should be spread out as they are so that the root tips are not damaged this is important for the growth of the roots . 3. Press the soil firmly with feet and make a basin around the sapling/tree. 4. Support the trees/sapling with a sturdy stake put in to the pit by the side of the tree/saplings and tied to it. 5. Protect the trees with iron mesh tree guards.

Basic maintenance	1. Water the plants for every three days in first year and later once in a week from second year. 2. Remove lateral buds and lateral braches to inhibit lateral growth till 3m height to maintain proper shape of the tree 3. Usually trees are affected with caterpillars. Spray the affected trees with neem oil extract 6ml/litre .

LIST OF AVENUE TREEES (2M) HEIGHT

S.NO	BOTANICAL NAME	COMMON NAME	TAMIL NAME
1.	*Anthocephalus kadamba*	Kadamba	Kapam
2.	*Alstonia scholaris*	Devils Tree	Palai,
3.	*Bauhinia purpurea*	Camels Foot	Mandari
4.	*Polyalthia longifolia*	False Ashok tree	Asoothi
5.	*Cordia sebestena*	Scarlet Cordia	Acchinaruvihli
6.	*Delonix regia*	Gulmohar	Mayarum
7.	*Cassia fistula*	Indian Laburnum	Konnei
8.	*Cassia javanica*		
9.	*AzadirachtaIndica*	Indian Neem Tree	Vepa
10.	*Mangifera indica*	mango	
11.	*Pongamia glabra*	Indian Beech Tree	Ponga
12.	*Tabebuia rosea*	Rosy Trumpet Tree	
13.	*Filicium decipiens*	Fern Tree	Ningal
14.	*Peltophorum ferrugineum*	Copper Pod Tree	
15.	*Melia azedarach*	Pirde Of India	malaivembu
16.	*Terminalia catappa*	Indian almond tree	nattvaduma
17.	*Spathodea campamulata lutea*	Yellow Spathodea	Patadi
18.	*Bignonia metapotomica*		
19.	Erythrina Crista Galli		
20.	*Millingtonia hortensis*		Katte malli
21.	Plumeria alba	Temple tree white	arali
22.	Plumeria rubra	Temple tree red	arali

LIST OF ACCENT TREES

S.NO	BOTANICAL NAME	COMMON NAME
1.	*Roystonia regia (5m)*	Royal palm
2.	Wodyetia bifurcata - 4m (over all ht)	Fox tail palm

3.	*Bismarckia nobilis blue form(4m)*	
4.	*Areca catechu*	arecanut
5.	Ficus retusa	Chinese banyan tree
6.	Mimusops elengii	

SHRUBS AND GROUND COVERS

Type of plantations	Shrubs & Ground Covers/Flower beds
Planting Time	June 3rd week –December 1st week
Methodology	1. Excavating pits of size 0.30m x 0.30m x 0.30m for shrubs and 0.15m x 0.15m x 0.15m for ground covers supplied with garden soil mixture of well rotten farmyard manure or leaf mould , red earth, river sand in appropriate ratios with folidal dust. The spacing, location and other details as per the drawings and specifications. 2.While placing the shrub/ground cover in the pit the tap roots should not be folded back and fibrous roots should be spread out as they are so that the root tips are not damaged this is important for the growth of the roots .
Basic maintenance	1.Water the plants daily. 2.Prune the over growth shrubs for proper shape.

LIST OF SHRUBS & GROUNDCOVERS

S.NO	BOTANICAL NAME	COMMON NAME
1.	*Cuphea hyssopifolia hybrid purple*	Cuphea blue
2.	*Cuphea hyssopifolia hybrid white*	Cuphea white
3.	*Pisonia alba*	pisonia
4.	*Alternanthera species red (broad deep red leaf)*	Alternanthera (border)
5.	*Bixa orellana*	Annatto Tree, Lipstick Tree
6.	*Caesalpinia pulcherima red yellw orange*	Peacock Flower
7.	*Acalypha rosea*	
8.	*Tabernamontana variated nana dwarf*	
9.	*Vinca rosea*	

RAIN GARDEN

Type of plantations	Water tolerant plants
Planting Time	June 3rd week –December 1st week

Methodology	1. Excavating ponds of circular or oval surface area each of depth 0.4m-0.5m . the spacing, location and other details are mentioned in the drawings. 2. The primary media in each pond consists of dug up in situ soil horizon of about 0.4 m depth. 3. The dug up soil from the each circular or oval pond can be used for landscaping the rain garden provided the soil should be fertile if not garden soil with soil amendments should be used. 4. The gaps between circular ponds/oval ponds should be filled with in situ stones or pebbles in the rain garden which reduces the velocity of surface runoff as well as helps obtain sediment free water entering the ponds which enhances infiltration all along the flow path of strom water flows. 5. depth of the pond varies from 0.4m to 0.5m(fig 2&3)
Basic maintenance	1.Water the plants daily except rainy season . 2.Prune the over growth shrubs for proper shape of the pond.

LIST OF PLANTS FOR RAIN GARDEN

RAIN GARDEN- OPPOSITE TO PARKING

S. NO	BOTANICAL NAME	COMMON NAME	TOTAL AREA IN SQM	NO. OF PLANTS/ SQM	SPACING C/C	QNTY OF PLANTS
1.	Canna gernalis red	Canna Red Leaved	148	8	1’	1184
2.	Canna malawiensis variegata	Canna Yellow Variegated	151	8	1’	1208
3.	Hymenocallis littoralis (broad leaved)	Beach Spider Lily	273	8	1’	2184
4.	Pennisetum rueppeli	Red fountain grass	176	15	9”	2640
5.	Pennisetum species	Green fountain grass	165	15	9”	2475
6.	Canna x generalis lineata yellow	Canna Dwarf Yellow	19	35	6”	665
7.	Canna x generalis lineata red	Canna Red Dwarf, Indian Shot	22	35	6”	770
8.	Hymenocallis narcissiflora	Narrow Leaf Spider Lily	31	8	1’	248

S. NO	BOTANICAL NAME	COMMON NAME	TOTAL AREA IN SQM	NO. OF PLANTS/ SQM	SPACING C/C	QNTY OF PLANTS
9.	Hymenocallis littoralis variegata	Spider Lily Variegated	192	8	1’	192
10.	Sansevieria trifasciata laurentii,/ S. zebrina	Mother In Laws Tongue/ Snake Plant	142	15	9”	2130
11.	Euphorbia pulcherrima christmas star	Poinsettia Christmas Tree/ Tamil Magilkunni	109	8	1’	872
12.	Heliconia varities	heliconia	60	15	9”	900
13.	Ensete ventricosum	Ornamental Banana	5	-	-	1
14.	Caesalpinia pulcherima flava-yellow	Shankasur Yellow/ Tamil-Mayikonnai	6	5	15”	30
15.	Bambusa vulgaris	Golden Bamboo	6	5	15”	30
16.	Chrysalidocarpus lutecens	Areca Palm	6	5	15”	30
17.	Bismarckia nobilis green form	Bismark Palm – Green	6	-	3’	3
18.	Caesalpinia pulcherima flava-yellow-orange-red	Shankasur Yellow(10)-orange(10)-red(10)Tamil-Mayikonnai	6	5	15”	30

RAIN GARDEN-ADMINSTRATION-202

S. NO	BOTANICAL NAME	COMMON NAME	TOTAL AREA IN SQM	NO. OF PLANTS/ SQM	SPACING C/C	QNTY OF PLANTS
1.	Canna x generalis lineata yellow	Canna Dwarf Yellow	38.5	35	6”	1365
2.	Pandanus amaryltifolius variegatus	Pandanus	19.5	8	1’	20
3.	Canna gernalis red	Canna Red Leaved	8.5	15	9”	135
4.	Pennisetum species	Green fountain grass	55.5	15	9”	840
5.	Hymenocallis littoralis (broad leaved)	Beach Spider Lily	46	8	1’	368

6.	Pennisetum rueppeli	Red fountain grass	42	15	9”	630
7.	Heliconia varities	heliconia	30	15	9”	450
8.	Chrysalidocarpus lutecens	Areca Palm	5.5	5	15”	30

RAIN GARDEN-COUNTRY ZONE

S. NO	BOTANICAL NAME	COMMON NAME	TOTAL AREA IN SQM	NO. OF PLANTS/ SQM	SPACIN G C/C	QNTY OF PLANTS
1.	Bambusa vulgaris	Golden Bamboo	5.5	5	15”	30
2.	Euphorbia pulcherrima christmas star	Poinsettia Christmas Tree/ Tamil Magilkunni	55.5	8	1’	480
3.	Licuala grandis/Pritchardia Grandis	Prichardia Palm	5.5	-	36”	3
4.	Sansevieria trifasciata laurentii,/ S. zebrina	Mother In Laws Tongue/ Snake Plant	55.5	15	9”	900
5.	Pennisetum species	Green fountain grass	55.5	15	9”	900
6.	Hymenocallislittoralis (broad leaved)	Beach Spider Lily	55.5	8	1’	480
7.	Pennisetum rueppeli	Red fountain grass	55.5	15	9”	900
8.	Ensete ventricosum	Ornamental Banana	5.5	-	-	1
9.	Caesalpinia pulcherima flava-yellow-orange-red	Shankasur Yellow(10)-orange(10)-red(10)Tamil-Mayikonnai	55.5	5	15”	300

RAIN GARDEN-ADMINSTATION-202

S.NO	BOTANICAL NAME	COMMON NAME	TOTAL AREA IN SQM	NUMBER OF PLANTS/SQM	SPACING C/C	QNTY OF PLANTS
1.	Pennisetum species	Green fountain grass	29	15	9”	435
2.	Hymenocallis littoralis (broad leaved)	Beach Spider Lily	58	8	1’	928
3.	Pennisetum rueppeli	Red fountain	83	15	9”	1245

		grass				

Earth Works for Avenue Trees (2m) Height Shrubs & Ground Covers/Flower beds. Rain garden	Providing top Soil Mix for Plants and Mounds 1.In the ratio of 2:1:1 of good quality red earth, river silt and manure with all pesticides, fungicides, nutrients and plant growth regulators. 2.Additives / m3 of Top soil mix 19:19:19 complex of NPK @ 1Kg/m3 3.Bavistine @ 50 gm / m3 4.Bio organic fertiliser with all Bio inoculants such as trichoderma, azorpyrillum, azatobacter, psuedomonas, 10 Kg / m3

K. HARD LANDSCAPING WORKS

1.0 GENERAL CIVIL WORKS

This specifications covers the general requirement for excavation, brick masonry, plastering, flooring, doors, windows, ventilators, wood work, water proofing, painting, plumbing and sanitary work etc., and such other related work forming a part of this job which may be required to be carried out though not specifically mentioned above. The work under this specification shall consist of furnishing of all tools, plants, labour, materials, any and everything necessary for carrying out the work.

2.0 BRICKWORK

2.1 Material – Bricks

Bricks shall be sound, hard, homogeneous in texture, well burnt in kilns without being vitrified, table moulded, deep red, cherry or copper coloured of regular shape and size and shall have sharp and square edges and parallel of faces. The bricks shall be free from pores, chips, flaws or humps of any kind. Bricks containing unground particles and/or which absorb water more than 1/6th of their weight when soaked in water for twenty-four hours shall be rejected. The bricks shall give clean / ringing sound when struck and shall have minimum crushing strength of 50 Kg/sq.ct. Sample bricks shall be submitted to the engineer for approval. If demanded by engineer brick sample shall be got tested as per IS-3495 by Contractor at no extra cost to owner. Bricks rejected by Project Consultant shall be removed from site within 24 hours.

2.2 Mortar

The sand used shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by Project Consultant. The mixed mortar shall be used within 25 minutes of mixing. Mortar left unused beyond 25 minutes shall be rejected.

2.3 Workmanship

Workmanship shall confirm to I.S. 2212.

All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry shall be as specified in the respective item of work. Brickwork 230mm thick and over shall be laid in English bond unless otherwise specified. 115mm thick brick work shall be laid with stretchers. The thickness of joints shall be well filled with mortar with minimum thickness of 6mm and maximum depth of 12mm by raking tools daily during the progress of work when mortar is still green. The face of brickwork shall be cleaned daily and all mortar droppings removed. All brickwork shall be built tightly against columns floor slabs or other structural members. Miscellaneous inserts in masonry e.g. sleeves, wall ties, anchors conduits, structural steel, steel lintels, doors, windows shall be installed by the Contractor at no extra cost to the owner.

It shall be clearly understood that the rates quoted by the Contractor include for fixing of inserts, leaving openings, cutting chases etc.

3.0 PLASTER WORK

3.1 Material

The proportion of the mortar shall be as specified under the respective item of work. The quality of water, sand and cement shall be as per respective I. S. Code. The mortar shall be used immediately after mixing and in no case shall be allowed to stand in more than 25 minutes after mixing with water.

3.2 Workmanship

The surface to be rendered shall be washed with fresh clean water, free from all dirt, loose material, grease etc. and thoroughly wetted for 6 hours before plastering work is commenced, concrete surfaces to be rendered will however be kept dry. The wall should not be too wet but only damp at the time of plastering.

3.3 Internal Plaster

This plaster shall be laid in a single coat of 20mm thickness. The mortar shall be dashed on the prepared surface with a trowel and finished smooth by wooden floats. Interior plaster shall be carried out on jambs, lintels, sills, soffits as shown in drawing or as directed by Architect. Rate quoted shall be deemed to include plastering of all surfaces and no separate payment will be considered for any particular, surface like jambs etc.

3.4 Curing

Curing of both interior plaster shall be started as soon as the applied plaster has hardened enough so as not to be damaged. Curing shall be done by continuous applying water in a fine spray.

At places the thickness of plaster may go higher than specified thickness. In such event Contractor shall provide chicken mesh and perform plastering in layers without additional cost.

3.5 Measurement

3.6 Admixture

If directed by Project Consultant, the Contractor shall use approved water proofing / water reducing admixtures in the mortar for plaster work, in the proportion and method prescribed by the manufacturer. Payment shall be made for actual quantity of such admixtures used unless it is already covered in the rates for the work concerned.

4.0 STONE FLOORING FOR LANDSCAPING

4.1 Material

Stones should be of approved quality, hard, sound, durable and uniform in thickness as specified. Edges shall be machine cut / hand cut, machine dressed / hand dressed as specified in respective item of work. Top surface shall be pre machine polished, machine polished at site, hand polished, any other finish as specified in Schedule of Quantities. Stone slabs should meet all the required properties and test requirements as stipulated in I. S. Standard.

4.2 Workmanship

Stone should be laid on a bed of cement mortar of specified mix. Thickness of mortar bedding shall not be less than 12mm and shall not be more than 25mm. Before laying the stone slabs should be thoroughly wetted with clear water, Neat white cement should spread over the mortar bed (at the rate of 5 kg per 1 sq.meter.) over as much area as could be covered with slabs within half an hour. The slabs are then laid and gently tapped with wooden mallet till it if firmly and properly bedded. There should be no hollows left. The joints should not be more than 2mm thick. The joints should be struck smooth. The joints should run true and parallel. The floor should be kept covered with damp sand or water for a week.

Stones laid adjoining the wall shall project 12mm under the plaster / dado / skirting.

For skirting work the vertical surface shall be thoroughly cleaned and wetted. Thereafter it shall be evenly and uniformly covered with 0.5”mm thick 1:2 cement mortar. The back of each tile to be fixed shall covered with a thin layer on neat white cement plaster pigmented to match the shade of the stone slab and tile shall then be gently tapped against the wall with a wooden mallet. The joints shall be as close as possible and the work shall be truly vertical and flush.

5.0 PAINTING

5.1 Material

Paints to be used for various terms of work should be of approved make and colour. The Contractor shall obtain Project Consultant’s approval in regard to the make and colour of paint that is proposed to be used for various items of work.

5.2 Workmanship

The painting work shall be carried out as directed by the Consultant, keeping however, in view the recommendations of the manufacturer. In case of plastic emulsion paint, all uneven surfaces shall be made up by use of putty of appropriate quality, after the surface has been thoroughly cleaned of all dust, dirt and sand papered. Two coat of primer, and two/three coasts of emulsion as specified shall be applied. Workmanship shall conform to the requirement of I.S. 2395.

6.0 CERAMIC TILE WORK IN FLOORING AND DADO

6.1 Material

The tiles used shall be as specified and of approved make, size and shade. The tiles shall be of standard size without warp and straight edges, true and even in shape and size and uniform colour.

6.2 Workmanship – Flooring

Tile shall be laid on base of minimum 12mm thick cement mortar of specified mix. Neat white cement pigmented to match the shade of the tile shall be spread at the rate of 5 kg. Per 1 Square metre area over mortar before laying the tiles. The joints shall be filled with joint filling cement based compound.

6.3 Dado work

The vertical surface shall be thoroughly cleaned and wetted. Thereafter it shall be uniformly covered with about 12mm thick 1:3 cement mortar plaster for leveling purpose. The back of each tile to be fixed shall be covered with a thin layer of approved waterproof tile adhesive cement and the tile shall then be gently tapped against wall and fixed as per adhesive cement manufacturer's instructions. The joints shall be very thin, uniform, perfectly straight and truly vertical. The joints shall be filled with joint filling cement based compound specially manufactured for the purpose.

Flooring, Treads, Skirting – Dado – Risers

6.4 Material

Size, shade and colour of tiles shall be approved by Project Consultant before starting of the work.

6.5 Workmanship

Tiles shall be laid on a bed of cement mortar of specified mix. Thickness of mortar bedding shall not be less than 20mm and shall not be more than 25mm. Tiles shall be covered with white cement / and placed over mortar bed and tapped gently till it is firmly and properly bedded. There should be no hollows left. The joints should run true and parallel. The floor should be cured for one week.

Tiles laid adjoining the wall shall project 12mm under the plaster / dado / skirting.

6.6 Skirting-dado-risers

The masonry surface shall be thoroughly cleaned and wetted. Thereafter it shall be evenly and uniformly covered with 12mm thick 1:3 cement mortar. The back of each tile shall be covered with tile adhesive cement and then the tile shall be fixed as per manufacturer's instructions. The joints shall be filled with tile joint filling coloured cement specially manufactured for the purpose.

7.0 MARBLE / GRANITE WORK

Marble / granite shall be hard, sound, dense and homogeneous in texture with crystalline texture as far as possible. It shall generally be uniform in colour and free from stains, cracks, decay and weathering.

7.1 Classification

The marble / granite blocks, slabs and tiles shall be classified broadly in the following two categories:

White Marble / granite.

Coloured Marble / granite such as Black, Green, Pink, Brown, Grey Marble / granite etc.

7.2 Approval of Sample

Before starting the work, the contractor shall get samples of marble / granite approved by the Engineer-in-Charge. Approved samples shall be kept in the custody of the Engineer-in-Charge and the marble / granite supplied and used on the work shall conform to samples with regard to soundness, colour, veining and general texture.

7.3 Sampling

In any consignment all the blocks / slabs / tiles of the same group, size and finish shall be grouped together to constitute a lot. Sample shall be selected and tested separately for each lot for determining its conformity or otherwise to the requirements of the specification. The number of blocks / slabs / tiles to be selected for the samples shall depend upon the size of the lot and shall be in accordance with the Table given below:

7.4 Sample size and Criteria for Conformity.

Number of Blocks / slabs /tiles in the lot	Number of blocks slabs / Tiles to be selected in sample	Permissible number of defectives	Sub sample size in No.
(1)	(2)	(3)	(4)
Upto 25	3	0	2
26 to 100	5	0	2
101 to 200	8	0	3
201 to 500	13	0	4
501 to 1000	20	1	5

Note: The blocks/ slabs/ tiles in the sample shall be taken at random and in order to ensure to randomness of selection, random tables may be used.

Explanation 1: All the blocks / slabs / tiles, selected in the sample, shall be examined for dimensions workmanship and general requirements.

Any block / slab / tile failing in any one or more of the above requirements shall be considered as defective. All lot shall be considered as conforming to these requirements if the number of defectives obtained is not more than permissible no. of defectives given in Col. 3 pf the Table.

Explanation 2: The lot having been found satisfactory with respect to dimensions, workmanship and general requirements shall be tested for physical properties of the marble / granite. For this purpose a sub sample of the size given in Col. 4 of table shall be selected at random.. These blocks/ slabs / tiles in the sub sample shall be tested for moisture absorption, hardness and specified gravity. The lot shall be considered having satisfied the requirements of the physical properties if none of the blocks / slabs / tiles tested for the requirements fails in any of these tests.

7.5 Marble / granite Work in Floor, Jambs, Steps and other Plain Work

Dressing and Rubbing

Every marble / granite stone shall be cut to the required size and shape, chisel dressed on all beds and joints, so as to be free from any waviness and to give truly vertical, horizontal, radian or circular joints as required. The exposed faces and sides of stones forming joints

upto 6mm. from the face shall be fine tooled such that a straight edge laid along the face of the stone is in contact with every point on it. These surfaces shall then be rubbed smooth. All visible angles and edges shall be true, square and free from chipping. Beyond the depth of 6mm from face, the joints shall be dressed with a slight splay so that the thickness of joint increases, in an inverted 'V' shape so as to give good mortar bond between two stones. The inverted portion of the joints shall be filled with bedding mortar and face 6mm portion with pointing mortar. The surfaces of the stones coming in contact with backing need not be chisel dressed.

A sample of dressed and rubbed stone shall be prepared for approval and it shall be kept on worksite after being approved by the Engineer in-charge.

7.6 Mortar

The Mortar used for jointing shall be as specified.

7.7 Laying: All marble / granite stones shall be wetted before placing in position. These shall then be floated on mortar and bedded properly in position with wooden mallets without the use of chips or under pinning of any sort. The walls and pillars shall be carried up truly in plumb or battered as shown in the drawings. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical.

When necessary jib crane or other mechanical appliances shall be used to hoist the heavy pieces of stones and place these in to correct positions, care being taken that the corners of the stone are not damaged. Stone shall be covered with gunny bags, before putting chain or rope is passed over it, and it shall be handled carefully. No piece which has been damaged shall be used in work. The matching of grains shall be carried out as direct by the Engineer in-charge.

7.8 Curing The work shall be kept constantly moist on all faces for a period of at least seven days.

7.9 Finishing After the marble / granite work is cured, it shall be rubbed with carborandum stone of different grades No. 60, 120 and 320 in succession, so as to give a plane true and highly smooth surface. It shall then be cleaned with a solution of oxalic acid, washed and finished clean.

7.10 Protection Green work shall be protected from rain by suitable coverings. The work shall also be suitably protected from damage during construction.

7.11 Scaffolding Double scaffolding having two sets of vertical supports shall be provided where necessary. The supports shall be sound and strong, tied together by horizontal pieces over which the scaffolding plank shall be fixed.

7.14 Use of Finished Marble / granite Slabs and Tiles

In case such finished tiles are used, these shall be measured and paid for separately under different head of the schedule of quantities.

8.0 WALL LINING / VENEER WORK

Unless and otherwise specified in the nomenclature of the item, the marble slabs used for wall lining / veneer work shall conform to dimensions as shown on the drawings.

8.1 Dressing: Dressing shall be same as specified in earlier para except that the back shall not be dressed, but left rough cut, in order to ensure a good grip with the hearting of backing. The dressed slabs shall be of the thickness as specified with permissible tolerance. The tolerance in wall lining when straight edge of 3m length is placed should not be more than 2mm.

8.2 Laying: The stone shall be wetted before laying. They shall then be fixed with mortar in position without the use of chips or under pinning of any sort. Care shall be taken to match the grains of veneer work as directed by the Engineer-in-Charge. For purpose of matching the grains, the marble slabs shall be selected judiciously having uniform pattern of veins/ streaks. Preferably the slabs shall be those got out of the same block from the quarry. The area to be veneered shall be reproduced on the ground and the marble slabs laid in position and arranged in the manner to give the desired matching of grains. Any adjustment needed for achieving the best results shall be then carried out by replacing or interchanging the particular slabs. Special care shall be taken to achieve the continuity of grains between the two slabs one above the other along the horizontal joints. This shall then be got approved by the Engineer-in-Charge and each marble slabs numbered properly and the same number shall be marked on a separate drawing as well as on the surface to be actually veneered, so as to ensure the fixing of the particular slabs in the correct location.

For the facing of the columns also the same procedure as mentioned above shall be followed. Where so desired, the adjoining stones shall be secured to each other by means of copper pins 75m long and 6mm diameter or as specified. Further the stones shall be secured to the backing by means of clamps. The material for clamps shall have high resistance to corrosion under condition of dampness and against the chemical action of mortar or concrete in which clamps are usually embedded.

Clamps shall be of 25 x 6 mm and 30 cm long in case of backing of stone masonry walls and brick masonry walls thicker than 230mm. In case of backing with brick masonry walls 230 mm or less thick or RCC members clamps shall be of 25 x 6mm and length as per requirement made out of gun metal or any other metal specified. Generally the outer length of clamp in half brick work backing shall be 115 mm and in one brick work backing it shall be 150mm. Clamps shall be spaced not more 60 cm apart horizontally.

The adjoining stones shall be secured to each other by means of gun metal clamps or copper pins of the specified size. Clamps may be attached to its sides or top and bottom. The actual number of clamps and their sections, however, shall be as per requirements of design to carry the loads.

Where clamps are used to hold the unit in position only, the facings shall be provided with a continuous support on which the stones rest at the ground level and other storey levels, the support being in the form of project from or recess into the concrete floor slab, or a beam between the columns or a metal angle attached to the floor slab or beams. These supports shall preferably be at vertical intervals not more than 3.5 m apart and also over the heads of all openings. Such supports shall also be provided where there is transition from thin facing below to thick facing above.

Alternatively clamps may be used to hold the units in position and in addition to support the units thus transferring the weight of the units to the backing. Such clamps should be properly designed as per IS : 4101 (Part 1). The clamps may be of copper alloyed with zinc, tin, nickel, lead or stainless steel. The pins, clamps and dowels shall be laid in cement mortar 1:2 (1 cement : 2 fine sand) and their samples got approved by the Engineer-in-Charge and kept at site. All joints shall be full of mortar. Special care shall be taken to see that groundings for veneer work are full of mortar. If any hollow groundings are detected by tapping the face stones, these shall be taken out and re-laid. The thickness of the face joints shall be uniform, straight and as fine as possible, not more than 1.5mm and in the face joint, the top 6mm depth shall be filled with mortar specified for the pointing.

8.3 Mortar: The mortar used for jointing slabs shall be as specified.

8.4 Curing, Finishing, Protection and Scaffolding.: It shall be as specified in earlier Para.

L. ALUMINIUM WINDOWS, VENTILATORS, COMPOSITE

Scope of work :

The scope of work in the tender item includes fabrication supply and installation of anodized matt finished aluminium windows, ventilators, composite units, glazing etc. strictly in accordance with these specifications and relevant detailed approved shop drawings.

General :

The contractor shall submit six copies of shop drawings covering all types. Details of work as generally shown in Architectural drawing and envisaged under these specifications before manufacture. The drawing shall show all dimensions, details of construction, installation, fixtures and relation to adjoining and related work. No fabrication work shall be undertaken prior to the approval of the shop drawings from the Engineer-in-charge. The tenderer shall intimate at the time of tendering, the types of sections he proposes to use on the works.

Materials :

The aluminium alloy used in the manufacture for extruded window section shall correspond to IS 733- 1966 (or any further revision thereof). Extruded sections shall conform to IS designation HE9-WP and Hollow sections shall conform to IS Designation HV9-WP. The frame work, stiles, mullions, beadings, transoms, hinges, peg stays, handles etc. shall be structurally suitable to withstand all the load, the members have to sustain. Conter sunk screws, nuts, bolts, washers, rivets and other miscellaneous fastening devices shall be of approved cadmium plated or stainless steel as specified in the approved drawings.

Fabrication :

The frames shall be manufactured square and flat. The corners of the frames shall be fabricated to true right angles. All the fixed, sliding, openable frames shall be constructed from sections which have been cut to length, mitred and mechanically jointed or welded at

the corners. Where hollow sections are used with welded joints, argon are welding or flash butt welding shall be employed (Gas welding or brazing not to be done). Sub-dividing bars of units shall be tennoned an riveted into the frames. Water bar in aluminium section shall be provided. The dimensions shown in the drawings are overall heights and widths to the outside of frames of aluminium windows. The side hung shutters shall have projected friction type hinges of aluminium alloy. Concealed projected hinges having structural stability and of good quality will also be considered only after the inspection of the sample submitted by the tenderer. The necessary peg stays, handles, windows fasteners etc. shall be of aluminium. The handle shall be mounted on a handle plate riveted to the opening frame.

The peg stays shall be 300mm. long or as required complete with peg and locking bracket and shall have holes for keeping the shutters open in three different positions. No field fabrication of frames is permitted. The complete fabricated assembly shall be anodized in approved satin finish with minimum film thickness of 0.015 mm. for the entire surface. A thick layer of clear transparent lacquer based on methacrylate or cellulose butyrate shall be applied on the finished sections for the aluminium windows etc. by the supplier to protect the surface from wet cement, lime, dirt, dust etc. during the installation. This lacquer coating shall be removed after installation is complete, if approved by the Engineer-incharge and all sections of the windows shall be protected by the Engineer-in-charge and all sections of the windows shall be protected by P.V.C. film covering.

Hardware :

All cut outs, recesses, mortising or milling and operation required for fixing the hardware shall be accurately made reinforced with packing plate as required to ensure adequate strength of the connection. All the hardware, accessories shall be of best approved type and of anodized finish same as for the frame and other sections. All hardware shall be

free from defects which may affect the appearance and serviceability. All hardware shall be fixed after obtaining the prior approval of the Engineer-in-charge. Approved samples of hardware shall be kept in the custody of Engineer-in-charge.

Fixing :

The window frames shall be accurately fixed in the brick masonry or R.C.C. work.

The fixing of the frame shall be done with cadmium plated brass counter sunk screws driven on the teak wood rough grounds if required or fixed tot eh walls with holdfasts. All aluminium windows shall be fixed in position as per IS 1081-1960 (or any revision thereof):Code of practice for fixing and glazing of aluminium windows. All joints between metal and masonry / rough ground wooden frame shall be fully caulked and mastic or polysulphide compound in order to ensure water tight joints. Joints shall be neatly painted with matching cement an excess materials shall be removed. Hardware shall be fixed in workman like manner all as directed by the Engineer-in-charge.

Samples :

The sample of different windows shall be submitted to the Engineer-in-charge for approval.

Glazing :

The glazing shall be of Indian make plain sheet / frosted figured glass of special selected quality and size as mentioned in item description and drawings shall be of M/s Triveni / Saint Gobain / I.A.G./ Modi / approved make

The specifications specified herein before shall hold good as far as applicable Glazing will be paid on square metre basis.

Guarantee :All materials and workmanship in above work shall be guaranteed for a period of one year (unless otherwise specified) from the date of handling over.

Unqualified performance

guarantee for smooth operations of the windows, doors, wall spans and precautionary measures against leakages etc. shall be furnished by the contractor on stamped paper. If so specified, in schedule of quantities. Any defect found during the guarantee period shall be replaced / made good to the original conditions/positions entirely at the cost of the contractor.

Testing:

All windows shall be tested for water tightness. Any leakage found during testing shall be rectified by the contractor without extra charge.

M. M.S. GRILLS/RAILING

1.0 GENERAL

The contractor shall submit 6 copies of shop drawings shall show all dimension, details of construction, installation relating to the adjoining work.

2.0 MATERIALS:

All structural steel shall conform to IS 226-1963 sections for grills and shall be free from loose mill scales, rusts, pitting or any other defects affecting its strength and durability.

3.0 FABRICATION:

The grills shall be fabricated to the design and pattern shown in the drawings. All joints shall be made in best workman like manner with slotting and welding as required to the specified size and shape. The edge of the M.S. flats shall be suitably mitred before welding to get the desired shape.

The joints shall be filled to remove excess stay after welding screws, nuts, washers, bolts, rivets and any other miscellaneous fastenings devices shall be of steel and shall be provided by the contractor Manufactured M.S. Grills then be fixed in between the posts, balusters, M.S. frame work etc. to correct alignment. Any undulations, bends etc. found shall be rectified by the contractor at his own cost. The complete assembly of rill / railing so fixed shall be firm and there shall not be any lateral movements.

4.0 SAMPLES:

Samples of grill and railings shall be submitted for approval of the Engineer-in-charge and to be got approved before taking up for mass fabrication.

Installation: The approved grills shall be fixed in position where specified and shown in drawings including in masonry walls, teakwood frames, hand railings etc. Any damages to walls, frames etc. caused during fixing the grills shall be made good by grouting with cement mortar/packing /repairing properly at the contractors cost.

5.0 PAINTING:

Painting shall be done as per the specification specified under painting.

Finishing / Painting/Polishing for railing: Teak wood hand rail shall be polished with wax polish / French polish / melamine with two or more coats over one coat of wood/primer or painted with two coats of synthetic enamel paint / flat oil paint of approved make and shade over one coat of approved primer. M.S. grills, balusters, etc. also to be painted as per specifications specified under Painting/ Polishing.

N. ACCESS FLOORING

1.0 GENERAL:

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Gravity-held panels on bolted stringer understructure.

B. Related Sections:
1. Section for Reinforced Cement Concrete for concrete floor sealer.
2. Sections for computer room air-conditioning units.
3. Electrical Specifications for connection to grounding of access flooring understructure.

1.3 PERFORMANCE REQUIREMENTS

A. Performance Requirements, General: Provide access flooring systems that comply with the following requirements:
1. Access flooring systems are proprietary portable systems composed of modular floor panels on elevated supports (understructures) forming accessible underfloor cavities (air spaces) to accommodate electrical and mechanical services.
2. Access flooring systems comply with performance requirements specified as determined by testing manufacturers' current standard products representing those indicated for this Project.

B. Structural Performance per CISCA A/F: Provide access flooring systems capable of supporting the following loads, within limits and under conditions indicated, as demonstrated by testing according to the referenced procedures in Ceilings and Interior Systems Construction Association's (CISCA) "Recommended Test Procedures for Access Floors." This publication and its procedures are referenced elsewhere in this Section as CISCA A/F.
1. Concentrated-Load Performance: Capability of floor panels, including those with cutouts, to support concentrated design loads of the following magnitude, with a top-surface deflection under load and a permanent set not to exceed, respectively, 0.10 and 0.010 inch, according to CISCA A/F Section I.
   a. 1250 lbf.
2. Ultimate-Load Performance: Capability of access flooring systems to support a minimum ultimate concentrated load equal to the value obtained by multiplying the specified concentrated floor panel design load by the factor indicated below, without failing, according to CISCA A/F Section II. Failure is defined as the point at which the access flooring system will not take any additional load.
   a. Factor: 2.
3. Rolling-Load Performance: Capability of access flooring system to withstand rolling loads of the following magnitude applied to panels, with a combination of local and overall deformation not to exceed 0.040 inch after exposure to rolling load over CISCA A/F path A or B, whichever path produces the greatest top-surface deformation, according to CISCA A/F Section III.
   a. CISCA A/F Wheel 1 rolling load: 1000 lbf.; 10 passes
   b. CISCA A/F Wheel 2 rolling load: 800 lbf.; 10,000 passes
4. Stringer Concentrated-Load Performance: Capability of stringers, without panels in place, to support a concentrated load of 200 lbf at center of span with a permanent set not to exceed 0.010 inch, as determined per CISCA A/F Section IV.
5. Pedestal Axial-Load Performance: Capability of pedestal assemblies, without panels or other supports in place, to withstand the following axial load per pedestal, according to CISCA A/F Section V.
   a. 5000 lbf.
6. Pedestal Overturning-Moment Performance: Capability of pedestal assemblies, without panels or other supports in place, to withstand the following overturning moment per pedestal, according to CISCA A/F Section VI.
   a. 1000 lbf x inches.

C. Floor Panel Impact-Load Performance: Capability of access flooring system to withstand the following impact load when dropped from 36 inches onto a 1-sq. in. area located

anywhere on panel, without failing. Failure is defined as the point at which the access flooring system will not take any additional load.

1. 150 lbf.

D. Static-Conductive Floor Covering Resistance: Not less than 25,000 ohms, nor more than 1 megohm, as determined by testing identical products according to the method for conductive flooring specified in Chapter 12 of NFPA 99 but modified to place 1 electrode on floor surface and to attach the other electrode to understructure.

E. Panel to Understructure Resistance: Not more than 10 ohms.

1.4 SUBMITTALS

A. Product Data for each type of access flooring specified.

B. Shop Drawings showing complete layout of access flooring based on field-verified dimensions; include dimensional relationships to adjoining work and installation tolerances. Include details, with descriptive notes indicating materials, finishes, fasteners, typical and special edge conditions, accessories, understructure, and other data to permit a full evaluation of entire access flooring system.

C. Samples for initial selection in the form of manufacturer's color charts consisting of actual units or sections of units showing the full range of colors, textures, and patterns available for each type of floor covering and exposed finish indicated.

D. Samples for verification in full-size units of each type of floor covering and exposed finish indicated.
   1. In addition, submit one complete full-size floor panel, pedestal, and understructure unit for each type of access flooring system required.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who is approved by the access flooring manufacturer for installing the types of access flooring indicated for this Project.

B. Single-Source Responsibility: Obtain access flooring from one source and by a single manufacturer.

C. NFPA Standard: Provide access flooring complying with NFPA 75 requirements for raised flooring.

D. Provide floor panels that are clearly and permanently marked on their underside with the panel type and concentrated-load rating.

E. Mockups: Prior to installing access flooring, construct mockups for each type of panel and understructure required to verify selections made under Sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mockups to comply with the following requirements, using products indicated for final access flooring installation.
   1. Locate mockups on-site, in the location and of the size indicated or, if not indicated, as directed by Architect.
   2. Notify Construction Manager one week in advance of the dates and times when mockups will be constructed.
   3. Obtain Architect's approval of mockups before start of final unit of Work.
   4. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
      a. Approved mockups in an undisturbed condition at the time of Substantial Completion may become part of the completed Work.

F. Preinstallation Conference: Conduct conference at Project site

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver access flooring components in original, unopened packages, clearly labeled with manufacturer's name and item description.

B. Handle and store packages containing access flooring in a manner which avoids overloading building structure.

1.7 PROJECT CONDITIONS

A. Environmental Conditions: Do not proceed with installation of access flooring until installation area is enclosed and has an ambient temperature of between 40 and 90 deg F and a relative humidity of not more than 70 percent.

B. Field Measurements: Check actual locations of walls and other construction to which access flooring must fit by accurate field measurements before preparing Shop Drawings; show recorded measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
   1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with preparing Shop Drawings for access flooring without field measurements. Coordinate construction to ensure that actual dimensions correspond to guaranteed dimensions.

1.8 COORDINATING AND SCHEDULING

A. Coordination of Work: Coordinate location of mechanical and electrical work in underfloor cavity to prevent interference with access flooring pedestals.

B. Mark pedestal locations with a grid of size indicated below on concrete subfloor so that mechanical and electrical work can proceed without interfering with pedestals.
   1. 120 by 120 inches.

C. Do not proceed with installation of access flooring until after Substantial Completion of other construction within affected spaces.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents.
   1. Field Panels and Understructure: Furnish quantity of standard field panels and understructure components equal to 2 percent of amount installed.

PRODUCTS

1.10 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide access flooring by one of the following or an system with matching or better specifications:
   1. Systems with Cementitious-Filled Formed-Steel Panels:
      a. Maxcess Technologies, Inc.; RWC 200
      b. Tate Access Floors, Inc.; Concore SF 1250

1.11 FLOOR PANELS

A. Provide modular field panels complying with the following requirements that one person, using a portable lifting device, can interchange with other field panels without disturbing adjacent panels or understructure and that are free of exposed-metal edges with floor covering in place.
   1. Nominal Panel Size: 24 by 24 inches.
   2. Fabrication Tolerances: Fabricate panels to the following tolerances with squareness tolerances expressed as the difference between diagonal measurements from corner to corner.

a. Size and Squareness: Plus or minus 0.015 inch of required size, with a squareness tolerance of plus or minus 0.015 inch, unless tolerances are otherwise indicated for a specific panel type.
b. Flatness: Plus or minus 0.020 inch, measured on a diagonal on top of panel.

3. Panel Attachment to Understructure: By gravity.

B. Cementitious-Filled Formed-Steel Panels: Cementitious-filled panels fabricated with die-cut flat top sheet and die-formed and stiffened bottom pan formed from cold-rolled steel sheet and joined together by resistance welding to form an enclosed assembly, with metal surfaces protected against corrosion by manufacturer's standard factory-applied finish.

1.12 FLOOR PANEL COVERING

A. Provide floor panels prepared to receive carpet tile where access flooring is scheduled for carpet tile.

B. Provide factory-applied floor coverings laminated by the access flooring manufacturer to tops of floor panels other than carpet tile applications.

C. Colors and Patterns: Provide floor covering materials in colors and patterns as indicated below:
1. Provide Architect's selections made from manufacturer's full range of colors and patterns.

D. Conductive Plastic Laminate: NEMA LD 3, High-Wear Type, of grade indicated below, fabricated in one piece to cover each panel face within perimeter plastic edging or with integral trim serving as edging, and with static decay of 5000 to 0 V in less than 0.5 seconds per FED-STD-101C/4046 at 15 percent relative humidity.
1. Grade: HW 62.

E. Edging: Manufacturer's standard form of edge trim. For applied edge trim, use method standard with manufacturer to attach edge trim to perimeter of each panel. Provide size and profile of applied edge trim that fits floor covering selected.

1.13 UNDERSTRUCTURE

A. Pedestals: Assembly consisting of base, column with provisions for height adjustment, and head (cap); made of steel.
1. Base: Square base with not less than 16 sq. in. of bearing area.
2. Provide vibration-proof leveling mechanism for making and holding fine adjustments in height over a range of not less than 2 inches. Include means of locking leveling mechanism at a selected height that requires deliberate action to change height setting and prevents vibratory displacement.
3. Provide units of sufficient height to achieve underfloor clearance indicated.
4. Head: Designed to support understructure system indicated.
5. Postinstalled Expansion Anchors: Where required to comply with performance requirements, provide expansion anchors for bolting pedestal bases to subfloor that have the capability to sustain, without failure, a load equal to 5 times that specified under Part 1 Article "Performance Requirements."

B. Stringer Systems: Modular steel stringer systems made to interlock with pedestal heads and form a grid pattern placing stringers under each edge of each floor panel and a pedestal under each corner of each floor panel. Protect steel components with manufacturer's standard galvanized or corrosion-resistant paint finish.
1. Bolted Stringers: System of main and cross stringers connected to pedestals with threaded fasteners accessible from above.
a. Provide continuous gasket at contact surfaces between panel and stringers to deaden sound, to seal off underfloor cavity from above, and to maintain panel alignment and position.

C. Lateral Bracing: Provide manufacturer's recommended lateral diagonal bracing bolted to pedestals and bolted to floor with post-installed expansion anchors.

1.14 ACCESSORIES

A. Colors and Finishes: For exposed accessories available in more than one standard color or finish, provide color or finish complying with the following requirements:
   1. Match Architect's sample.
   2. Match color or finish indicated by referencing manufacturer's standard designations for these characteristics.
   3. Provide Architect's selections made from manufacturer's full range of available colors and finishes.

B. Cutouts: Provide cutouts in floor panels for cable penetrations and service outlets. Comply with requirements indicated for size, shape, number, and location. Provide reinforcement or additional support, if needed, to make panels with cutouts comply with standard performance requirements.
   1. Trim edge of cutouts with manufacturer's standard plastic molding.
   2. Fit cutouts with manufacturer's standard grommets in sizes indicated or, where size of cutouts exceed maximum grommet size available, trim edge of cutouts with manufacturer's standard plastic molding having tapered top flange.
      a. Furnish removable covers for grommets.
   3. Provide foam-rubber pads for sealing annular space formed in cutouts by cables and trim edge of cutout with molding having flange and ledge for capturing and supporting pads.

C. Service Outlets: Standard UL-listed and -labeled assemblies, for recessed mounting flush with top of floor panels, for power, communication, and signal services, and complying with the following requirements:
   1. Structural Performance: Cover capable of supporting a 1000-lbf concentrated load.
   2. Cover and Box Type: Hinged polycarbonate cover with opening for passage of cables when cover is closed and including frame and steel box or formed-steel plate for mounting electrical receptacles.
   3. Location: Locate outlets in center of panel quadrant.
   4. Receptacles and Wiring: Equip each service outlet with power receptacles to comply with requirements indicated below.
      a. Type of Receptacle: Heavy-duty duplex, 2-pole, 3-wire grounding, 20 A, 125 V, NEMA configuration 5-20R, unless otherwise indicated.
      b. Number of Receptacles for Outlet: 4.
      c. Wiring Method: Power-in connectors, built into outlet housing, of type to fit power-in and power-out connectors of branch circuit cables supplied with building electrical system.

D. Die-Cast Aluminum Floor Grates: Standard load-bearing die-cast aluminum grates complying with the following requirements:
   1. Air-Distribution Characteristics of Units Without Dampers: 56% free area.
   2. Structural Performance: Capable of supporting a 1000-lbf concentrated load.

E. Panel Lifting Device: Manufacturer's standard portable lifting device of type and number required for lifting panels with floor covering provided.
   1. Provide 4 lifting devices of each type required.

F. Perimeter Support: Where indicated, provide manufacturer's standard method for supporting panel edge and form transition between access flooring and adjoining floor covering at same level as access flooring.

EXECUTION

1.15 PREPARATION

A. Locate each pedestal, complete any necessary subfloor preparation, and vacuum clean the subfloor to remove dust, dirt, and construction debris before beginning installation.

1.16 INSTALLATION

A. Install access flooring system and accessories under supervision of the access flooring manufacturer's authorized representative to produce a rigid, firm installation that complies with performance requirements and is free of vibration, rocking, rattles, and squeaks.

B. Attach pedestals to subfloor by postinstalled expansion anchors.

C. Lay out floor panel installation to keep the number of cut panels at the floor perimeter to a minimum. Scribe perimeter panels to provide a close fit with adjoining construction with no voids greater than 1/8 inch where panels abut vertical surfaces.

1. To prevent dusting, seal cut edges with sealer recommended by panel manufacturer:

2. Connect grounding strips embedded in static-conductive floor covering to connector clips attached to pedestals at the intervals needed to comply with performance requirements for electrical resistance of floor covering.

D. Secure stringers to pedestal heads according to the access flooring manufacturer's instructions.

E. Clean dust, dirt, and construction debris caused by floor installation, including vacuuming the subfloor area, as installation of floor panels proceeds.

F. Cut and trim access flooring and perform other dirt-or-debris-producing operations as remotely as possible from installation area and to prevent contamination of subfloor under access flooring already installed.

G. Level installed access flooring to within 0.10 inch of true level over the entire access flooring area and within 0.062 inch in any 10-foot distance.

1.17 ADJUSTING, CLEANING, AND PROTECTION

A. After completing installation, vacuum clean access flooring and cover with continuous sheets of reinforced paper or plastic. Maintain protective covering until the time of Substantial Completion.

B. Replace access flooring panels that are stained, scratched, otherwise damaged, or not complying with specified requirements.

O. THEORETICAL, STANDARD REQUIREMENT OF CEMENT FOR VARIOUS ITEMS OF WORK FOR GUIDANCE OF CONTRACTOR.

Sl. No.	Brief description of item	Unit	Qty. of cement in bags
1	Cement Concrete 1:5:10	Cum	2.60
2	Cement Concrete 1:4:8	Cum	3.40
3	Cement Concrete 1:3:6	Cum.	4.40 *

Sl. No.	Brief description of item	Unit	Qty. of cement in bags
4	Cement Concrete 1:2:4	Cum	6.40 *
5	Reinforced Cement Concrete1:2:4	Cum.	6.40 *
6	Reinforced Cement Concrete:1:1½:3	Cum.	8.00 *
7	Reinforced Cement Concrete 1:1:2	Cum.	12.20 *

Note : For controlled concrete items like M-10, M-15, M-20, M-25 etc. the Consumption of cement will have to be assessed by the Engineer-in-charge on the basis of design mixes approved for individual work.

8	Brick Masonry in C.M. 1:4	Cum.	1.90
9	Brick Masonry in C.M. 1:6	Cum.	1.25
10	Half brick masonry in C.M. 1:4 with RCC 1:2:4 stiffeners	Sqm.	0.27
11	Half brick masonry in 1:4	Sqm.	1.21
12	a. R.R. Masonry in C.M. 1:6	Cum.	1.65
	b. C.R. Masonry in C.M. 1:6	Cum.	1.56
13	IPS Flooring (C.C. 1:2:4, Finished smooth)		
	a. 30 mm thick	Sqm	0.23
	b. 40 mm thick (smooth / broom finish)	Sqm.	0.30
	c. 50 mm thick	Sqm.	0.36
	(+) 20 mm thick skirting /dado in cm. 1:3	Sqm.	0.30
14	Hardonate flooring – 50 mm thick (C.C. 1:2:4, finished smooth)	Sqm.	0.41
15	Kota Stone :		
	a. Flooring (with lime mortar bedding pointed with matching cement slurry)	Sqm.	0.13
	b. Skirting with 20mm thick C.M. 1:3 backing	Sqm.	0.27
	c. Coping Sqm. 0.13 16 Terrazzo Tile :		
	a. Flooring (with lime mortar bedding and pointed with cement slurry)	Sqm.	0.18
	b. Skirting with 20 mm thick C.M. 1:3	Sqm.	0.28
	c. Treads, hydraulically pressed with C.M. 1:3 bedding	Sqm	0.37
	d. Treads in one piece	Sqm	0.28
	e. Risers, hydraulically pressed with C.M. 1:3 backing	Sqm.	0.28
	f. Risers in one piece	Sqm.	0.23
	a. Flooring 40 mm thick (28 mm C.C. 1:2:4 + 12mm with marble chips & powder)	Sqm.	0.26
	b. Skirting, 20mm thick (12mm C.M. 1:3 + 8 mm marble chips with cement & marble powder)	Sqm.	0.25
	White glazed tile flooring and dado over 20mm C.M. 1:3 bedding	Sqm.	0.31
	Cement tile :		
	a. Flooring (Lime mortar bedding)	Sqm.	0.18
	b. Skirting with 20 mm thick C.M. 1:3	Sqm.	0.28

Sl. No.	Brief description of item	Unit	Qty. of cement in bags
20	Plaster skirting, 20 mm thick in C.M. 1:3	Sqm.	0.30
21	Cuddapah stone kitchen platform over 20mm thick C.M. 1:4	Sqm	0.30
22	Cuddapah stone window sill over 20mm thick C.M. 1:4	Sqm.	0.27
23	Fixing hold fasts in cement concrete 1:3:6 of size 300 X 100 X 150mm for door & windows	100 nos.	2.20
24	Cement plaster in C.M. 1:4 / 1:5 with neeru finish		
A.	Cement mortar 1:4		
a.	12 mm thick	Sqm.	0.1
b.	15 mm thick	Sqm	0.13
c.	20 mm thick	Sqm.	0.1
B.	Cement mortar 1:5		
a.	12 mm thick	Sqm.	0.09
b.	15 mm thick	Sqm.	0.11
c.	20 mm thick Sqm. 0.14 25 Cement plaster in C.M. 1:4 in two coats with neat cement punning		
a.	12 mm thick 10 mm + 5 mm (for ceiling)	Sqm.	0.18
b.	15 mm thick 15 mm + 5 mm (for internal walls)	Sqm.	0.22
25 .	Cement plaster in C.M. 1:4, 20 mm thick rough finish (for external brick / concrete surfaces)	Sqm	0.17
26.	Sand faced plaster, 20 mm thick (12 mm C.M. 1:4 + 8mm C.M. 1:3)	Sqm.	0.21
27.	Rough cast plaster, 25mm thick (12 mm C.M. 1:4 + 13mm C.M. 1:3)	Sqm.	0.27
28 .	(+) 10 mm wide & 18 mm thick plain or moulded cement mortar band in CM 1:4	100 RM	0.152
29 .	Cement plaster in C.M. 1:3 with water proofing compound finished smooth with neat cement		
	a. 12 mm thick	Sqm.	0.19
	b. 20 mm thick	Sqm	0.27
30 .	Cement pointing in C.M. 1:3		
	a. Ruled pointing (groove pointing)	Sqm.	0.02
	b. Raised & cut pointing	Sqm.	0.04
31.	Cement based waterproofing work		
	a. Terrace type average 115mm thick	Sqm.	0.45

Sl. No.	Brief description of item	Unit	Qty. of cement in bags
	b. Basement type (Box type)	sqm .	0.70
	c. Basement type (surface)	Sqm.	0.60
	d. In sunken floor of toilets, chajjas, parapets	Sqm	0.30
	e. Brickbat coba in toilets, extra in roof terrace	Cum.	3.00
	f. O.H. water tanks	Sqm.	0.50
	g. Expansion joints	RM	0.50
32.	Damp proof course in CC 1:2:4		
	a. 25 mm thick	Sqm.	0.16
	b. 38 mm thick	Sqm.	0.24
33.	Laying R.C.C. spun pipes in C.M. 1:1 / 1:2		
	A. 100 mm dia	10 m	0.1
	B. 150 mm dia	10 m	0.12
	C. 250 mm dia	10 m	0.18
	D. 300 mm dia	10 m	0.22
	E. 450 mm dia	10 m	0.48
	F. 600 mm dia	10 m	0.64
34.	Cement mortar 1:4 screed		
	a. 20 mm thick	Sqm.	0 .30
	b. 50 mm thick	Sqm.	0.60
35	Chain link fencing / barbed wire fencing C.C. 1:3:4 pockets of 45 X 450 X 600 mm		
	a. Angle iron posts	m	0.21
	b. Cement concrete 1:2:4 posts	m	0.37
36	Kerb stone in CC 1:3:6 of size 125 X 375 mm	m	0.21
37	Shahabad stone paving, pointed in C.M. 1:3 15 X 10 mm groove	Sqm .	0.02
38	Pointing & grouting stone pitching in CM 1:3	Sqm.	0.14

P. METAL CLADDING

1.0 GENERAL

1.1 WORK INCLUDED

A. This Section specifies the requirements necessary to furnish and install the metal cladding systems.

1.2 RELATED WORK

A. This Section shall be used in conjunction with, but not necessarily limited to, the other relevant specifications, the Drawings and the Contract Documents to establish the total requirements for the metal cladding.

B. CAUTION: Using this Section without including the above-listed items will result in omission of basic requirements

C. In accordance with the General Conditions of Contract, the aforesaid documents shall be taken as mutually explanatory, and any ambiguities or discrepancies shall be resolved by the Purchaser, who shall then instruct the Contractor thereon. In the event of conflict regarding the metal cladding requirements between this Section and any other document, the more stringent requirement shall apply unless specifically instructed by the Purchaser in writing otherwise.

1.3 DESIGN CRITERIA

A. The work in this Section shall include the design, supply, installation, completion and maintenance of all metal cladding systems.

B. The work in this Section shall include all accessories, parapet cappings, end cappings, soffit trims, reveal linings, jamb linings, sills, and the like, which may not be expressly indicated on the drawings, but which are necessary to provide a total metal cladding systems package, which interfaces in a complete manner with the adjacent building surfaces.

C. The proposed cladding systems shall include all required sealant systems, fixing systems, anchorage systems, and framing systems.

D. The Contractor shall provide all additional structural support systems, which are required for the proposed cladding systems, but not already provided under a separate contract, in the building structural works.

E. A set of “Only For Reference” structural works drawings form part of the Contract Documents. The Contractor will be deemed to have acquainted himself with the contents of these drawings and shall include in his tender any costs in respect to additional structural support systems which are not shown on these drawings, but which are required for the proposed cladding systems.

F. No consideration will be granted to any misinterpretation or unforeseen difficulties for which provision has not been made in the tender and this will in no way relieve the Contractor from the full execution of the Contract.

G. The Contractor shall note that the structural columns of the building superstructure, provided under a separate contract, are constructed of both cast in-situ and pre-cast concrete, with no provision for cast-in components for the anchorage systems of the proposed cladding systems.

H. Any cast-in anchorage components, which are required, shall be provided by and placed in position by the Contractor, ready for casting of concrete. Provide shop drawings of proposed anchorage systems.

H. The proposed cladding systems shall be so designed to meet or exceed the specified performances required for the prevailing local weather conditions. All fixings and joints shall be designed to provide for the expected thermal expansion and contraction, and to accommodate structural movement. The cladding systems shall be designed for air and water tightness, and moisture disposal.

J. The entire metal cladding systems shall be designed, constructed and installed to bond to the lightning protection systems as specified in Clause 1.12 Bonding of Cladding to Lightning Protection System.

1.4 QUALITY ASSURANCE

A. The metal cladding shall comply with Authorities' requirements and regulations in force in Tamil Nadu and shall guarantee durability with particular attention to the following critical factors:
- Effects of atmospheric corrosion typical to the area.
- Avoid contact between dissimilar metals to avoid electrolytic corrosion.

1.5 WARRANTY

A. Provide a two (2) year warranty under the provisions of Conditions of Contract.

B. The Contractor and the Specialist Sub-Contractor shall jointly provide a two (2) year warranty for the completed works on its performance against any defects and failure as a cladding system, in particular to its prevention of corrosion.

1.6 ORDERING AND DELIVERY

A. The Contractor shall be responsible for timely ordering, scheduling, delivery, receiving, protection and installation of all materials necessary for completion of the Contract work, on site or in transit.

B. The Contractor shall be responsible for all carriage freight, insurance, damage, breakage, duties, customs, clearance, etc.

C. All materials to be used shall be new and unused. Proof of ordering and delivery including shipping documents may be required to be given by the Contractor on demand at the discretion of the Purchaser.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to site.

B. Protect prefinished aluminum surfaces. Do not use adhesive papers or sprayed coatings, which bond when exposed to sunlight or weather.

C. The Contractor shall replace any defective, damaged, or broken cladding system components at his own expense and shall leave the systems clean and perfect on completion.

1.8 SUBMITTALS

A. Provide the following with the bid:
1. Product Data
2. Proposed Work Programme
3. Method Statement

B. The Contractor shall submit with his bid design recommendations including relevant information and physical properties of the selected elements. Notwithstanding the acceptance of the design recommendations by the Purchaser, the Contractor shall remain solely responsible for the adequacy of all the works and shall make good any damages arising from any inadequate design or provision.

C. Shop Drawings: Submit shop drawings for fabrication and installation of cladding units and accessories. Include schedules, plans, elevations and details of sections and connections to adjoining work. Indicate materials, finishes, fasteners, joints, trims, and other information to determine compliance with specified requirements.

Shop drawings shall give all pertinent information of construction method proposed, together with all required dimensions for proper fitting and connection with other work and materials, together with all special conditions as may be required to complete the installation.

Indicate system and component dimensions, framed opening requirements and tolerances, anchorage and fasteners, anticipated deflection under load, affected related work, and field welding required. Include components within assembly, weep drainage network, and expansion and contraction joint locations and details. Submit preliminary data with the bid. After preliminary submission, all shop drawings shall be computer generated, Autocad-14 files. Shop drawings, product data, and samples shall be submitted to the Purchaser for review and approval, before ordering materials and commencing fabrication.

D. Product Data: Submit manufacturer's specifications including finishes and materials; certified test data, where applicable; and installation instructions; for required products. Provide framing member structural and physical characteristics, dimensional limitations, special installation requirements. Provide data on components within assembly, anchorage and fasteners, sheets and panels, sealant systems and drainage systems. Data sheets shall fully describe properties of materials, processes and finishes.

E. Proposed Work Programme: The Contractor shall prepare and submit a detailed programme of all phases of the work, including but not limited to the design, submissions, testing, ordering, fabrication, transportation, installation and after care, for the completion of the whole works to the Purchaser following award. Submit a preliminary work programme with the bid.

F. Method Statement for Site Installation and Quality Control: The Contractor shall prepare and submit a detailed step by step method statement for approval. Submit a preliminary method statement with the bid. The method statement shall include:

1. Setting out.
2. Transportation of cladding and framing.
3. Structural surface preparation if necessary.
4. Installation of fixings, such as drilling, installation of shims, angle, plate, anchors and bolts, inclusive of testing (pull out test) of anchor
5. Installation of cladding and framing.
6. Method of replacement of damaged units, framing, etc, if necessary.

G. Samples: The Contractor shall submit the following to the Purchaser for approval.

1. Samples of profiled metal sheet cladding.
2. Samples of aluminum flat panel cladding.
3. Samples of edge and corner details for cladding units.
4. Samples of support frame systems.
5. Samples of fixing and anchoring systems.
6. Samples of sealant systems.
7. Submit samples not less than 300 x 300mm in size illustrating finishes and materials.
8. Samples of coating for color.

H. Certificates: Submit manufacturer's certification, and other independent certification where applicable, that products meet or exceed specified requirements.

I. Test Reports: Submit substantiating engineering data, test results of previous tests by independent laboratory of the systems which purport to meet performance criteria, and other supportive data

J. Manufacturer's Instructions: Indicate special installation procedures.

K. Professional Engineer's Certificate: The design, fabrication and installation of the cladding systems shall be certified by the Contractor's Professional Engineer as safe, and in compliance with the regulations and requirements of the Authorities.

L. As-Built Drawings: During construction, the Contractor shall keep accurate records of the contract works, "as-built", on Autocad-14 construction drawings and details. This information shall be supplied to the Purchaser on Autocad-14 files, and shall form the basis of an "as-built" record of the construction of the building.

M. Prior to the issue of the Final Acceptance Certificate, the Contractor shall hand over to the Purchaser transparencies and Autocad-14 files of all as-built drawings, all Professional Engineer's certificates, and all other documents related to the Contract work, which will be required for the application for Temporary Occupation Permit.

1.9 SEQUENCING

A. Coordinate work under provisions of Conditions of Contract.

B. Coordinate work with installation of structural works, masonry works, waterproofing and roofing works, door / roller shutter works, and other cladding systems works.

1.10 MOCK-UPS AND SAMPLES

A. The Contractor shall install mock-ups of the typical metal cladding systems in conjunction with the other systems as and when directed by the Purchaser for his review and approval. These mock-ups are to ensure proper installation and coordination. Once accepted these mock-ups will be used as acceptance yardsticks for all production units.

B. Provide mock-ups of system components as part of the exterior wall mock-ups. Assemble to illustrate component assembly including cladding materials, weep drainage system, moisture disposal, attachments, anchors, and perimeter sealant.

C. Samples of components, fixtures, etc, shall, where required, be submitted to the Purchaser for review and approval before commencement of work.

D. The Contractor shall replace or modify such mock-ups and samples if deemed necessary by the Purchaser, and such final mock-ups and samples shall be used as the basis of installation work. However, any agreement by the Purchaser to such mock-ups and samples does not exonerate the Contractor from any responsibility under the terms and conditions of the Contract.

E. Delays caused by late installation of mock-ups or submission of samples, or delays caused by modifications of mock-ups / samples due to repeated errors, will under no circumstances be construed as reasons for extension of the Contract Period.

F. If the Contractor requires early review and approval of any mock-up / sample to avoid delay in the delivery or installation of the works, he shall advise the Purchaser to such effect when submitting them.

G. The Contractor shall be responsible for any claims arising out of errors / omissions in samples and mock-ups.

H. The Contractor shall obtain and pay for permits required for the work.

1.11 VERIFICATION AND PERFORMANCE TESTING

A. General

1. The Contractor will be required to verify that the work of this section meets the specified design criteria as well as all other conditions of this specification, through submission of shop drawings, calculations, data sheets, samples and test results.

2. Structural calculations, engineering data, and test data, shall be provided by a registered Professional Engineer, acceptable to the Purchaser.

3. Testing by independent testing laboratory or review of data by the Purchaser shall not avoid or reduce the Contractor's responsibility for performance of the work, nor relieve the Contractor of his responsibility to verify for himself that the work conforms to the intent of the Contract documents.

4. Data sheets shall fully describe properties of materials, processes, and finishes.

B. Performance Testing

1. After approval of structural calculations and shop drawings of the installation, the Contractor shall fabricate and erect test units of sizes and configurations acceptable to the Purchaser for testing.

2. Prior to fabrication of the test units, submit shop drawings of the test units and the test programmes for the Purchaser's approval.

3. Fabrication of test units and testing shall be carried out expeditiously and concluded in such time as not to delay fabrication and erection schedule.

4. The Contractor shall be responsible for all costs in connection with the performance testing.

5. If the test units fail to meet the performance requirements of this specification during testing, the Contractor shall make the necessary corrections to the test unit, and shall have the test unit re-tested until it passes the tests. The cost of corrections to the test unit, and of re-testing, shall be paid by the Contractor at no cost to the Purchaser.

6. The test programme shall require meeting the structural criteria at design load and at 1.5 overload (1.5 times the design load) at which no failure shall occur. The Contractor shall propose method of testing.

1.12 BONDING OF CLADDING TO LIGHTNING PROTECTION SYSTEM

A. The entire metal cladding systems shall be designed, constructed and installed so that all metal parts are electrically continuous. Sampling tests shall be carried out on site to verify the electrical continuity.

B. Earthing bosses shall be provided behind the cladding and curtain wall panels / frames. Each earthing boss shall basically consist of an "ear" piece of the same material as the cladding and shall have a hole of 10mm diameter to permit connection of 25mm x 3mm bonding aluminum tapes. The Contractor shall provide earthing boss "ears" as shown in the Lightning Protection System Drawings. The bonding of the aluminum tapes and connection of the tapes to the earthing bosses will be provided / undertaken by the C43 contractor under a separate contract. A set of Lightning Protection System Drawings form part of the Contract Documents.

C. At areas where the top of the cladding wraps round the parapet walls, 25mm x 3mm aluminum tapes will have to be mounted on the top of these claddings. To avoid puncturing the cladding, the Contractor is to supply and install saddles at every 600mmm along the top of the cladding. The details of the saddle are as shown in the Lightning Protection System Drawings.

D. The Contractor shall coordinate with the C43 contractor to ascertain the exact positions of the earthing bosses to suit the lightning protection system

2.0 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. To the extent that products of the following manufacturers meet or exceed specified requirements, the following are acceptable:

1 For Main Wall Cladding System:

Lloyd
Kirby
Metecno

2 For Canopies and Sun Shades above doors and windows

Aluminium Panel
Alucobond
Durobond

B. Products of manufacturer's other than the above-listed will be considered for acceptance providing they meet the specified criteria and that the substitution requests are made in accordance with the Conditions of Contract.

2.2 TECHNICAL SPECIFICATIONS & INSTALLATION METAL WALL CLADDING SYSTEM

2.2.1 Supplying and Fixing Pre-Fabricated Rockwool Sandwich Panels For Walls Comprising Of

A. **Exterior sheet** : Profiled sheets with 1000 mm cover width, 35 mm crest height at 333 mm centres, made out of 0.5 mm TCT, 300 Mpa – yield stress, Galvalume Steel, 150 gsm Zinc – Aluminium alloy (as per ASTM : A 792) coating with 20 microns polyster coating.

B **Core Insulation Material :** High density Rockwool of 100 kg/cu.m density converted to lamellar in 80 mm thick and bonded to steel sheets with industrial Grade adhesive.

C. **Interior sheet :** Plain sheet with slight ribs, with 1000 mm cover width, made out of 0.5 mm TCT, 300 Mpa – yield stress, Bare Galvalume steel, 150 gsm Zinc-Aluminium alloy (as per ASTM : A 792) coating with 20 microns polyester coating.

D. Panel shall be supplied in 1 m width and in single length upto 12 m without any joints depending on site requirements.

E. **Fixing:** Panel shall have tongue and groove joint with concealed fixing system and shall be fixed on to the support system with self drilling and self tapping fasteners as per manufacturer's specification.

2.2.2 Supplying & Fixing Site Fabricated Double Skin Insulated Cladding Comprising Of

A **Exterior sheet** : Profile sheet 1000 mm cover width, 28 + 2 mm crest height at 195 centres made out of 0.6 TCT, 550 MPa – yield stress, Galvalume Steel, 150 gsm Zinc-Aluminium Alloy (as per ASTM : A 792) coating and with 20 microns of Polyster coating.

B **Vapour Barrier** : Providing and fixing SIL / Polynum Refective Vapour Barrier of Supreme Industries Ltd,./ Polyon Barkai Industries between exterior sheet & Insulation.

C **Core Insulation Material** : Bonded Rockwool slabs of 64 Kg/cu.m density in 100 mm thickness encased in Black Polythene sheet.

D **Interior sheet** : Profile sheet 1000 mm cover width, 28 + 2 mm crest height at 195 centres made out of 0.6 TCT, 550 MPa – yield stress, Galvalume Steel, 150 gsm Zinc-Aluminium Alloy (as per ASTM : A 792) coating and with 20 microns of Polyster coating.

E **Fixing procedure** : The internal sheets shall be fixed to the purlins with self drilling self tapping fasteners, Z Sub-girts shall be 50 x 100x 50 and made out of 1.6 mm Galvanised steel sheet shall be provided at purlin locations and collinear to the purlin.

F. The insulation material shall be then laid between the Z sub-girts as exterior sheet shall then be fixed to Z Sub-girts with self drilling self tapping screws.

G. The wall cladding shall be complete with necessary flashings and wherever necessary

2.2.3 Supplying & Fixing Partitions with Pre-Fabricated Rockwool Insulated Panels comprising of

A. **Exterior sheet** : Plain sheets with micro ribs, made out of 0.5 mm TCT, 300 MPa – yield stress, Galvalume Steel, 150 gsm Zinc-Aluminium Alloy (as per ASTM : A 792) coating and with 20 microns of Polyster coating over 5 microns primer.

B **Core Insulation Material** : High Density Lamellar Rockwool having 100 Kg/cu.m density in 80 mm thick.

C **Interior sheet** : Plain sheets with slight ribs, made out of 0.5 mm TCT, 300 MPa – yield stress, Galvalume Steel, 150 gsm Zinc-Aluminium Alloy (as per ASTM : A 792) coating and with 20 microns of Polyster coating over 5 microns primer.

D Panels shall be supplied in 1000 mm width and in single length upto 12 m without any joints depending on site requirements and shall be laid vertically.

E **Fixing procedure** : Panels shall have tongue and groove joint with concealed fixing system and shall be fixed on to the support system with self drilling and self taping fasteners as per manufacturer's specification.

2.2.4 Supplying And Fixing Single Skin Partitions Comprising Of

A. **Partition sheet** : Profile sheet 1000 mm cover width, 28 + 2 mm crest height at 195 centres made out of 0.6 TCT, 550 MPa – yield stress, Galvalume Steel, 150 gsm Zinc-Aluminium Alloy (as per ASTM : A 792) coating and with 20 microns of Polyster coating.

B. **Fixing procedure** : The partition sheets shall be fixed to the support structure with self drilling self tapping at crest locations with required overlaps and partitions shall be complete with all necessary flashings wherever necessary.

2.2.5 Accessories

A **Cappings, Flashings and Trims** : Cappings, Flashings and Trims shall be made out of 0.7 mm TCT, 550 Mpa – yield stress, Galvalume Steel, 150 gsm, Zinc-Aluminium Alloy (as per ASTM : A 792) coating and with 20 microns of Polyster coating.

B Cappings, Flashings and Trims may be formed to required shape and profile based on shop drawings in 2.5 m lengths of profile of external / internal sheet except where metal crapped foam fillers are used.

C **Fixing** : Cappings, Flashings and Trims shall be screwed to the external / internal sheeting with colour matched nylon head self drilling stitching fasteners at max. 500 mm centres along the length of the capping / flashing shall be installed at 90°C to the material being fastened.

D All longitudinal joints in cappings and flashings shall be overlapped a minimum of 50 mm and sealed with a continuous run of sealant.

2.2.6 Fixing Accessories :

A **Fastners**

12 – 14 x 90 Galvanised head self drilling screws with integral washers shall be used for fastening Pre-fabricated sandwich Panels for Wall Cladding.

12 – 14 x 55 Galvanised head self drilling screws with integral washers shall be used for Partition Sheets and fastening Double Skin Insulated Cladding.

10 -16 x 16 hexagonal head stitch fasteners shall be provided on side laps at 900 mm centers maximum.

The fasteners shall generally confirm to ASTM A 3566 and shall be Hilti / Corroshield make.

B **Profiled Foam Fillers** :

Profiled foam fillers shall be provided wherever required to close the voids between cappings and the troughs of the external sheet so as to provide a weather tight exterior. These shall be made out of closed cell Polyethylene Foam die cut in profile to match external sheeting.

C **Gutters, down-spouts and down-takes**:

Gutters shall be provided wherever shown on the drawings, Gutters shall be fabricated and brake-formed from 3.15 mm Cold Rolled Steel conforming to IS 513.

For reinforcing gutters 38mm x 38mm x 3 mm angle shall be provided at 1000 mm c/c and support bottom of gutters to structural steel at 1000 mm c/c. longitudinal joints in gutter shall be continuously welded. The gutter surfaces shall be cleaned, and provided with 2 mm thick FRP coating.

The mouth of each downtake pipe in the gutter shall be provide with a weldmesh screen with mesh size of 6 mm x 6 mm.

D Down spouts:

Down spouts will be either 200 mm dia or 300 mm dia UPVC pipes, as indicated in the drawings. Pipes shall have joints sealed and shall be laid plumb or to horizontal slope as indicated in drawings. Pipes shall be clamped to the columns / cladding

runners by means M S clamps bent to shape and fixed by colour matched self drilling screws.

E Roof Openings:

Roof Openings with curbs shall be located at the place of openings. Wherever such framed openings are to be provided, the contractor shall provide flashing around such framed openings or curbs.

Flashings around such openings shall be formed of same material as flashings. The flashing shall normally be with a flat sheet of size adequate to overlap the roof sheeting all around the opening by at least 200 mm. This flat sheet flashing shall be sealed to roof sheeting at transverse laps with foam fillers and at side laps with continuous runs of sealant.

Where required, curbs shall be fabricated from 14 G (2 mm) pre painted steel and flashed around the opening. All curbs shall be min. 300 mm high and shall feature a 50 mm wide MS angle flange around the top of the curb and a sloped drainage surround. Contractor shall furnish details of curb construction for approval prior to commencement of work. All structural loads will be supported by structural framing in roof by others.

Such framed openings may be provided-while the roof sheeting is being installed or subsequent to the roof sheeting installation

2.3 TECHNICAL SPECIFICATIONS AND INSTALLATION ALUMINIUM PANEL CLADDING SYSTEM FOR CANOPIES AND SUN SHADES

Description of the work: The aluminum composite cladding panels shall be fixed securely to the aluminum extrusion supports. The fixing shall allow for building tolerance adjustment. Where reinforcement of the panel is required, extruded aluminum profiles of suitable cross-section and strength shall bonded to the reverse side of the panel. Application of the bonding systems shall be strictly in accordance with the manufacturer's specification. No cladding element shall sustain permanent deformation or failure under loading equivalent 1.5 times of design wind pressure (positive and negative) specified. Deflection of any aluminum frame shall not exceed 1/500 of the clear span. All component parts shall be installed level, true to line with uniform joints and reveals.

Maximum deviation for vertical member: 3mm max. in an 5.2m run.

Maximum deviation for horizontal member: 3mm max. in an 8.5m run.

Maximum deviation form true alignment between the abutting member shall not exceed 1.0mm.

The tolerance of the width of the joints between two panels shall be maximum ± 2mm.

3.0 EXECUTION

3.1 See execution notes under various products and items listed under 2.2 above

3.2 SITE INSPECTION

The Contractor is to examine and satisfy himself of other related-trades site conditions under which, the metal cladding is to be installed. Do not proceed until unsatisfactory conditions have been rectified. The Contractor shall compensate the owner any additional cost due to above reason.

All parts of the works done on site will be subject to inspection and shall be completed to the satisfaction of the Purchaser. The Contractor shall provide all facilities and assistance for inspection during the progress of the site works and until the completion of the contract.

Q. SPECIFICATIONS FOR FAÇADE ALUMINIUM AND GLAZING WORKS

1.0 SCOPE OF WORK:

The scope of work under this sub-head includes structural analysis and design, preparation of shop drawings, setting out, fabrication, supply, installation, aligning, fixing and protection of the Fixed Glazing butt to butt joint, patch fitted door, Aluminum Composite Panel Cladding, Conventional curtain wall with butt flat & Cap, Skylight, Sunshade Louvers, Suspended Spider Glazing etc. it also includes guarantee for the works under this sub head as described above, for the system, materials and performance requirements for a period of 10 years form the date of completion of the work.

The work under this section includes cost of all inputs of labour, materials including wastages, hardware and accessories, transport & packaging, access equipments such as cranes or cradles, scaffolding etc., other enabling temporary structures and services and all other incidental charges, if any, not specifically mentioned here, but as required for complete design, engineering, fabrication, assembling delivery, anchorage, installation, protection of Fixed Glazing butt to butt joint, patch fitted door, Aluminum Composite Panel Cladding, Conventional curtain wall with butt flat & Cap, Skylight, Aluminium Louvers, Suspended Spider Glazing etc water tight and complete all in accordance with the true intent and meaning of the specifications and the drawings taken together regardless of whether the same may or may not be particularly shown on the drawings and / or described in the specifications, provided that the same can be reasonably inferred there from. All items as mentioned in the above scope of work shall be structurally and mechanically designed to achieve the architectural elevations as well as performance parameters specified herein. Anchorage shall include all supporting brackets and anchor fasteners, as required to rigidly secure the structural framing to the RCC/ Masonry / Structural steel members of the building.

Fixed Glazing butt to butt joint, patch fitted door, Aluminum Composite Panel Cladding, Conventional curtain wall with butt flat & Cap, Skylight, Sunshade Louvers, Suspended Spider Glazing etc described hereafter shall include but will not necessarily be limited to the following:

a. Frames, fixed vision panels, spandrels, openable panels, as indicated in the drawings inclusive of all accessories and fittings. The scope of work also includes replacement of any defective and / or broken glass panes [single or insulated Glazed Units (IGUs) (breakage not attributable to vandalism or accident), evident due to condensation or dirt between the lites, failure of seal and damage to internal glass panes, staining, damage to the coating etc., for a period of 10 years from the date of completion of work for which nothing extra shall be payable. The decision of Engineer-in –Charge as

regards for reason for breakage of glass shall be final and binding on the contractor.

b. Glass wool insulation panel fire stop (barrier) –cum –smoke seals, splice plates, connectors, sleeves, anti-buckling clips etc.

c. Access panels and inspection of lightening protection and test clamps including ironmongery and accessories to all the open able panels of curtain glazing, structurally glazed aluminum windows and doors etc.

d. Doors and vents where indicated.

e. Structural, weather and other silicone sealants within and all round the perimeter of all the work under this sub head for fabricating IGUs, holding the glass to the aluminum and glass to glass and to provide water tightness to the Fixed Glazing butt to butt joint, perforated metal sheet cladding, patch fitted door, Glas Canopy, Sandstone Cladding, Aluminum Composite Panel Cladding, conventional Curtain wall with butt flat & cap, skylight, Sunshade Louvers etc.

f. Ozone resistant EPDM/ silicone gaskets, trims, shims, setting blocks, double sided spacer tape, spacer blocks, weathering strips etc.

g. All caulking, sealing and flashings including sealing at junctions with the building members.

h. All brackets, anchor fasteners, screws, inserts, nuts, bolts & washers, and attachments required for complete installation and fixing to the RCC, Masonry and / or the structural steel members of the building.

i. All accessories, fasteners, screws, nuts and bolts, toggles, rivets etc. and other items implied in the drawings and the specifications through are not specifically indicated or mentioned here

j. Isolation of all dissimilar metal surfaces as well as moving surfaces by use of suitable separators.

k. Electrolytic & Bimetallic isolation Different metals that are in direct contact and at risk of electrolytic and bimetallic corrosion shall be isolated form one another to prevent electrical connectivity and interment corrosion between the metals.

l. Aluminium composite panel Cladding and trimmers etc. as per the drawings.

m. Engineering proposals, design, drawings and architectural data.

n. Shop drawings, engineering data and structural calculations (analysis & design) of all systems including aluminium structural framing, fasteners, sealants etc.

o. Scheduling and monitoring of the work.

p. Cost of all samples of the individual components mock-ups at site, field tests for individual materials/ components and the curtain wall system as a whole, as specified.

q. Coordination with work of other agencies / contractors employed on site.

r. Protection, during storage and construction until handing over the building for occupation, of Fixed Glazing butt to butt joint, perforated metal sheet cladding, patch fitted door, glass canopy, sandstone Cladding, Aluminium composite panel cladding, conventional Curtain wall with butt flat & cap, skylight, sunshade louvers etc.

s. All final exterior and interior cleaning of the Fixed Glazing butt to butt joint, perforated metal sheet cladding, patch fitted door, glass Canopy, Sandstone Cladding, Aluminium Composite panel cladding, Conventional Curtain wall with butt flat & Cap, Skylight, Sunshade Louvers etc before handing over the building for occupation to the satisfaction of the client.

t. Hoisting, staging, scaffolding and temporary enabling structural work/ services, cranes and cradles etc,

u. All the loading, unloading cartage, insurance and other incidental charges of any kind on account of transporting material to site / factory shipment etc., all complete as required for the execution of the work.

v. Specified tests, of necessary records, reports, logbook etc. including all certifications and documentation from the contractor/ curtain wall fabricator / specialist agency / manufacturer / suppliers/ processors etc. as specified.

w. Maintenance manuals. Design and performance guarantees in the enclosed formats.

x. Construction monitoring for regular quality control and technical inspection to ensure the work conforms to the approved shop drawings and details (including any modifications made after initial/ mock up testing) and acceptable standards of quality including monitoring the progress of the work.

2.0 STANDARDS

2.1 RELEVANT CODES AND STANDARDS

The Contractor shall, as a minimum, comply with all the relevant regulations and with the current edition of the relevant Standards and Codes. Where conflicts arise between this specification and the code or standard listed below the more stringent requirement shall apply.

Materials and workmanship shall, in general, comply with the latest editions of the following standards as a minimum. The following standards are applicable to the design of the works covered by this specification. This is not an exclusive list and additional standards shall be referenced where required to meet the contract intent, Indian standards shall also be referred as appropriate.

ANSI Z97.1	Safety glazing material used in Buildings
ASTM C 1036	Specification for float glass
ASTM C 1048	Specification for Heat – treated Float Glass
ASTM E 774	Specification for sealed insulating Glass Units
ASTM C 864	Specification for compression Seal Gaskets
ASTM C 1115	Specification for Silicone Rubber Gaskets
ASTM C 920	Specification for Sealants

ASTM C 509	Specification for sealing material
CPSC 16 CFR 1001	Specification for safety glass
GTA Specification No. 89-1-6	Specification for environment durability for heat strengthened spandrel Glass with Applied opacifiers.
BS EN12150 BS EN14179 BS EN12600	Specification for toughened safety glass(Shatter proof) Heat-soak test Pendulum test
BSCP 118	Structural use of Aluminium

2.2 International Standards

In general, the Contractor shall follow either of the latest Indian/ international standards issued by BIS, ASTM, SAA, AAMA, BSS, ISO, & SSIR. The contractor shall state reasons for adopting particular standards / codes. Nothing in this clause shall relieve the contractor of his obligations to provide high standard of quality and workmanship as required.

2.3 Submittal of Codes

All relevant codes proposed to be followed for design, materials, installation and testing etc. shall be procured by the contractor and submitted to the Engineer –in –charge within 2 months of the issue of letter for commencement of work failing which these shall be purchased by the Engineer-in-charge and cost shall be recovered from the contractor.

2.4 Building Regulations

Design of the Fixed Glazing butt to butt joint, perforated metal sheet cladding, Patch fitted door, Glass Canopy, Sandstone Cladding, Aluminium Composite panel Cladding, conventional Curtain wall with butt flat and skylight , toughened safety glass(Shatter proof), sunshade louvers etc shall comply with all Government codes and regulations. The design for dead loads, wind loads, seismic loads, and other loads, shall comply with the requirements of the relevant National Building Code and Indian standard code / international standards, unless specified otherwise.

2.5 Structural Adequacy

- Installation:- Erect panel ,plumb. level and true. Panel shall be erected as per the approved shop drawings if required.
- Specialized Contractors are required to do this kind of job

Any façade system is to be structurally adequate to resist the loads that it will experience over its structural design life. These are considered to be the following:

2.6 Dead Loads

All Systems Are To Support And Transfer Their Own Self Weight And Other Associated Dead Loads To The Main Building Structure. The Contractor Will Be Required To Identify, Design, Co-Ordinate And Supply All Necessary Sub Frames And Secondary Structure

2.7 Live loads

Sunshades with a dimension greater then 600mm: 0.50kp
Canopy and skylights with access only for maintenance: 0.75kpa

Accidental human point load on sunshade and fins: 075kn in any direction
Horizontal barrier loads for walls to all occupied spaces: 0.36kn/m @ +1m Above Floor Finish Level

Large panels forming horizontal surface should be designed for multiple concentrated loads of 2.25 kN concentrated at any critical location.

Component	Material & Grade	Comments and other requirements
Glass	Following should be considered in the absence of any specific glass types noted during tender. Use Annealed –generally Use Head Strengthened (HS), if required to resist thermal stress, impact loads and comply regulations. Use Toughened, it HS is not adequate for strength and impact loads. Use Laminated, if required for safety	All toughened glass to be 100% head soaked. Base float glass (uncoated) to be any one of the following glass manufacturers • Asahi • Glaverbel • Guardian • Saint Gobain • Pilkington High performance coated glass to be any one of the following 1. Glaverbel 2. Saint Gobain 3. Pilkington 4. Viracon All glasses should be sourced form one single source. Glass type and thickness should satisfy respective standards and special conditions as mentioned in the tender.
Toughened safetyglass(Shatter proof)	Thermally toughened safety glass which has increased resistance to mechanical and thermal stresses than conventional annealed glasse.if the glass breaks; it fragments safely into small pieces with dulled edge.	High performance safety glass to be any one of the following 1. Glaverbel 2. Saint Gobain 3. Pilkington All glasses should be sourced form one single source. Glass type and thickness should satisfy respective standards and special conditions as mentioned in the tender.
Laminated glass	PVB laminated	Use PVB from saflex or Dupont Resin laminated shall to be acceptable as an alternate to PVB. Contractor should seek approval to use resin laminated glass.

Vision glass for curtain walls	Double glazing for typical areas single glazing for glass screens Thickness to suit strength	Must satisfy performance requirements toughened glass to be used for fire access panels and laminated inner lite adjacent to floors. Comply with local statutory requirements. Contractor to check for strength.
Spandrel Glass for curtain walls	Single glass –Heat strengthened thickness of glass to suit strength	Contractor to check for strength.
Glass for windows	Single glass- clear HS Thickness of glass to suit strength	
Framing Extrusions	Aluminium grade 6063 T5 or T6 min wall thickness 2.5 mm(struct) 1.5mm (non-struct). For coating refer to specification.	Use of thinner walls acceptable if supported by calculation and demonstration of extrusion quality. Contractor should seek prior approval to select Aluminium extruder. The proposed extruder shall only be acceptable upon review by consultants.
Spandrel air seal (back pan) Alum panels (vertical and part of sunshades)	Alumiium (Minimum thickness 1.6mm) or zicalume (minimum thickness 1.2mm) 4 mm min. solid aluminium or composite panel fire rated with metallic finish.	Thickness to be verified by calculation thickness should be adequate to achieve flat and consistent paint finish. Acceptable Aluminium composite panel brands: alplic, alucobond and Reynobond to be fire resistance (FR) grade PVDF coated

2.8 Wind Loads

The façade is to be designed in accordance with the minimum design pressures as per Indian Standard is 875 and appropriate pressure coefficients to be taken from the codes of practice. Basic wind speed is 47 m/s with terrain category 2, in any case the design with pressure shall not be less than 1.8kpa (including Factor of safety).

Dynamic response to wind effects and associated loads, deflections and vibrations are to be considered for all elements of the façade.

2.9 Maintenance Loads

All trafficable areas including parapet copings shall make allowance for maintenance loadings this will include person loadings, point loads and indirect loads form abseiling ropes.

2.10 Building Maintenance Unit (BMU) Loads

BMU restraint Points: 1.50 kN (in any direction)
BMU impact loads: in accordance with requirements of the equipment supplier.

2.11 Movement Related Loads

Any forces resulting from support structure movements, thermal effects, etc to be accommodated.

2.12 Verification Methods

Acceptable evidence of adequacy may be provided by:

- Calculation
- Testing / demonstration – small prototypes, mock-ups and in-situ testing

Where the calculation will not be adequate to demonstrate the strength then façade contractor should carry out testing as instructed by consultant.

3.0 MATERIALS AND MINIMUM REQUIREMENTS

In addition to meeting the performance standards the following minimum material properties are required

Sealants	Silicone	Acceptable suppliers: dow corning, GE silicones Structural sealants must be clearly identified and suitable material used .
Backing Roads	Open cell	Closed cell accepted upon review of glazing method
Glazing Tapes	Breathable spacer tape	Double sided tape from Norton or 3m
Insulation	50 mm glass fibre insulation min. weight 60 kg/m^3	
Fire Proof	Glass fibre insulation Min. Weight 70 kg/m^3	
Stainless steel elements	Grade 316 linished finish with passivation	Large SS elements to be isolated from aluminium and mild steel frames
Fixings	External (visible) stainless steel grade 316 Inside of air seal: hot-dipped Galvanised steel	
Screws & Bolts	Non-visible: Stainless steel gr 304 Visible grade 3160	
Pop Rivets	Stainless steel with stainless steel mandrel. Stainless steel grade 316 or higher	Aluminium rivets with SS madrels may be accepted providing the design allows for redundancy.
Concrete inserts/ cast –in	Hot –dipped galvanized steel.	
Anchor bolts	Stainless steel for building external (visible or non-visible area)	Acceptable brands are fischer or hilti

	Hot dip galvanized or electro galvanized for internal space i.e. inside airseal	
Brackets (internal space, invisible) Brackets (visible)	Aluminium extrusions or hot dip galvanized mild steel with intermediate coat- Epoxy MIO 125 micom. Stainless steel (Gr. 316)	Systems and corrosion protection to consider finished and construction environment
Flashings	0.8mm (min.) aluinium sheet anodized or chromate	Thickness verified for wind loads
Sub- frames/ support frames (invisible) Panel Fixing brackets	Mild steel gr.43/50 Hot dip galvanized (min75um) in exposed conditions or in contact with envelope. Aluminium 6061 –T6 extrusions SS Gr. 316	Structural steel specifications apply concealed elements. Finish for exposed steelwork to be determined. Min 3.0 mm thk – anodized or chromate Min 1.5 mm thick
Cladding Support frame (runners)	Aluminimum extrusion 6063 – T5 or SS Gr. 316	Min 3.0 mm thk- Hollow sections to be sealed
Backing wall waterproofing	Water resistant render or flexible membrane system	Full submissions, sample and testing to be conducted
Hardwares (handle, stay arms etc.)	Stainless steel	Acceptable brands are Alutec, Giesse, Sobinco and securistyle

4.0 CURTAIN WALL CONTRACTOR'S QUALIFICATIONS:

Work of this section shall be performed by one contractor, who is regularly engaged in the engineering, fabricating, finishing and installation of curtain walls including glazing and sealing of glass, comparable to work on this project. The contractor shall demonstrate to the satisfaction of Architect and Client that the has successfully performed comparable projects over the previous five years.
Subcontracting any part of the work is specifically prohibited, except for that which may be approved by the architect/ Client in writing prior to award of the contract. If approval is granted to subcontract installation and / or glazing, approval is contingent upon the supervision of his subcontractor (s) by the same full time supervisor who coordinates and supervises mock-up work and installation at the project.

5.0 PERFORMANCE GUARNTEE

5.1 The contractor shall be solely responsible for the design including shop drawings and performance of the installed Fixed Glazing butt to butt joint, perforated metal sheet cladding, patch fitted door , glass canopy, sandstone cladding, aluminium composite panel cladding, conventional curtain wall butt flat & cap, skylight, sunshade Louvers etc. the installations shall be guaranteed by the contractor during the guarantee period for materials used, workmanship, water tightness (wherever specified) structural design,

performance requirements and other requirements as given in the specifications. The contractor shall submit in the enclosed format a written guarantee for the same for period of 10 years form the date of completion of the work. In addition, the contractor shall obtain and submit to the engineer-in-charge a similar back- to back guarantee for same duration from the specialist agency engaged by them.

5.1 The design , fabrication, supply and installation of the fixed glazing butt to butt joint, perforated metal sheet cladding, patch fitted door, glass Canopy, sandstone cladding, aluminum composite panel cladding, conventional curtain wall but flat & cap, skylight, sunshade louvers etc. shall be to the best of national / international standards and shall be guaranteed to take the dead loads, wind and seismic loads, storms, air pollution, thermal stresses, building movements and the consequent deflection without compromising the performance characteristics. It shall be water tight wherever specified and prevent ingress of water / moisture , pollutants etc. further, the individual members of the structural framing shall not deflect beyond permissible limits as specified.

5.2 In addition, guarantee for 10 years for all the material used and their performances shall be submitted by the contractor. Besides the contractor shall obtain and submit similar back to back guarantees form the specialist agency and also from the manufacturers / suppliers / processors, as applicable, of various materials to the tune that they conform to the specifications and other criteria as specified herein for:

5.3 Glass (single or IGUs, Ceramic frit glass) substrate, coatings, assembly of IGUs etc.

5.4 Sealants- usage as per requirement of structural design and functional requirements, compatibility with different substrates and sealants, bite size, quality assurance during sealing of IGUs and fixing glass to glass and glass to the aluminium frame, etc.

5.5 EPDM/ silicone gasket –for ozone resistance and other properties as specified etc.

5.6 Aluminium material quality, tem penning requirements, suitability of aluminium grade and anodizing etc.

5.7 Anchor fasteners – suitability and strength requirements as per manufacturers' specifications etc.

5.8 Aluminium composite panel cladding- material quality and PVDF coating etc.

5.9 The contractor shall also submit guarantee in the enclosed format for replacement of glass during the guarantee period of 10 years form the date of completion of work. All the guarantees shall be submitted before final payment is released after the date of the completion of work and shall not in any way limit any other rights, which the engineer-in – charge may have under the contract.

6.0 CONTRACTOR'S RESPONSIBILITY FOR DESIGN

a. Architectural drawings and specifications only indicate the required basic dimensions, profiles and performance criteria..
b. The contractor shall design the Fixed Glazing butt to butt joint, perforated metal sheet cladding, patch fitted door, glass canopy, sandstone cladding, aluminium composite panel cladding, conventional curtain wall with butt flat and cap, skylight, sunshade louvers etc. as per the parameters specified and submit the same for the approval of

the Engineer –in –charge if required, the contractor shall re-design the system based on the directions of the Engineers-in-charge and / or based on the outcome of the mock up test(s) in the laboratory . Nothing extra shall be payable on these accounts.

c. The contractor may, at his own cost, have the option of minor modifications and addition of details and profiles subject to the approval of the Engineer -in –charge provided the architectural concept and performance requirements are achieved.
d. The acceptance by the contractor, of any modifications(s) suggested by the Engineer-in –charge, shall to relieve the contractor form his sole responsibility for the structural design and performance.
e. The contractor shall be solely and fully responsible for proper structural analysis and design for various load cases and their combination, fabrication, supply and installation and its satisfactory performance. This shall include design and proper sizing of all sections, meeting structural and architectural requirements. The anchor assemblies shall meet the performance and design requirements including installation of all inserts, clips, bracing and framework, as required for the proper anchorage to the structure, unless otherwise specified.
f. The approval of the structural design and shop drawings by the Engineer-in –charge shall not relieve the contractor from his responsibility for the structural design.
g. In the end, the contractor shall be solely and fully responsible for design of the Fixed Glazing butt to butt joint, perforated metal sheet cladding, patch fitted door, Glass Canopy, Sandstone Cladding, Aluminium composite panel cladding, conventional curtain wall with butt flat & cap, skylight , sunshade Louvers etc. including providing and installing a stable, safe and completely water tight (wherever specified) Fixed glazing butt to butt joint, perforated metal sheet cladding, patch fitted door, Glass Canopy, Sandstone cladding, Aluminium composite panel cladding conventional curtain wall with butt flat & cap, skylight , sunshade louvers etc pergola with sun-Breaker Louvers etc. which shall perform to the required standards during the guarantee period of 10 years from the date of completion of work . The contractor shall indemnify the Department against all claims, of whatsoever nature, due to defective designing and / or non- performance during the 10 years guarantee period. The provisions of this clause shall not in any way limit the rights of the Engineer-in- charge to take action under other clauses of the contract agreement .

7.0 SHOP DRAWINGS

7.1 Submittals

Within seven days after the issue of letter for commencement of works / letter of intent (LOI), the contractor shall prepare and submit preliminary shop drawings by incorporating necessary modifications to the architectural drawings and within seven days thereafter should submit four (4) copies of all shop drawings to the Engineers- in- charge for review and final approval. Based on the review of the preliminary shop drawings, the Fabricator to order all necessary raw materials such as extrusions, glass, Aluminium Composite panel etc.

The review of the shop drawings by the Engineer-in –charge shall be limited to their conformity to the architectural and structural design concept & specification. However the approval of the shop drawings by the Engineers –in –charge shall not relieve the contractor from any of his responsibilities and requirements as specified herein.
No fabrication shall be taken up until the shop drawings and all other related submittals, documentation, certification, samples and the mock-up for that work have been reviewed and approved by the Engineers –in charge.

On approval by the Engineer-in –charge, the contractor shall submit four (4) sets of the approved shop drawings to the Engineer –in –charge within two (2) weeks thereafter. After the completion of work, two (2) sets and two (2) CD's each of the as built drawings incorporating final approved shop drawings incorporating all the approved modifications, if any, as per the site requirements, shall be submitted to the Engineer-in-charge within fifteen days from the date of completion of work.

7.2 Scope of Shop Drawings

Shop drawings shall incorporate scaled and dimensioned plans, elevations, section and complete size details for all the woks including site survey as carried out.
The shop drawings shall indicated the required dimensional profiles and modules, function design and performance standards and in general cover all dimensional and details required fabricating and installing the curtain wall at site.

The contractor shall verify and co-ordinate the shop drawings with all applicable and inter-related trades, drawings and specifications.

All dimensions/ modules, etc, shall be field checked and the drawings shall be modified, if required based on actual measurements at site.

Details shall show and specify all metal sections, types of finishes, areas to be sealed and sealant materials gaskets, applicable construction materials including fasteners and welds, all anchorage assemblies and components, fabrication and reaction tolerances for the work.

All details shall be subject to the approval of the Engineer-in-charge, after incorporating all the modifications as suggested by the Engineer-in-charge or otherwise.

All dimensions / modules, etc, shall be field checked and the drawing shall be modified, if required, based on actual measurements at site.
Details shall show and specify all metal sections, types of finishes, areas to be sealed and sealant materials, gaskets, applicable construction materials including fasteners and welds, all anchorage assemblies and components, fabrication and erection tolerances for the work.

All details shall be subject to the approval of the Engineer-in-change, after incorporating all the modifications as suggested by the Engineer-in-change or otherwise.

7.3 Section Profiles

Profile adjustments, if required as per the site conditions may be allowed by the Engineer-in-change subject to meeting the architectural / performance requirements. However, this shall be carried out only with the approval of the Engineer-in-charge Provided that the general design and intent of the drawings and specifications are also maintained. Also, if any new / non-standard aluminium extruded section is required as per the site requirement and /or the architectural drawings for the structural, functional and / or aesthetic reasons, the contractor shall procure the same from the approved manufacturers for the aluminium sections, even if it entails preparing new die, etc. Nothing extra shall be payable to the contractor on this account.

8.0 STRUCTURAL DESIGN AND CALCULATIONS

A The contractor / specialist agency shall employ a competent curtain wall design engineer to design the system and its components for Fixed Glazing butt to butt joint, Perforated mental sheet cladding, Patch fitted door, Glass Canopy, Sandstone Cladding, Aluminium Composite Panel Cladding, Conventional curtain wall with butt flat & Cap, Skylight, Sunshade Louvers etc. The design engineer shall have fich past experience of successfully designing and detailing of similar system installed for at least three prestigious projects during last five calendar years.

B During the design stage, the contractor shall interact actively with the Engineer-in-charge, concerning all aspects of design and detailing and shall obtain the relevant information on architectural and structural design parameters concerning the structure, probable deflections and other building movements etc.

C The design shall account for all design considerations, codal provisions, possible loads & building movements as well as the movements within and relative movements etc. The Contractor shall obtain the approval of the Engineer-in-charge for the provisions made in his design in this regard.

D The Contractor shall submit his detailed structural analysis and design calculations for the system and cach of its typical and non-typical components along with the shop drawing for the approval of the Engineer-in-charge. Also, the contractor shall guarantee that his design ensures the structural stability, safety, integrity and required performances against all natural forces, superimposed loads, building movements and environmental effects, as specified and as called for under various codal provisions. The contractor shall also get the structural design checked and the shop drawing vetted from the Principals of the curtain wall system.

E The Contractor shall modify his design as required by the Engineer-in-charge for meeting the various provisions as specified and resubmit the same for the approval till the design is finally approved. Nothing extra shall be payable on this account.

F The Grade of R.C.C. in the building structure is as specified in DESIGN DATA. The Contractor shall design anchorages (capacity and numbers of the anchor fasteners) for this grade of concrete.

G The contractor shall submit for record only the glass manufacturer's wind pressure analysis and thermal analysis showing that the specified maximum deflection and probabilities of breakage are not exceeded.

9.0 DOCUMENTATION AND CERTIFICATION

The contractor shall obtain and submit to the Engineer-in-charge the manufacture's certificate for compliance of the various parameters for the various components to be used in the work (under this sub head) as per the manufacturer's specifications. A copy of the manufacturer's test report, for each lot of material procured and supplied for the work shall also be obtained from the respective manufacturers and submitted to the Engineer-in-charge for the record.

9.1 Glass and Glazing Documentation

a. Before taking up the work, the glass manufacturer / processor shall submit written certification for the review of the Engineer-in-charge and record, stating that all glass (properties as specified such as U value, shading coefficient, light transmission, light reflection (internal as well as external), solar factor, relative heat gain etc.) and glazing requirements (including heat strengthening / toughening, fabrication of IGUs including

sealants etc.) as per the shop drawings are recommended by them for use related to their specific applications and design parameters and that they are in conformity with the specifications.

b. Tests shall be carried out for glass, including properties after processing, for each lot supplied, by the glass manufacturer / processor in his factory / laboratory or any other accredited international laboratory at his own cost and the copies of the test results shall be obtained by the contractor and submitted to the Engineer-in-charge for the record.

9.2 Sealant Documentation

a. All sealant applications must be clearly designated on shop drawings. Before taking up the work, a master sealant schedule shall be prepared and submitted to the Engineer-in-charge specifying materials, special instructions and application procedures.

b. The sealant manufacturer shall certify that all sealant requirements as detailed and specified on the shop drawings have been reviewed and approved for use related to their specific applications and / or design intent, compatibility to adjacent materials and in conformity with specifications including size of the structural silicone bite for tensile and shear requirements and for silicone sealant and its compatibility with adjacent materials shall also be certified by the sealant manufacturer. The sealant manufacturer shall also certify against streaking of the silicone. The contractor shall obtain certificate from the sealant manufacturer for the performance requirements of the sealant during the 10 years guarantee period from the date of completion of work and submit the same to the Engineer-in-charge for records.

c. The sealant manufacturer shall certify that the Contractor / specialist agency / curtain wall fabricator / glass processor has followed all application and quality assurance procedures recommended by them for fabrication and installation of panels including cleaning, curing sealant storage, application at a controlled temperature and clean dust free environment as per the relevant specifications. The sealant manufacturer shall also carryout field and laboratory tests on the samples of the sealants being used and collected from the factory / workshop of the Contractor / specialist agency / glass processor like butterfly test and snap-time tests on pump start –up, peel and pull adhesion tests by deglazing, compatibility test, water immersion test, UV chamber test, weather meter test, etc., as specified and submit the copies of the test reports to the Engineer-in—charge for records.

d. The deglazing tests for sealant adhesion on the working glazed panels shall be performed by the sealant manufacturer / supplier who shall certify the test results and the quality assurance of the same.

e. The contractor shall maintain a log book indicating the details of glass panel number, batch number of silicone sealants and the solvents including its shelf life and the name of the operator who fabricated the particular panel which shall be reviewed periodically and countersigned by the sealant manufacturer who shall also carry out deglazing test on the working panels, as specified and prepare deglazing summary report. The logbook and the deglazing summary report, duly authenticated by the sealant manufacturer, shall handed over to the Engineer-in-charge, for record, after the completion of the work. This logbook and the deglazing reports shall also be available for the review by the Engineer-in-charge during the execution of the work.

9.2 Aluminum Composite Panel Cladding Documentation

Before taking up the work, the Aluminum Composite Panel manufacturer shall submi9t written certification for the review of the Engineer-in-charge and record, stating all the quality parameters and other characteristics for the material for the use related to their specific application and design parameter and that, they are in conformity with the specifications. The test shall be carried out for the PCDF / lumiflon-based fluoropolymer resin coating to the Aluminum Composite Panel Cladding material, for each lot supplied, by the manufacturer in his factory / laboratory or any other accredited international laboratory at his own cost and the copies of the test results shall be obtained by the contractor and submitted to the Engineer-in-charge for the record.

9.2.1 Quality Control Documentation

a. The contractor shall submit the methodology and quality assurance statement for in-plant and job site quality control procedures for the review and approval of the Engineer-in-charge before taking up the work to ensure the design integrity and performance of the curtain wall with Fixed Glazing butt to butt joint, Perforated matel sheet cladding, Patch fitted door, Glass canopy, Sandstone Cladding, Aluminum Composite Panel Cladding, Conventional curtain wall with butt flat & Cap, Skylight, Sunshade Louvers etc.

b. Documentation shall include schedules, details and / or schematic explanatory sketches cross-referenced to the shop drawings, data sheets, etc., all as required to assess methods and materials and to ensure that both the fabrication and quality assurance procedures.

c. The Engineer-in-charge or his authorized representatives may, time to time, visit the plant / workshop / factory to inspect material, fabrication and quality assurance procedures.

i) The in-plant quality control procedures shall include but not be limited to the following items:

- Material : Visual inspection and other field tests.
- Fabrication : Tolerances, Joinery, Sleeves, screws, cleats, etc.
- Finish Match : Approved finished and controls required for matching the exposed surfaces.
- Assembly : Welds, fasteners, sealants, gaskets, separators, setting blocks,
- Glazing, structural silicone bite.
- Protection : Handling, protection, shipping

ii) The job site quality control procedures shall include, but not necessarily be limited to the following items:

- Anchorage : Lines, grades and related tolerances.
- Installation : Setting-out, tolerances, finish match, connections, Sleeves, flashing, welds, fasteners, sealants, bolt Tensioning.
- Sealing : As recommended by the respective manufacturer.
- Storage : As recommended by the respective manufacturer(s) / processor(s).
- Protection & : As recommended by the respective material Cleaning manufacturer(s) / processor(s).

10.0 SAMPLES AND MOCK-UP AT SITE

10.1 Submittals

The samples of the following materials together with detailed technical data / catalogues shall be submitted in triplicate for review of the Engineer-in-charge and approval along with the shop drawings. Any omission of an item or items which require the compliance of the contractor shall not relieve him from responsibility.

a) Aluminum Composite Panel : Each type and thickness 600 mm x 600 mm

b) Aluminum extrusions: Each section: 500mm long

c) Glass : each type 600mm x 600mm.

Gaskets, separators, glass setting blocks, double sided spacer tape, backer rods etc: Each section or unit, 300mm long or unit.

Brackets of each type (material), anchor fasteners and connecting devices: Each type and size.

Finish samples: After approval of the final finish coating, the Engineer-in-charge shall be provided with three (3) approved samples.

Window and door ironmongery and accessories, as applicable.

Finished flashing samples.

Finished samples of shadow boxes, fire stop (barrier)-cum smoke seals

Structural and weather silicone sealant

In addition to the above, the contractor shall also submit one sample of the assembly of various components forming a typical fixing detail of curtain glazing, composite panel Cladding, structurally glazed aluminum window.

10.2 Mock-up at site

Before the fabrication and site installation is taken up and within Seven (7) days after the approval of shop drawings by the Engineer-in-charge, the Contractor shall prepare mock-ups of the proposed curtain wall and fix it on the building. The width of the mock up for curtain glazing (including one openable panel) shall be not less than three typical adjoining wall panels / units. The height of the mock up test sample of curtain glazing shall be not less than 1 storey high and must contain full height modules. The mock up shall also incorporate all types of in fill panels, fire stop / barrier-cum-smoke seal, flashings, shadowbox, bracketry, hardware and fixtures etc. A typical mock up shall also be put up for the aluminum windows including fittings and the other hardwares. The mock ups shall be essentially put up at site for final approval of all materials and installation details by the Engineer-in-charge. The mock up shall not form part of the work and shall not be paid for separately. It shall be dismantled and taken away by the contractor at this own cost, with the prior permission of the Engineer-in-charge. Nothing extra shall be payable on this account.

10.3 Maintenance Manual

After the completion of the work, the contractor shall submit two (2) copies each, of detailed procedures for the periodic inspection, maintenance and cleaning of all the Fixed Glazing butt to butt joint, Perforated metal sheet cladding, Patch fitted door, Glass Canopy, Sandstone cladding, Aluminum Composite Panel Cladding, Conventional Curtain wall with butt flat & Cap, Skylight, Sunshade Louvers etc to the Engineer-in-charge.

11.0 WORK SCHEDULE

Immediately after award of work, the Contractor shall submit the final programmed micro work schedule/Bar chart for the completion of whole of the work under this sub-head Fixed Glazing butt joint, Perforated metal sheet cladding, Patch fitted door, Glass Canopy, Sandstone Cladding, Aluminum Composite Panel Cladding, Conventional Curtain wall with butt flat & Cap, Skylight, Sunshade Louvers etc including submittals, mock up test at site as well as in the approved laboratory (optional), approvals, fabrication, supply of materials at site & installation etc.

12.0 STORAGE, PROTECTION AND PROGRAMME

a. The contractor shall submit a schedule of procedure for inspection during installation so as to control and assure quality on the job site.

b. The Contractor shall submit a detailed method statement for the protection of the surface of the Fixed Glazing butt to butt joint, Perforated metal sheet cladding, Patch fitted door, Glass Canopy, Sandstone Cladding, Aluminum Composite Panel Cladding, Conventional Curtain wall with butt flat & Cap, Skylight, Sunshade Louvers etc during delivery and erection, with description as to when the protection can be removed. The protection paper shall not be kept for more than 45 days and shall be replaced with the fresh protection paper. Further, it shall not have acid content, which in any manner may affect the substrate.

c. The Contractor shall submit fortnightly reports on supplying, fabrication and installation as directed by the Engineer-in-charge.

d. Delivery and Storage of Materials: All materials delivered to site shall be stored in allocated spaces where the stored materials shall not get exposed to rainwater moisture or damage, and shall permit easy access to and handling of the materials. Materials shall be stored neatly and properly stacked.

   i. Factory made Aluminum composite panel Cladding / glazing units and / or their components shall be transported, handled and stored in a manner to preclude damage of any nature.

   II. Accessory materials, required for erection at the site shall be delivered in labeled containers by the Manufacturer / supplier.

   III. All units or components, which are cracked, bent, chipped, scratched or otherwise defective and unsuitable for installation shall be removed and replaced by the contractor. Nothing extra shall be Payable on this account.

R. METAL ROOFING

1.0 PART 1 – GENERAL

1.1 WORK INCLUDED

This Section specifies the requirements necessary for the supply and installation of the metal roofing system including rain water gutter.

1.2 RELATED WORK

This Section shall be used in conjunction with, but not necessarily limited to, the other relevant specifications, the Drawings and the Contract Documents to establish the total requirements for the metal decking.

CAUTION: Using this Section without including the above mention will result in omission of basic requirements.

In accordance with the General Conditions of Contract, the aforesaid documents shall be taken as mutually explanatory, and any ambiguities or discrepancies shall be resolved by the Purchaser, who shall then instruct the Contractor thereon. In the event of conflict regarding the metal decking requirements between this Section and any other document, the more stringent requirement shall apply unless specifically instructed by the Purchaser in writing otherwise.

1.3 DESIGN CRITERIA

The metal roofing system shall be in accordance to architectural requirement. The system shall be so designed to meet the specified performances for the prevailing local weather conditions and local Authority requirements.

1.4 QUALITY ASSURANCE

Materials used in the works shall be of best qualities and kinds specified herein and equal to approve sample. Delivery shall be made sufficiently in advance to enable samples to be taken and tested if required. No materials shall be used until and unless approved by the Purchaser/ Architect. Materials not approved shall be immediately removed from the work site at the Contractor's expense.

The Contractor is to examine and satisfy himself of other related-trades condition on site under which, the metal roof is to be installed. Do not proceed until unsatisfactory conditions have been rectified. The Contractor shall be responsible for any additional cost incurred and compensate the owner due to above reason.

1.5 WARRANTY

1.6

a) The Contractor shall provide a warranty for the completed work against any defects of materials and workmanship, which comprise a water-tightness for the roof.

b) Warranty shall be for a period of 20 years and shall begin following Date of Substantial Completion of the project.

c) Warranty shall include all labour and material necessary to complete required

activities and repairs, including joint scaling, penetration seals, bolts, and anchoring and grounding details.

1.6 SUBMITTALS

1.6.1 SAMPLES

The contractor shall submit the following to the Purchaser / Architect for approval before any work in this trade commences on site:

a) Sample of Metal Roofing System panel system;

b) Sample of fixing system elements.
(In compliance with the rules and requirements of the local authorities and to comply with FM guidelines for I-90 wind uplift).

1.6.2 SHOP DRAWINGS

The Contractor is to submit a design recommendation to the Purchaser/ Architect with the preliminary shop drawings showing fabrication and installation of the works including relevant information about the selected elements.

The shop drawings shall provide details including cuts, connections, and holes. The drawings shall show the size, length and type of each member, details for accessories, and method of assembly.

The Contractor shall submit to the Purchaser/ Architect with the final shop drawings for approval. Once approved, the typical installation details shall be fabricated strictly in accordance with the shop drawings.

After preliminary submission, all shop drawings shall be computer generated, AutoCad-2007 file.

During construction, the Contractor shall keep accurate records of the contract works, “as built”, on AutoCad-2007 construction drawings and details.

Prior to the issue of the Final Acceptance Certificate, the Contractor shall hand over to the Purchaser transparencies and AutoCad-2007 files of all as-built drawings, all Professional Engineer’s certificates, and all other documents related to the Contract work, which will be required for the application for Temporary Occupation Permit.

1.6.3 PROFESSIONAL ENGINEER’S CERTIFICATE:

The design, fabrication and installation of the metal roof system shall be certified by the Contractor’s Professional Engineer are safe and the systems are in comply with the manufacturer’s requirements and the rules and requirements of the local authorities.

1.6.4 QUALITY ASSURANCE DOCUMENT

Materials used in the works shall be of best qualities and kinds specified herein and equal to approve sample. Delivery shall be made sufficiently in advance to enable samples to be taken and tested if required. No materials shall be used until and unless approved by Purchaser/ Architect. Materials not approved shall be immediately removed from the work site at the Contractor’s expense.

Materials shall be transported, handled and stored on site or elsewhere in such a manner as to prevent damage, deterioration or contamination all to the satisfaction of the Purchaser/ Architect. The Purchaser/ Architect reserve the right to inspect any materials to be used on the works at any time and at any place of storage.

Unless otherwise specified or otherwise agreed by the Purchaser/ Architect, materials shall comply with the appropriate Standards, In compliance with the rules and requirements of the local authorities and to comply to FM guidelines for I-90 wind uplift with preference for materials of local manufacture. Where the requirements of the relevant standards are in conflict with this Specification then this Specification shall take precedence accordingly.

1.6.5 DELIVERY AND WORK SCHEDULE

The contractor shall submit a proposed delivery and installation work schedule for approval.

2.0 PART 2 - PRODUCTS

2.1 MATERIALS

2.1.1 METAL ROOFS

The metal roof has to comply with the authorities requirements in force in Tamil Nadu and has to be durable with particular attention to the following critical factors:

- Effects of atmospheric corrosion typical to the area.
- Electrolytic corrosion where dissimilar metals are used in contact.

a) The metal roof shall comprise of components that result in a “Klip Lock” type Metal Roofing System with insulation and complete with all accessories and installed at centres in accordance with the manufacturer’s instructions.

b) The metal roof material shall be 0.60 mm (BMT) in Hi Tensile (min tensile strength 550 Mpa) with a standard Z275 underside galvanised coating in accordance with ASTM A 525 G90 and Polyester Powder Coated on top side.

c) Contractor to provide a direct twenty (20) year’s guarantee against any failure of the roofs system in particular water-leakage.

2.2 METAL ROOFING

2.2.1 Supply and Fixing Single Skin Insulated Roofing System Complete Comprising Of

PROFILED STEEL ROOFING SHEETS

The Hi Tensile steel “Klip Lock” roof panel is designed for quick installation and easy handling. It is Hi Tensile galvanised steel sheet and is lightweight, trapezoidal ribbed. It has bold, widely spaced ribs and is available in long length, governed only by local transport considerations. The Contractor shall check whether the design for the roof and comply with the Manufacturer’s specification before the actual installation of the structure.

The Contractor’s Professional Engineer shall provide the metal roof structural plans and fastening details, supported by design calculations accordingly. The design shall satisfy

the Performance Requirements for its intended use and that include withstanding wind load, Air and weather tightness. The Contractor's Professional Engineer shall submit a **Certificate of Supervision** not later than two (2) weeks after completion of the works, stating that he has carried out such supervision works and is fully satisfied that the works have been constructed with such structural plans and fastening details.

The accessories such as capping, fascia capping, valley gutter, longitudinal and transverse parapet flashing cap flashing and corner moulds and others shall be shown in the drawings where applicable.

EXTERIOR SHEET: Kliplock Sheets of 500 mm cover width with 47 mm crest height at 250 mm centres and made out of 300 Mpa - yield stress, 0.6 mm TCT Galvalume Steel, 150 gsm Zinc – Aluminium alloy (as per ASTM : A 792) coating with 20 microns polyester coating.

CORE INSULATION MATERIAL: Bonded Rockwool Blankets as per IS : 8183 100 mm thickness (in 2 layers) with Aluminium Foil on one side and with flaps for over lapping at the joint locations.

VAPOUR BARRIER: Providing and fixing SIL / Polynum refective Vapour Barrier of Supreme Industries Ltd,. / Polyon Barkai Industries between exterior sheet & Insulation.

WELD MESH: Galvanised weld mesh of Size: 75 mm x 75 mm x 2 mm (120 gsm / Sqm Zinc coating mass) provided over the purlins.

FIXING PROCEDURE: The kliplock sheet shall be fixed to the purlins with special clips made out of 1.6 mm thick GI Steel with 120 gsm Zinc coating. The clips shall be fixed to the purlins with 10 – 16 x 25 mm self drilling wafer head fasteners as per manufacturer's specification and drawing.

The Kliplock sheets shall be site rolled and shall be in single length from roof ridge to eve or eve to ridge. Kliplock sheets shall be provided with suitable end closures made out of Closed cell polyethylene foam at the ridge locations. The insulated Roofing shall be complete with all accessories like ridge cappings, flashings at eve locations and barge locations and wherever necessary.

HANDLING AND STORAGE: To preserve the surface, handling should only be carried out using clean, dry, gloves. Do not slide sheets over rough surfaces or each other. Packs of the claddings in all finishes must be kept dry in transit, and stored clear off the ground under cover to prevent water and / or condensation being trapped between adjacent surfaces.

2.2.2 Supply & Fixing Of Pre-Fabricated Rockwool Sandwich Panels For Roofing Comprising Of

A Interior sheet : Plain sheets with slight ribs, with 1000 mm cover width, made out of 0.5 mm TCT, 300 Mpa – yield stress, Galvalume Steel with150 gsm Zinc – Aluminium alloy (as per ASTM : A 792) coating with 20 microns polyester coating.

B Core Insulation Material : High density Rockwool 100 kg/cu.m density converted to Lamellar in 80 mm thick and bonded to steel sheets with Industrial Grade Adhesive.

C Exterior sheet : profiled sheets with 1000 mm cover width, 35 mm crest height at 333 mm centre, made out of 0.5 mm TCT, 300 Mpa – yield strength, Galvalume Steel, 150 gsm Zinc-Aluminium alloy (as per ASTM : A 792) coating with 20 microns polyester coating.

D Panel shall be supplied in 1 m width and in single length upto 12 m without any joints depending on site requirements.

E Fixing Procedure : The panel shall be fixed on to the purlins with self drilling fasteners and with necessary overlap as per manufacturer's specification. The Insulated Roofing shall be complete with all accessories like capping, flashings wherever necessary

2.2.3 Accessories

A Cappings, Flashings and Trims: Cappings, Flashings and Trims shall be made out of 0.7 mm TCT, 550 Mpa – yield stress, Galvalume Steel, 150 gsm, Zinc-Aluminium Alloy (as per ASTM : A 792) coating and with 20 microns of Polyster coating.

Cappings, Flashings and Trims may be formed to required shape and profile based on shop drawings in 2.5 m lengths of profile of external / internal sheet except where metal crapped foam fillers are used.

Fixing: Cappings, Flashings and Trims shall be screwed to the external / internal sheeting with colour matched nylon head self drilling stitching fasteners at max. 500 mm centres along the length of the capping / flashing shall be installed at 90°C to the material being fastened.

All longitudinal joints in cappings and flashings shall be overlapped a minimum of 50 mm and sealed with a continuous run of sealant.

B Fixing Accessories:

12 – 14 x 125 Galvanised head self drilling screws with integral washers shall be used for fastening Pre-fabricated Sandwich Panels for Roofing.

12 – 14 x 90 Galvanised head self drilling screws with integral washers shall be used for fastening Pre-fabricated sandwich Panels for Wall Cladding.

12 – 14 x 55 Galvanised head self drilling screws with integral washers shall be used for Partition Sheets and fastening Double Skin Insulated Cladding.

10 -16 x 16 hexagonal head stitch fasteners shall be provided on side laps at 900 mm centers maximum.

The fasteners shall generally confirm to ASTM A 3566 and shall be Hilti / Corroshield make.

C Profiled Foam Fillers:

Profiled foam fillers shall be provided wherever required to close the voids between cappings and the troughs of the external sheet so as to provide a weather tight exterior. These shall be made out of closed cell Polyethylene Foam die cut in profile to match external sheeting.

D Gutters, down-spouts and down-takes:

Gutters shall be provided wherever shown on the drawings, Gutters shall be fabricated and brake-formed from 3.15 mm Cold Rolled Steel conforming to IS 513.

For reinforcing gutters 38mm x 38mm x 3 mm angle shall be provided at 1000 mm c/c and support bottom of gutters to structural steel at 1000 mm c/c. longitudinal joints in

gutter shall be continuously welded. The gutter surfaces shall be cleaned, and provided with 2 mm thick FRP coating. The mouth of each downtake pipe in the gutter shall be provide with a weldmesh screen with mesh size of 6 mm x 6 mm.

E Down spouts:

Down spouts will be either 200 mm dia or 300 mm dia UPVC pipes, as indicated in the drawings. Pipes shall have joints sealed and shall be laid plumb or to horizontal slope as indicated in drawings. Pipes shall be clamped to the columns / cladding runners by means M S clamps bent to shape and fixed by colour matched self drilling screws.

F Roof Openings:

Roof Openings with curbs shall be located at the place of openings. Wherever such framed openings are to be provided, the contractor shall provide flashing around such framed openings or curbs. Flashings around such openings shall be formed of same material as flashings. The flashing shall normally be with a flat sheet of size adequate to overlap the roof sheeting all around the opening by at least 200 mm. This flat sheet flashing shall be sealed to roof sheeting at transverse laps with foam fillers and at side laps with continuous runs of sealant.

Where required, curbs shall be fabricated from 14 G (2 mm) pre painted steel and flashed around the opening. All curbs shall be min. 300 mm high and shall feature a 50 mm wide MS angle flange around the top of the curb and a sloped drainage surround. Contractor shall furnish details of curb construction for approval prior to commencement of work. All structural loads will be supported by structural framing in roof by others. Such framed openings may be provided-while the roof sheeting is being installed or subsequent to the roof sheeting installation.

3.0 PART 3 -- EXECUTION

3.1 INSTALLATION

3.1.1 INSPECTION & PREPARATION

Verify all field coordination and examine the substrates before start of installation. Beginning of installation means acceptance of the existing conditions. Do not install roofing sheets that are observed to be warped, bowed, deformed or damaged to such extent as to impair strength or appearance.

3.1.2 FASTENING METHOD

See in item 2.2 above. The panels shall be fixed to the purlin supports with a minimum of 4 fasteners per panel (i.e.: one fastener at every alternative valley). All stainless steel self tapping fasteners shall attach with EPDM washer for metal deck fastening. All sheeting shall be fixed in a workman like manner, leaving the job clean. All debris (nuts, screws, cuttings, filings etc.) shall be cleaned off daily.
The Contractor shall be responsible for supplying the following information to the Purchaser / Architect and obtain his approval prior to commencing work.

a) Detail to scale showing all relevant information in connection with roof sheeting such as falls, sumps, expansion joints, pipe penetration roofs, etc.

It shall be the responsibility of the Contractor to inspect all roof construction prior to the laying of roofing including checking work by others connected with roof coverings such as

cover flashing, etc. All labour employed on roofing shall be skilled roofing labour. A section of roof shall be laid as prototype for final approval of the Purchaser/Architect of materials and method of fixing before the main work is put in hand. This shall involve showing all detailed fixings as required for the whole of the roofing.

3.1.3 END LAPS

Should the end laps occur and necessary to use two or more shorter sheet to provide full length coverage, the locking ribs of the “Klip Lock” Hi Tensile steel Roofing System shall have sufficiently flexibility to enable it to be end lapped.

3.2 TESTS

The Purchaser / Architect reserves the right to take samples of roofing materials or accessories delivered or used at the work and subjects them to chemical or physical tests to determine if they have comply with specifications. If they do not comply, the materials shall be rejected and any materials that have been built shall be taken out and removed from the site immediately. Any replacement of proper materials in compliance with the specification shall at Contractor’s expense.

3.3 GUARANTEE OF WATERTIGHTNESS

The Contractor shall lodge with the Purchaser / Architect a 20-years guarantee against any defects in the workmanship, quality of materials, installation, water- tightness or deterioration in the works. Under this guarantee, the Contractor will be required to make good any defects and will be responsible for any consequential loss directly attributable to any leakage during the warranty period.

If, in the opinion of the Contractor, the foregoing Specifications are insufficient for him to give the Guarantee then he shall allow for upgrading as he shall deem necessary to enable him to do so guarantee.

3.4 CLEANING

On completion, clean down all roofs, including underside of metal decking, remove all debris, loose nails, mortar droppings, paint drips, clean out gutters and outlets and test all roofing and down pipes and leave the whole roofing and rainwater disposal system clean and water-tight to the complete satisfaction of the Purchaser / Architect.

Ensure that metallic particles are swept off sheet surfaces immediately following any cutting, drilling.

S. LOUVERS

PART 1 -- GENERAL

1.1 WORK INCLUDED

This Section specifies the requirements necessary to supply and install metal wall louvers, complete with frames, sealant, bird and insect screens, and blank-out panels.

1.2 RELATED WORK

A. This Section shall be used in conjunction with, but not necessarily limited to, the other relevant specifications, the Drawings, the Schedules, and the Contract Documents to establish the total requirements for metal louvers.

B. CAUTION: Using this Section without including the above-listed items will result in omission of basic requirements.

C. In accordance with the General Conditions of Contract, the aforesaid documents shall be taken as mutually explanatory, and any ambiguities or discrepancies shall be resolved by the Purchaser, who shall then instruct the Contractor thereon. In the event of conflict regarding metal louver requirements between this Section and any other document, the more stringent requirement shall apply unless specifically instructed by the Purchaser in writing otherwise.

1.3 DESIGN CRITERIA

A. General

Install louvers to permit passage of air at required velocity, without blade vibration or noise, without exceeding the maximum permissible static pressure loss. The Contractor shall provide written support material with respect to system performance with respect to, airflow performance, rain defense performance, and structural loading under design conditions of the building. Comply with AMCA and BSRIA test requirements.

B. References

1. AMCA 500 (Air Movement Control Association) – Test Method for Louvers, Dampers, and Shutters.
2. BSRIA (Building Services and Research Information Association) – Test Method for Determining Louver Effectiveness.

C. Airflow Design Requirements

1. Maximum Permissible Pressure Drop: 50 Pa at 2.5 m/s face velocity

D. Rain Defense Performance Requirements

The Contractor shall submit certified test data to the requirements contained in the 4th edition of HEVAC Technical Specification - Laboratory testing of weather louvers when subjected to simulated rain, based on a 1m x 1m unit tested at rain fall rate of 75mm/hr and with wind directed at louver face of velocity of 13m/s.

Test data will show the following:

1. Single-Bank Louvers: The louver system shall achieve a 'C' rating providing proof of a rain performance effectiveness of between 80.0% to 94.9% for airflow velocity between 0 m/s to 3 m/s (ventilation rate of 0 to 3 m3/s/m2) and a maximum allowed penetration of simulated rain of 15.0 litre/hr/m2.

2. Double-Bank Louvers: The louver system shall achieve a 'B' rating providing proof of a rain performance effectiveness of between 95.0% to 98.9% for airflow velocity between 0 m/s to 3 m/s (ventilation rate of 0 to 3 m3/s/m2) and a maximum allowed penetration of simulated rain of 3.75 litre/hr/m2.

E. Structural Requirements

1. Wind Load Requirements: In accordance with requirements of applicable building code.

F. Appearance Requirements

1. Louvers shall match in appearance, configuration, profile and elevation with the louvers in the approved samples.

G. The Contractor shall provide factory pre-assembled louver units, and take into consideration the necessity of fixing the louver units to the sub-surface structure from outside the wall.

H. Where louvers are operable, they shall be equipped with a fixed frame.

I. Where louver doors are incorporated in louver units, they shall be concealed frame louver doors.

J. The work in this Section shall include the design, supply, installation, completion and maintenance of all metal louver systems, including metal louvers used as wall/screen cladding systems.

K. The work in this Section shall include all accessories, parapet cappings, end cappings, soffit trims, reveal linings, jamb linings, sills, and the like, which may not be expressly indicated on the drawings, but which are necessary to provide a total wall/screen cladding systems package, which interfaces in a complete manner with the adjacent building surfaces.

L. The proposed wall/screen cladding systems shall include all required sealant systems, fixing systems, anchorage systems, and framing systems.

M. The Contractor shall provide all additional structural support systems, which are required for the proposed wall/screen cladding systems, but not already provided under a separate contract, in the building structural works.

N. A set of "Only For Reference" structural works drawings form part of the Contract Documents. The Contractor will be deemed to have acquainted himself with the contents of these drawings and shall include in his tender any costs in respect to additional structural support systems which are not shown on these drawings, but

which are required for the proposed wall/screen cladding systems. No consideration will be granted to any misinterpretation or unforeseen difficulties for which provision has not been made in the tender and this will in no way relieve the Contractor from the full execution of the Contract.

O. The Contractor shall note that the structural columns of the building superstructure are constructed of concrete, with no provision for cast-in components for the anchorage systems of the proposed wall/screen cladding systems. Some structural beams are of post-tensioned concrete construction, requiring special coordination of the cladding anchorage systems.

P. Any cast-in anchorage components, which are required, shall be provided by and placed in position by the Contractor, ready for casting of concrete. Provide shop drawings of proposed anchorage systems.

1.4 QUALITY ASSURANCE

Performance Requirements: Where louvers are indicated to comply with specific performance requirements, provide units whose performance ratings have been determined in compliance with Air Movement and Control Association (AMCA) Standard 500.

AMCA Certification: Where indicated, provide louvers with AMCA Certified Ratings Seal evidencing that product complies with above requirements.

Field Measurements: Verify size, location and placement of louver units prior to fabrication, wherever possible

Shop Assembly: Coordinate field measurements and shop drawings with fabrication and shop assembly to minimize field adjustments, splicing, mechanical joints and field assembly of units. Pre-assemble units in shop to greatest extent possible and disassemble as necessary for shipping and handling limitations. Clearly mark units for re-assembly and coordinated installation.

All the elements shall be determined with due consideration to the India Standard Codes of Practice.

The Contractor is responsible for the calculation of the maximum admissible panel span.

The manufacturer of the louvers shall be a company with minimum 10 years experience in supply and installation of AMCA-certified and BSRIA-certified louvers. All aluminum alloy components shall comply with BS 1470.

1.5 SUBMITTALS

A. Provide the following with the bid:

1. Product Data
2. Proposed Work Programme
3. Method Statement

B. Preliminary Shop Drawings: The Contractor shall submit with his bid design recommendations with preliminary shop drawings showing fabrication and

installation of the works including relevant information and physical properties of the selected elements.

Notwithstanding the acceptance of the design recommendation by the Purchaser, the Contractor shall remain solely responsible for the adequacy of all the works and shall make good any damages arising from any inadequate design or provision.

C. Product Data: Submit manufacturer's specifications; certified test data, where applicable; and installation instructions for required products, including finishes and materials.

D. Samples: Submit samples not less than 300 x 300mm in size illustrating finishes and materials, and colour of exterior and interior surfaces.

E. Manufacturer's certificate: Submit manufacturer's certification that products meet or exceed specified requirements.

F. Shop Drawings: Submit shop drawings for fabrication and erection of louver units and accessories. Include plans, elevations and details of sections and connections to adjoining work. Indicate materials, finishes, fasteners, joints, trims and other information to determine compliance with specified requirements.

After preliminary submission, all shop drawings shall be computer generated, on Autocad-2008 files. Shop drawings, product data, and samples shall be submitted to the Purchaser for review and approval, before ordering materials and commencing fabrication.

G. Proposed Work Programme: Submit a work programme for approval by the Purchaser.

H. Method Statement for Site Installation and Quality Control: The Contractor shall prepare and submit a detailed step by step method statement for approval. Submit a preliminary method statement with the bid.

1.6 SEQUENCING

A. Coordinate work under provisions of Conditions of Contract.

B. Coordinate work with mechanical ductwork.

C. Coordinate work with installation of masonry works flashings.

1.7 WARRANTY

A. Provide a two (2) year warranty under the provisions of Conditions of Contract.

B. The Contractor and the Specialist Sub-Contractor shall jointly provide a two (2) year warranty for the completed works on its performance against any defects and failure. Include warranty coverage on PVdF Kynar 500 finish.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

Not used

2.2 MATERIALS

A. Aluminium Extrusions: ANSI /ASTM B221 alloy 6063-T5, or BS 1474 6063-T6. Extrusions shall be not less than 0.081 inches (2.06 mm) thick.

B. Aluminum shall have stoved polyester powder coat finish.

C. Fastenings: Stainless steel philips flat head machine screws.

D. Anchors and Inserts: Stainless steel anchors and inserts for exterior installations.

E. Bituminous Paint: SSPC Paint 12 (cold-applied asphalt mastic).

2.3 METAL FINISHES

A. General:

1. Comply with NAAMM "Metal Finishes Manual" for finish designations and application recommendations, except as otherwise indicated. The colours of the louvers shall be Ultramarine Blue, RAL colour code no. and Silver Metallic, RP 25 Alucobond colour code no. as specified in the finishes schedules. The Contractor shall submit samples of the coloured louver types for the Purchaser's approval.

2. Apply finishes in factory after products are assembled.

3. Protect finishes on exposed surfaces with protective covering, prior to shipment.

4. Remove scratches and blemishes from exposed surfaces which will be visible after completing finishing process.

B. Preparatory Work:

1. Grind welds flush and smooth.

2. Polish exposed weld marks to match the approved sample.

4. Use pretreatment complying with FS TT-C-490 to remove grease, oil, dirt and other foreign matter.

C. High-Performance Coating: AA-C12C42R1x (cleaned with inhibitive chemicals, conversion coated with an acid-chromate-fluoride-phosphate treatment and painted with fluorocarbon coating specified below).

1. Fluorocarbon Coating: Inhibitive thermo-cured primer, 0.2 mil (0.05 mm) minimum dry film thickness, and thermo-cured fluorocarbon coating containing "Kynar 500" resin, 1.0 mil (0.25 mm) minimum dry film thickness.

2.4 FABRICATION

A. Fabricate units rigid, neat in appearance, to true alignment, free from defects, warp or buckle. Dress exposed welds for smooth flush appearance.

B. Finished louver shall be free of exposed horizontal and vertical intermediate mullions. Provide mitered corners on louvers.

C. Provide continuous blade type louvers.

D. Joint frame members to one another and to fixed louver blades by welding. Maintain equal blade spacing to produce uniform appearance.

E. Blades shall be equally spaced at 2" (51mm) o.c.

F. Provide custom extruded aluminum sill to duplicate the spacing of top blade to head section. Profile and finish to match the approved louver sample.

G. Provide sill extensions and loose sills in metal and finish matching louvers.

H. Powder coated blade metal louvers and frames of aluminum alloy complying with BS 1470.

I. Proper brackets made of extruded aluminum shall be provided to ensure installation of the louvers.

J. Fasteners and anchors of aluminum or stainless steel type.

2.5 LOUVERED DOGHOUSE

A. Roof: 12 gauge (2.75 mm) 3003-H14 Aluminum sheet with condensation barrier on underside.

B. Unless otherwise specified, provide same louver profile in the penthouse as specified elsewhere, in matching metal and finish.

C. Posts: Aluminum support angles, of size as required to support penthouse.

2.6 LOUVER SCREENS

A. Fabricate screen frames in metal and finish matching louver units to which secured. Frames shall consist of U-shaped metal for permanently securing screen mesh.

B. Use bird screen of 1/2inch (12.7 mm) sq. mesh, 0.063 inch (1.6 mm) aluminum wire.

C. Locate screens on inside face of louvers, unless otherwise indicated. Secure screens to louver frames with machine screws, spaced at each corner and in between at 12" (300mm) o.c.

2.7 ACCESSORIES

A. Flashings: Of same material as louver frame. Thickness as required to avoid warping, buckling and "oil canning"; minimum 0.081" (2.06 mm) thick.

B. Sealants: Type as specified in Division 7.

C. Fasteners: Manufacturer's standard, compatible with items.

D. Blank-Out Sheeting on Interior of Louver: Metal, finish and colour matching louver and frame.

2.8 MANUFACTURED LOUVERS

The louver types shall be single, double and triple bank louvers. All louvers, mullions, frames, blades, braces, and associated components shall be manufactured to give the required rigidity and strength stipulated by AMCA and BSRIA.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions, verify that prepared openings and flashings are ready to receive work, and that opening dimensions are as indicated on the shop drawings.

B. Beginning of installation means acceptance of existing conditions.

3.2 PREPARATION

A. Coordinate setting out drawings, templates, instructions and directions for installation of anchors, which are to be embedded in, or attached to, concrete, masonry or steel construction.

3.3 INSTALLATION

A. Install louver assembly in accordance with manufacturer's instructions.

B. Install louvers level and plumb.

C. Install flashings and align louver assembly to ensure moisture is shed from flashings and to ensure diversion of moisture to exterior.

D. Install insect screening to interior of louvers as indicated on louvers schedule.

E. Install perimeter sealant and backing rod.

F. Where indicated, prepare louvers to receive ductwork attachment.

G. Where louvers are fixed over a backing wall, the surface behind shall be painted black by the Contractor.

H. Locate and place louver units plumb, level and in proper alignment with adjacent work.

I. Use concealed anchors wherever possible. Provide stainless steel washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

J. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers.

K. Repair finishes damaged by cutting, welding, soldering and grinding operations required for fitting and jointing. Restore finishes so there is no evidence of corrective work. Return items to shop, make required alterations, and refinish entire unit, or provide new units.

L. Protect galvanized and non-ferrous metal surfaces from corrosion or galvanic action by application of a heavy coating of bituminous paint on surfaces which will be in contact with concrete, masonry or dissimilar metals. Wherever possible, the design of the installation shall avoid dissimilar metals being placed in contact with, or in close proximity of, each other.

M. Adjust operable louvers for freedom of movement of control mechanism. Lubricate operating joints.

N. Clean surfaces and components.

O. Refer to Division 7 sections for sealants in connection with installation of louvers.

3.4 CLEANING

At completion, clean surfaces and components to remove foreign substances.

T. TOILET COMPARTMENTS AND CUBICLES

PART 1 - GENERAL

1.1 WORK INCLUDED

A) This Section details works, which shall be carried out by the Interior Works Sub-Contractor, hereinafter referred to as the Contractor, in this Section. The Interior Works Sub-Contract is hereinafter referred to as the Contract, in this Section.

B) This Section specifies the requirements necessary to furnish and install the partition walls and accessories of the toilet cubicles.

1.2 RELATED WORK

A) This Section shall be used in conjunction with, but not necessarily limited to, the other relevant specifications, the Drawings, the Room Finishes Schedule, and the Contract Documents to establish the total requirements for compartments and cubicles in toilets.

B) CAUTION: Use of this Section without including the above - listed items will result in omission of basic requirements.

C) In accordance with the General Conditions of Contract, the aforesaid documents shall be taken as mutually explanatory, and any ambiguities or discrepancies shall be resolved by the Purchaser, who shall then instruct the Contractor thereon. In the event of conflict regarding compartments and cubicles requirements between this Section and any other document, the more stringent requirement shall apply unless specifically instructed by the Purchaser in writing otherwise.

1.3 DESIGN CRITERIA

A) The partition walls and doors of the cubicle toilets shall be sandwich construction made from 3mm high-pressure laminated decorative panels, with CFC free polyurethane foam core or Phenolic core board.

B) Doors and all exposed edges of the laminate to be chamfered.

C) Fully framed in extruded anodized aluminium E6/EU1with perimeter head stabilising section and continuous side fixing channels.

1.4 QUALITY ASSURANCE

A) The partition walls and doors of the toilet cubicles shall be of approved manufacturer. The integral laminate contracts dimensionally at low humidity and expands at high humidity: therefore enlarged holes for the stay-bolts and adequate spaces on the joints will have to be calculated at the time of project engineering and the cost of this will be borne by the Contractor.

B) Manufacturer Qualifications: company specializing in plastic laminate toilet cubicles with 5 years' minimum documented experience.

C) Installer Qualifications: company with 5 years' minimum documented experience and approved by manufacturer.

1.5 WARRANTY

The Contractor and the Specialist Sub-contractor shall jointly provide a two (2) years warranty for the completed works on its performance against any defects and failure.

1.6 SUBMITTALS

A) Product Data - Submit manufacturer's technical data for materials, fabrication, finishing, fastenings, hardware, and installation details.

B) Shop Drawings - Submit shop drawings indicating elevations of partitions, thickness of material, fastenings, proposed method of anchoring, size and spacing of anchors, details of construction, hardware, fittings, mountings and other related items and installation details.

C) Samples - Submit samples of materials to be used, and colours and patterns selected for verification.

D) Proposed Work Schedule.

1.7 MOCKUPS

Provide a field sample of 1 partition wall complete with the partition door, urinal divider with all accessories for approval. Locate where directed.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A) Formica, century ply, green lam/ply, kitpy

B) Others approved equivalent manufacturers meets the standards and specifications will be evaluated by the owner.

2.2 MATERIALS

A) Toilet cubicles shall be floor mounted, and made of 15mm thick solid compact laminate board with rough matt finish on both sides, complete with extruded anodized aluminium E6/EU1 or powder coated aluminium round profile framing. The panels shall be water, scratch and impact resistant. Accessories shall be made of Nylon.

B) The system shall be constructed of pilasters fixed with 45mm diameter extruded aluminium profile on both edges. The vertical profile shall have a rebated edge that supports the door and a rubber strip to cushion the door closing.

C) Adjustable leg (partition columns) shall be of 40mm diameter stainless steel with nylon sleeve and collar, slotted into the vertical profile and secured firmly to the floor with stainless steel screws and plug. It shall be covered with a nylon rosette after fixing.

D) Top portion of the pilasters shall be slotted with a 45mm x 86mm extruded aluminium head-rail with rounded corner. The head-rail shall run the total length of the cubicle front with fixing point at the pilaster vertical profiles for rigidity and stability.

E) Revolving doors, flush fitting shall be 600 mm wide (unless otherwise specified) and complete with the following accessories:

1) Nylon spring hinges or Stainless steel hinges (3 nos. per door)

2) Nylon pull Door knob handle on both sides of door

3) Nylon lock fitting with vacant/engaged sign Indicator lockset with emergency opening

4) Coat hook

F) Toilet cubicles shall have a continuous dividing partition without joint.

G) The total height of the toilet cubicles shall be 2150mm high inclusive of a 150mm from floor clearance.

H) Color of the toilet cubicles shall be selected by the Purchaser/Owner, and the entire installation work shall be carried out by the Specialist.

I) Color Scheme: To be selected from the standard range.

J) The solid compact laminate shall comply with the following physical properties:

Physical Property	Test Method	Test Results

Gross density	DIN 53479	1430 kg/m^3
Thickness tolerance	DIN 16926	+0.50 mm
Thickness swelling (24 hr at 20+1°C)	EN 317	0.07%
Flexural strength	BS 2782	> 120 N/mm^2
Tensile strength • Machining direction • Cross direction	BS 2780	> 130 N/mm^2 > 90 N/mm^2
Resistance to surface wear (Taber Abrasion Test)	BS 2782	> 500 cycles（周）
Resistance to impact	EN 438-2	> 40 N
Resistance to scratching	EN 438-2	> 4 N
Resistance to colour change in Xenon arc light	EN 438-2	> Blue wool standard No. 6

K) The solid compact laminate shall comply with the following physical properties:

Physical Property	Test Method	Test Results
Resistance to immersion in boiling water (100°C for 2 hrs) • increase in weight • increase in thickness	EN 438-2	0.44% 0.28%
Resistance to dry heat (180°C)	EN 438-2	No visible change
Resistance to cigarette burns	EN 438-2	No visible change
Resistance to steam (1 hr)	EN 438-2	No visible change
Coefficient of thermal conduction	DIN 52612	0.3 W/mK
Surface hardness • Micro-Vickers	Mitutoyo MVK-G1 Hardness tester 100 gf load	60

2.3 ACCESSORIES

- Coat hooks: Hewi No. 520.501 or equivalent
- Paper holder: Hewi No. 450 or equivalent
- Toilet brush: Hewi No. 475.2.171 or equivalent
- Door stopper
- Anti-trap protection: soft PVC finger guard fitted on the hinges side

PART 3 – EXECUTION

3.1 EXAMINATION

A) Before covering wall and ceiling framing with finish materials, examine framing to ensure that backing plates and structural framing have been installed in such position as to receive all attachment screws.

B) Verify spacing of plumbing fixtures to ensure compatibility with installation of compartments.

C) Do not start the work of this section until all deficiencies have been corrected.

3.2 INSTALLATION

Install toilet compartments as shown on the shop drawings and in accordance with the manufacturer's specifications and printed installation instructions. Install toilet compartments and doors in a rigid and substantial manner, straight and plumb, with horizontal lines level.

Secure pilasters to supporting members and level, plumb and tighten the installation with leveling nuts and washers.
Secure panels and doors to pilasters so that exterior faces are flush. Secure panels to walls, with 2 stirrup brackets located near the top and bottom of each panel, or with one continuous bracket from top to bottom. At concrete or masonry walls, fasten brackets with screws and expansion anchors. At light gauged steel-framed walls, fasten brackets with toggle bolts into metal studs or backing plates fastened directly to the studs. At wood framed walls, fasten brackets with wood screws into wood studs or blocking fastened directly to the studs.

3.3 ADJUSTING AND CLEANING

Hardware Adjustment - After installation, carefully adjust hardware for proper operation. Set hinges on in-swing doors to hold open approximately 30 degrees from the closed position when unlatched. Set hinges on out-swinging doors to return to the fully closed position. Adjust doors so that bottoms of doors are level with the bottoms of the pilasters when the doors are in the closed position.

Cleaning - Clean compartments and doors upon completion and leave free from imperfections.

3.4 INSPECTION

A) The installation shall be subject to inspection and shall be completed to the satisfaction of the Purchaser, failing which the works shall be rectified at the Contractor’s expense.

U. TOILET ACCESSORIES

PART 1 - GENERAL

1.1) WORK INCLUDED

A) This Section details works, which shall be carried out by the Interior Works Sub - Contractor, hereinafter referred to as the Contractor, in this Section. The Interior Works Sub - Contract is hereinafter referred to as the Contract, in this Section.

B) This Section specifies the requirements necessary to furnish and install the following:

1) Toilet and washroom accessories.

2) Attachment hardware inclusive Hand dryer – Hand Paper holder.

3) Provisions for handicapped toilets (i.e. grab bars).

1.2) RELATED WORK

A) This Section shall be used in conjunction with, but not limited to, the other relevant specifications, drawings and Contract Documents to establish the total requirements.

B) CAUTION: Use of this Section without including all of the above-listed items will result in omission of basic requirements.

C) In accordance with the General Conditions of Contract, the aforesaid documents shall be taken as mutually explanatory, and any ambiguities or discrepancies shall be resolved by the Purchaser, who shall then instruct the Contractor thereon. In the event of conflict regarding requirements between this Section and any other document, the more stringent requirement shall apply unless specifically instructed by the Purchaser in writing otherwise.

1.3) REGULATORY REQUIREMENTS

A) Conform to National Standards and Codes of Practice (India) for installing work.

B) Positioning of provisions for handicapped toilets shall conform to Authorities' regulations and requirements.

1.4) QUALITY ASSURANCE

A) Manufacturer Qualifications: Company specializing in toilet accessories with 5 years' minimum documented experience.

B) Installer Qualifications: Company with 5 years' minimum documented experience and approved by manufacturer.

C) The installation shall be subject to inspection and shall be completed to the satisfaction of the Purchaser, failing which the works shall be rectified at the Contractor's expense.

D) Installed toilet and washroom accessories for handicapped shall comply with Authorities' requirements.

1.5) WARRANTY

A) The Contractor and the Supplier shall jointly provide a 2 (two) years warranty covering the performance of the material and installation against any defects and failure.

B) The guarantee shall cover the cost for damages, which include the cost of finishing materials and labor required replacing the entire defective installation, should the installation be proven defective.

1.6) DELIVERY, STORAGE, AND HANDLING

A) The Contractor shall be responsible for timely delivery, storage, protection and installation of all materials necessary for completion of the works.

B) Deliver materials to project site in manufacturer's original packaging, clearly identified as to type and location.

1.7) SEQUENCE AND SCHEDULING

A) Coordinate the work of this Section with the placement of internal wall, tiling, toilet partitions, etc. to receive anchor attachments.

1.8) SUBMITTALS

A) Provide the following in addition to the standard requirements:

1) Product data on accessories describing size, finish, details of function and attachment methods.

2) Two samples of each component illustrating color and finish.

1.9) MOCK UPS

A) Provide field samples when requested, illustrating installed accessories.

B) Locate where directed.

C) Accepted sample may not remain as part of the work.

PART 2 - PRODUCTS

2.1) MATERIALS

A) Products quality for accessories shall conform to the following:

1) Sheet Steel: ASTM A366.

2) Stainless Steel Sheet: ASTM A167, Type 304.

3) Tubing: ASTM A269, stainless steel, Type SS316.

4) Adhesive: two-component epoxy type, waterproof.

5) Fasteners, Screws, and Bolts: stainless steel.

2.2) FABRICATION

A) Weld and grind smooth joints of fabricated components.

B) Form exposed surfaces from single sheet of stock, free of joints.

C) Form surfaces flat without distortion. Maintain flat surfaces without scratches or dents.

D) Paint back of components where contact is made with building finishes to prevent electrolysis.

E) Shop-assemble components and package complete with anchors and fittings.

F) Provide steel anchor plates, adapters, and anchor components for installation.

G) Hot-dip galvanizes exposed and painted ferrous metal and fastening devices.

2.3) FACTORY FINISHING

A) Galvanizing: ASTM A123 to 45g/m2 (1.25 ounce per square yard) or other equivalent standard.

B) Shop-Primed Ferrous Metals: Pre-treat and clean; spray apply one coat primer and bake.

C) Enamel: Pre-treat to clean condition; apply one coat primer, and minimum two coats epoxy electrostatic baked enamel.

D) Chrome/Nickel Plating: ASTM B456, Type SC 2 satin and/or polished finish as required.

E) Stainless Steel: No. 4 satin luster and polished finish as required.

2.4) KEYING

A) Supply 3 keys for each accessory to Owner where applicable.

B) Master-key all accessories where applicable.

PART 3 - EXECUTION

3.1) EXAMINATION

A) Verify that site conditions are ready to receive work and dimensions are as indicated on shop drawings.

B) Beginning of installation means acceptance of existing conditions.

3.2) PREPARATION

A) Deliver inserts and rough-in frames to site at appropriate time for installation.

B) Provide templates and rough-in measurements as required.

C) Verify exact location of accessories for installation.

3.3) INSTALLATION

A) Install fixtures, accessories, and items in accordance with manufacturer's instructions.

B) Install plumb and level, securely and rigidly anchored to substrate.

3.4) ADJUSTING AND CLEANING

A) Remove all protective masking and clean surfaces, leaving them free of soil and imperfections.

B) Fill all units final acceptance with necessary supplies just prior to of building.

C) Deliver to Owner all keys or other devices required to service units.

3.5) PROTECTION

A) The Contractor is to ensure that all completed toilet accessories are fully protected until full completion of construction.

V. LOCKERS

PART 1 – GENERAL

1.1 WORK INCLUDED

This Section specifies the requirements necessary to furnish and install the following:
Lockers

1.1 RELATED WORK

This Section shall be used in conjunction with, but not limited to, the other relevant specifications, drawings & Contract Documents to establish the total requirements.

CAUTION: Use of this Section without including all of the above-listed items will result in omission of basic requirements.

In accordance with the General Conditions of Contract, the aforesaid documents shall be taken as mutually explanatory, and any ambiguities or discrepancies shall be resolved by the Architect, who shall then instruct the Contractor thereon. In the event of conflict regarding requirements between this Section and any other document, the more stringent requirement shall apply unless specifically instructed by the Architect in writing otherwise.

1.2 QUALITY ASSURANCE

Manufacturer Qualifications: Company which has been in the business for at least 10 years and which has successfully produced products of a scope similar to this project.

Installer Qualifications: Company which is approved by manufacturer and which has successfully installed products of a scope similar to this project.

The installation will be subject to inspection and shall be completed to the satisfaction of the Purchaser. In case the requirements are not followed. The Purchaser can request the works to be amended up to complete satisfaction at Contractor's expenses.

The materials use shall be of the type and standard acceptable by the local authorities. The materials and the installation shall comply with the relevant local standards and code of practice.

1.3 WARRANTY

The Contractor and Supplier shall provide a one (1) year warranty on work of this Section for its performance against any defects and failure.

1.4 DELIVERY, HANDLING, AND STORAGE

Deliver products in manufacturer's original, unopened, protective wrapping with original, legible label intact.

Protect against damage and discoloration.

1.5 SUBMITTALS

Provide the following within 2 weeks of Contract award:

- Product data describing product type, size, configuration, layout, accessories, and finish color when applicable.
- Samples - Submit samples of materials to be used; colour and pattern selected for verification.
- Shop Drawings - Submit shop drawings indicating fastenings, details of construction, hardware, and other related items and installation details.
- Proposed Work Programme.

PART 2 – PRODUCTS

1.6 MANUFACTURER

- Godrej.
- Manufacturers that can meet the requirements specified will be considered.

1.7 MATERIALS

B) Materials used shall meet the following or other equivalent standards.

A. Aluminum – ASTM B 221, alloy 6063-T5 for extrusions; ASTM B 209, alloy 6061-T6, sheet and plate. Protect aluminum surfaces in contact with cementitious materials with zinc chromate primer or chromate conversion coating.

B. Stainless Steel – SS 316 with hairline finish, unless indicated otherwise, for plates, sheet and strips.

C. Structural Steel Shapes – ASTM36

D. Steel Plates – ASTM A283 Grade C

E. Scratch Resistance Plastic Laminate for counter and cabinet – The plastic laminate shall be of the type and standard acceptable by the Purchaser/Architect. Preferred laminates are Formica / Greenlam / Ventura / approved equivalent manufacturers.

PART 3 -- EXECUTION

1.8 INSPECTION

- Verify adequacy of backing and support framing and property, prepared, sized, and located.
- Verify that surfaces and openings are ready to receive work and field measurements are as shown on shop drawings.
- Beginning of installation means acceptance of existing conditions.

1.9 PREPARATION

- Protect other materials against damage and discoloration caused by work of this Section.

1.10 INSTALLATION

General:
Follow manufacturer's instructions and reviewed shop drawings.
Secure specialties plumb, level, square, and true as applicable.

1.11 ADJUSTING AND CLEANING

- Adjust the specialties to function correctly and satisfactorily at the time of substantial completion and during warranty period.
- Remove debris from project site upon work completion or sooner, if directed.
- Including work of other sections, clean, repair and touch up, or replace when directed products which have been soiled, discolored, or damaged by work of this Section.
- Leave installation clean and free of defects on completion.

W. CEILING SURFACES

PART 1 - GENERAL

1.1) RELATED WORK

A) This Section shall be used in conjunction with the other relevant specifications, the Drawings and Contract Documents to establish the total requirement for the installation of the ceiling works.

B) CAUTION: Use of this Section without including the above mentioned will result in omission of basic requirements.

1.2) DESIGN CRITERIA

A) The location and the type of ceiling panels and the location of the lighting points are shown in the architectural drawings.

B) The work in this Section shall include all accessories, control joints, end trims, which may not be expressly indicated on the drawings, but which are necessary to provide a total ceiling systems package, which interfaces in a complete manner with the adjacent construction.

1.3) QUALITY ASSURANCE

A) The installed ceiling shall have a sound transmission class of minimum STC40 for areas specified to have acoustic ceilings. The ceiling shall be free of any asbestos and shall be unaffected by moisture.

B) The installer shall be a company specializing in applying the work of this Section with a minimum of 5 years' documented experience and approved by the manufacturer.

1.4) WARRANTY

A) The Contractor and the Specialist Sub-contractor shall jointly provide a two (2) years warranty for the completed works on its performance against any defects and failure.

B) The guarantee shall cover the cost for damages, which include the cost of finishing materials and labor required replacing the entire defective installation.

1.5) SUBMITTALS

A) Provide the following with bid:

(i) Manufacturer's Data: installation literature for all ceiling systems and materials.

(ii) Certificates: copy of Certificate of License issued to system installer by manufacturer.

(iii) Submit evidence that the materials and systems have been tested, and that the fire rated systems have been approved by the Authorities. Submit environmentally friendly approval for suspended ceiling material.

B) The contractor shall submit the following to the Purchaser for approval before any work in this trade commences on site:

(i) Samples of ceiling panels, fixing systems of appropriate size and types of sound insulation and thermal insulation shall be submitted to the Purchaser for review and approval, before ordering materials.

(ii) Shop drawings: The Contractor shall submit typical installation details for the ceiling systems for Purchaser approval. The shop drawings shall provide complete details of the system. Shop drawings shall be drawn using AutoCad-2008 and soft copies made available upon request without charge.

(iii) Installation schedule: The Contractor shall submit proposed delivery and work installation programmed for approval.

(iv) As built drawings: During construction, the Contractor shall keep accurate records of the contract works, "as built", on AutoCad-2008 construction drawings and details. Prior to the issue of the final acceptance certificate, the Contractor shall hand over to the Purchaser transparencies and AutoCad-2008 files of all as-built drawings, and all other documents related to the Contract work, which will be required for the application for the occupation permit.

1.6) MOCK UPS

A) Provide field sample panels of specified systems, minimum 2 meter long by 2 meter wide, showing ceiling panels and suspension systems.

B) Locate where directed.

C) The accepted samples shall not remain as part of the completed permanent works.

1.7) DELIVERY, STORAGE, AND HANDLING

The Contractor shall be responsible for timely ordering, scheduling, delivery, receiving, protection and installation of all materials necessary for completion of the works, on site or in transit.

A) Deliver materials to project site in manufacturer's original packaging, clearly identified as to type and location.

B) Materials shall be transported, handled and stored on the site or elsewhere in such a manner as to prevent damage, deterioration or contamination all to the satisfaction of the Purchaser. The Purchaser reserves the right to inspect any materials to be used on the works at any time and at any place of storage.

1.8) SEQUENCING

A) Coordinate work under provisions of Conditions of Contract.

B) Coordinate work with installation of dry wall partitions, masonry works, blinds, other interior works and M&E services.

PART 2 - PRODUCTS

2.1) MATERIALS

2.1.1 ACOUSTICAL MINERAL FIBRE CEILING PANELS SUSPENDED CEILING AS SHOWN ON SCHEDULE

A) Acoustical mineral fiber or stone wool ceiling panels indicated in the Room Finish Matrix shall be 600x600x15mm/1200x600x15mm thick with recessed edges (Color: white). The panels shall be able to withstand temperatures above 1000 degrees Celsius without melting. Thermal conductivity of panel may not exceed 0.034 λ W/m degrees Celsius.

B) Sound Absorption:

Frequency, Hz	100	250	500	1000	2000	4000
Absorption	0.55	0.70	0.75	0.70	0.80	0.75

C) Supporting steelwork: Galvanized steel plate profiles

D) Surface: white finish with recessed edge installation.

E) Suspension: With spring or vernier hangers.

F) Fastening: With approved metal expansion anchor or other approved fasteners and associated screws.

G) Panels: Make, Rockon or equivalent recessed edges, Fire protection class O

H) Wall Joints: Shadow angle for recessed edge panels with white enamel finis.

I) Substructure: Vertical blinds flush with the ceiling. Vertical blinds shall be fitted to all office windows.

J) The acoustical ceiling panel shall be 100% moisture resistant when exposed between temperatures of 1 to 45 degrees Celsius and will not show any visible sagging or warping. The light reflectance shall be minimum 87% with surface and edges of the acoustical ceiling panel painted originally by the manufacturer to safeguard acoustical properties.

K) The acoustical panel must be inorganic and shall not be able to disintegrate and not sustain growth of bacteria, fungus and mould. The surface colour shall be white. The panel shall have a maximum density of 120kg/m3.

L) The acoustical ceiling panel shall be easily cleaned with ordinary cleaning agents dissolved in water.

M) The suspension system shall be exposed type grid in 600x600/1200x600 (Colour: white). Suspension member shall be double web design and pre-finished in manufacturer's standard baked enamel paint finish.

N) The main tee shall have an integral reversible splice piece, with connection values for basic loads of 90kg pull out tension, and 215kg compression. The cross tee shall have a high tensile steel locking tab. Its connection values shall be for basic loads of 155kg pull out tension, and 65kg compression.

O) Grid members shall be manufactured from hot-dipped galvanized steel. The system shall be either suspended or directly fastened to the structural slab soffit above by hangers. Main tee sections shall be suspended by means of 4mm galvanized rod. Perimeter panels shall be cut on site to suit the profile of the perimeter walls.

2.1.2 ACOUSTICAL CLEANROOM CEILING PANELS (MYLAR BOARD) AS SHOWN ON SCHEDULE

A) Shall be Thermaclean, laminated foil-faced ceiling panel made from new generation bio-soluble mineral wool, clay and starch indicated in the Room Finish Matrix shall be 1200x600x19mm thick with square edge (Color: white).

B) Sound Absorption: As per BS EN 20354: 1993

C) Sound attenuation : As per BS EN 20140-9: 1994 Dn,c,w = 34 dB (thickness 15mm)

D) Humidity resistance panels : up to 95% RH

E) Fire Resistance : Class A

F) Weight : 4.3 kg/m2

G) Thermal conductivity : λ = 0.052 – 0.057 W/mk

H) Fire protection up to 1hr in accordance with BS476: Parts 20-23; 1987. Fire resistance F30-F120 to DIN 4102, Part 2.

I) BIO-PRUF – Surface treatment

J) Clean room standard – in accordance with ISO 14644-1, U.S. Fed. Std. 209E, VDI Guidelines 2083 Page 1.

K) Dimension Stability : Shall withstand 40 ^{o}C and 95% RH without visible sag.

L) Supporting steelwork: Galvanized steel plate profiles

M) Surface: white finish. Exposed grid installation with notched panels.

N) Suspension: With spring or vernier hangers.

O) Fastening: With approved metal expansion anchor or other approved fasteners and associated screws.

P) Panels: Make, AMF or equivalent square edges with Fire protection at BS 476 Part 6/7 Class 'O'

Q) Wall Joints: Corresponding angle for notched panels with white enamel finis.

R) Substructure: Vertical blinds flush with the ceiling. Vertical blinds shall be fitted to all office windows.

S) The light reflectance shall be minimum 90% with surface and edges of the acoustical ceiling panel painted originally by the manufacturer to safeguard acoustical properties.

T) The acoustical panel must be inorganic and shall not be able to disintegrate and not sustain growth of bacteria, fungus and mould. The surface colour shall be white.

U) The acoustical ceiling panel shall be easily cleaned with ordinary cleaning agents dissolved in water.

V) The suspension system shall be exposed type grid in 1200x600 (Colour: white). Suspension member shall be double web design and pre-finished in manufacturer's standard baked enamel paint finish.

W) The main tee shall have an integral reversible splice piece, with connection values for basic loads of 90kg pull out tension, and 215kg compression. The cross tee shall have a high tensile steel locking tab. Its connection values shall be for basic loads of 155kg pull out tension, and 65kg compression.

X) Grid members shall be manufactured from hot-dipped galvanized steel. The system shall be either suspended or directly fastened to the structural slab soffit above by hangers. Main tee sections shall be suspended by means of 4mm galvanized rod. Perimeter panels shall be cut on site to suit the profile of the perimeter walls.

2.1.3 <u>ALUMINIUM/METAL CEILING PANELS, CLIP-0N SYSTEM AS SHOWN ON SCHEDULE</u>

A) Supporting steel work: Galvanized steel white capped interlocking tees in 24 mm (w).

B) Surface: White finish

C) Suspension: Rigid suspension with 3mm rod hangers with adjustable clips.

D) Fastening: with approved metal expansion anchors or other approved fasteners

and associated screws

E) Panels: Durlum make or equivalent

F) System: Durlum S3F flush lay-on tiles ceiling

G) Material: Galvanised steel plate approximately 0.5mm thk.

H) Grid dimension: 600 x 600

I) Edges: Panels flush recess tegular on all 4 sides

J) Design: Plain without perforation

K) Surface: Polyester powder costing in excess of 60 microns paint thickness on the surface and edges.

L) Building material raiting: A2

M) Miscellaneous: Perforated panels should be used if acoustical insulation are required. Soundtex tissue shall be laminated at the back of perforated surface panels.

N) Wall Joint: F025 aluminium wall angles with white polyester powder coated surface.

2.1.4 METAL TILE CEILING PANELS, Clip-in System

A) Supporting steel work: Galvanized steel white capped interlocking tees in 24mm(w).

B) Suspension: Rigid suspension with 3mm rod hangers with adjustable clips.

C) Fastening: with approved metal expansion anchors or other approved fasteners and associated screws

D) Panels: Durlum make or equivalent

E) System: Durlum S3F flush lay-on tiles ceiling

F) Material: Galvanised steel plate approximately 0.5mm thk.

G) Edges: Panels flush recess tegular on all 4 sides

H) Design: Plain without perforation

I) Grid dimensions: 600 x 600

J) Surface: Polyester powder costing in excess of 60 microns paint thickness on the surface and edges

K) Building material rating: A2

O) Miscellaneous: Perforated panels should be used if acoustical insulation are

required. Soundtex tissue shall be laminated at the back of perforated surface panels.

L) Wall joints: F025 aluminium wall angles with white polyester powder coated surface.

2.1.5 GYPSUM PLASTER CEILING

A) The dry wall ceiling board in the Room Finish Matrix shall be 12mm thick recessed edge gypsum plasterboard. The 1.5mm deep recess on face side of the plasterboard shall allow formation of shallow channel for joint reinforcement. The thermal co-efficient of linear expansion shall not exceed $16.2x10^{-6}$mm in the temperature range 4^{o} to 38^{o}C.

B) Install the ceiling plasterboard and framing in accordance with the manufacturer's instructions and in accordance with to the National Standards and Authorities' requirements.

C) Incorporate control joints for the gypsum plaster ceiling to permit movement and to prevent deformation and damage. Provide control joints for plaster ceilings abutting any structural element or dissimilar wall or ceiling assembly.

D) Fire rated double layer ceiling to be provided in protected corridors, the ceiling system must be walk able for maintenance of services above the ceiling system.

PART 3 - EXECUTION

3.1) EXAMINATION

The Contractor is to examine and satisfy himself of other related-trades site conditions under which, the ceiling is to be installed. Do not proceed until unsatisfactory conditions have been rectified. Beginning of installation means installer accepts existing surfaces and substrate.

3.2) INSTALLATION

A) During installation of acoustical mineral fibre ceiling panels and gypsum plasterboard the temperature shall remain stable within a range of 11 to 35°C. If there is a noticeable drop in temperature there will be a consequent increase in relative humidity (RH%) which harms the ceilings, whether already installed or not. At lower temperatures, especially lower than 11°C, slight drops in temperature cause an excessive increase in relative humidity (RH%).

B) GENERAL

(i) LIGHT FITTINGS: If the light fittings are held up by the support structure, the maximum load is 20 kg for two bearing sections and 6 kg for one or more cross-ties. Ceiling panels to be cut by Ceiling installer contractor to allow the light fittings installation by others.

(ii) CONTINUOUS LUMINOUS GROOVES: The bearing and intermediate sections shall have protruding ties without taking the presence of the luminous grooves into account, making sure to keep the minimum recommended distance between the ties.

(iii) LIGHT FITTINGS TO BE AFFIXED TO THE FALSE CEILING: The light fittings shall be affixed to the bearing sections by means of suitable fixing accessories.

(iv) AIR GRILLES: The air grilles shall always be independently fixed to the soffit, unless there are to be special installations. Ceiling panels to be cut by Ceiling installation contractor to allow the grille installation by others.

(v) CONTINUOUS VENTILATION GRILLES: See note on continuous luminous grooves.

(vi) SPRINKLER HEADS: The ceilings shall be designed for integration with fire sprinklers.

(vii) FITTING OF SMOKE DETECTORS: The smoke detectors must fit easily into all the ceilings.

(viii) SUPPORT OF SIGNS: The maximum load for signs is the same as that indicated for the light fittings.

C) Suspended ceilings shall have openings (requirements of lighting equipment and installation equipment). The Ceiling Contractor shall be responsible for providing openings.

3.3) ERECTION TOLERANCES

A) Maximum Variation from Dimensioned Position: 5mm.

B) Maximum Variation from Flat Plane: 3mm in 3m.

3.4) INSPECTION

The Contractor shall carry out the ceiling works to meet the requirements as specified in the contract documents and the drawings, failing which the works shall be rectified at the Contractor's expense.

3.5) ADDITIONAL MATERIALS

For future repairing works, the Contractor shall supply for 10% of same materials for the suspended ceiling systems used herein.

X. IRONMONGERY & DOOR HARDWARE

PART 1 – GENERAL

1.1 SCOPE OVERVIEW

1.1.1 The works in this scope includes, but are not limited to, the design, supply, delivery, installation, supervision, co-ordination, testing, commissioning, and handover in approved

conditions of the Ironmongery. All labor and material, transport, plant and necessary equipment for supply and installation of the ironmongery shall be included.

1.1.2 Manufacturer/approved material indicated in the specifications are included only for reference of quality and performance required and should not be read as pertaining to any particular preference or prejudice. Alternative proposal complying or exceeding the specifications are acceptable meeting the latest standards of appropriate installation. The drawings and door schedule depict the performance requirement and the Subcontractor shall review the details against his own system and propose solutions to meet technical requirements of the project.

1.1.3 Qualifications and exceptions to this specification shall be listed and specifically and included at the time of tender. Without such exceptions, tenders shall be deemed to fully comply with the specification.

1.1.4 The Ironmongery Supplier is to coordinate with door manufacturer to provide drawings, samples, and specifications for approval. The contractor shall assume full responsibility in ensuring that the assemblies meet the performance requirements of the specifications.

1.2 PROJECT/SITE CONDITIONS OR SPECIAL CONDITION

1.2.1 Hardware shall be complete with all necessary screws, bolts, anchors or other fastenings for proper application of suitable size and type, and match hardware as to materials and finish.

1.2.2 Regulatory Requirements

1.2.2.1 Conform to applicable building code for requirements applicable to fire rated doors and frames.

1.2.2.2 Conform to the applicable sections of Chapter 5 of NFPA 101, NFPA 80, and NFPA 252.

1.2.2.3 Provide hardware which has been tested and listed by UL or FM for fire rated assemblies of types which comply with requirements of door and frame labels.

1.2.3 Certification

1.2.3.1 Ironmongery Supplier/Manufacturer and Door Contractor shall jointly inspect complete installation and certify that ironmongeries & hardware installation has been furnished and installed in accordance with manufacturer's standard & instructions.

1.2.3.2 Provide two copies of certifications to Architect.

1.2.4 The contractor shall co-ordinate with other relevant trades and is responsible for obtaining all information required to achieve good and coordinated installation.

1.2.5 The Contractor shall carry out the following obligations and duties

1.2.5.1 Obtain field measurements and setting-out of areas before commencement of works.

1.2.5.2 Make enquiry if there are any discrepancies between site conditions and approved construction drawings prior to proceeding with work.

1.2.5.3 Provide/arrange necessary evidence/documentation as may be required by the relevant authorities to demonstrate compliance with relevant codes, regulations and standards.

1.2.5.4 Allow protection to completed works including all fixings and accessories.

1.3 REFERENCES/PROJECT REQUIREMENTS

1.3.1 Tender Drawings, Door Schedule and general provisions of Contract, including General and Supplementary Conditions and Scope Description & Specifications, apply to this Section. This section shall be used in conjunction with the above documents to establish the full requirement of the project.

1.3.2 The contractor to note that client is not an approving authority for the purposes of authority requirements. client will comment on drawings and proposal by the contractor it is the sole responsibility of the contractor to meet the performance requirements and the requirements of applicable statutory institutes or standards.

1.3.3 The contractor shall comply with all relevant local codes and regulations that may apply to the works. Equivalent standard in India in cases where they exist, with prior approval can replace the standards referred to in this document. The more stringent standard always applies.

1.3.4 Additional project requirements and references:

- Latest India Code on Barrier Free Accessibility in Buildings
- ANSI/NFPA 80 - Fire Doors and Windows.
- AWI - Architectural Woodwork Institute.
- BHMA - Builders' Hardware Manufacturers Association.
- DHI - Door Hardware Institute.
- NAAMM - National Association of Architectural Metal Manufacturers.
- NFPA 101 - Life Safety Code.
- SDI - Steel Door Institute.
- NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures.
- NFPA 252 - Fire Tests of Door Assemblies.
- UL 10B - Fire Tests of Door Assemblies.
- UL 305 - Panic Hardware.
- Code of Practice – CP96
- All Related India Standards and Code of Practice.

1.4 SUBMITTALS & TECHNICAL REQUIREMENTS

1.4.1 **Product Data Sheet & Samples**:

1.4.1.1 Provide product data on specified hardware. Include each hardware item cut sheet bound in each hardware schedule. Identify item on sheet.

1.4.1.2 Data sheet shall include information to show compliance with technical, physical and performance requirements.

1.4.1.3 Data sheet shall include instructions for installation and maintenance of operating parts and finish.

1.4.1.4 Submit sample for **each** type of ironmongeries properly labeled and tagged mounted on standard sample boards including all accessories, attachments, and fixings.

1.4.1.5 All approved sample shall be retained by client/Architect for future reference of ironmongery types.

1.4.2 Certifications:

Submit all other relevant certificates on quality conformance form local or international testing authority.

1.4.2.1 Ironmongery Schedule:

Submit schedule at earliest possible date, particularly where acceptance of ironmongery schedule must precede fabrication of other work that is critical in project construction schedule. Include in the schedule product data, samples, shop drawings of other work that is affected by finish ironmongery and other information essential for coordinated review of ironmongery schedule.

Ironmongery Schedule should contain the following information in an organized format:

- Type, style, function and finish of each ironmongery item
- Name, model number, and manufacturer of each item
- Fastening, fixing, and other pertinent information.
- Mounting locations for ironmongery with dimensions I reference to approved shop drawings.
- Door Frame size and material
- Keying information
- System and wiring diagram for all electronic ironmongery.

1.4.2.2 Keying Schedule

- THE CONTRACTOR and approved ironmongery supplier shall co-ordinate with to develop comprehensive keying schedule for the entire project.

- The keying schedule shall contain information with regard to keying system, master keying, numbering of keys and placement of cylinders.

- Comprehensive layout drawing showing cylinder tagging and numbering in relation to keying schedule shall be submitted by THE CONTRACTOR and approved ironmongery supplier.

- The keying/cylinder system shall be of highest security level and latest technology design.

- The keying system shall have the capacity to expand for the subsequent phases of the development without having to re-key the existing locks.

- The keying system shall be submitted to client for approval including all system information and required lead time for production and replacement.

- Cylinders shall be of removable core type, and shall conform to additional client requirements.

- Submit templates of finish ironmongery for door and frames as required by the various trades involve in the work.

- ❖ Ironmongery supplier will be required to meet with client to establish quantity and types of core required.

- ❖ Coordinate the ironmongery work required with the specialty door manufacturer / suppliers, the card reader, security alarm, and fire alarm Subcontractors.

1.5 QUALITY ASSURANCE

1.5.1 Manufacturers & Suppliers: Companies specializing in manufacturing door hardware, ironmongery and security systems with minimum ten (10) years experience with a record of successful service performance for similar quantity, type, and quality to that indicated project.

1.5.2 The Manufacturer/Supplier shall be available at reasonable times during course of the work for consultation about the project ironmongery requirements to the client and the Contractor.

1.5.3 Hardware installer: Employ a qualified carpentry person to perform the work of this Section.

1.5.4 Single Source Responsibility: each type of ironmongery shall be supplied from single manufacturer without substitution unless noted otherwise “or approved equivalent” which means “or equal is approved by client”.

1.5.5 Manufacturers: Items of other manufacturers than those scheduled will be considered for acceptance providing they meet the specified criteria and that the substitution requests are made in accordance with the specifications, no exceptions.

1.6 WARRANTY

1.6.1 Provide 5-year full warranty for all ironmongery. Door closers shall have 10 year full warranty. Warranty shall be signed by the Contractor and Ironmongery supplier and installer agreeing to repair or replace defective parts or workmanship.

1.6.2 Warranties to cover the cost of dismantling, removing, making new parts, making good to adjacent/surrounding surfaces, finishing and re-fixing to match existing.

PART 2 – PRODUCTS

2.1 HINGES

2.1.1 Hinges: All hinges shall be ball bearing with sufficient throw to clear door trim or wall construction, but no more than necessary. High frequency type, full mortice template butt hinge.

2.1.2 Hinges for exterior doors and security areas shall have pins held in place by a set screw which can only be removed while the door is open.

2.1.1 Provide additional hinges as required by door height in accordance with manufacturing recommendations

2.1.2 All hinges supplied shall be of the same manufacturer and available in low, medium and high frequency.

2.1.3 Unless otherwise specified, all hinges shall be of satin stainless steel Grade 304/316, full mortice template ball bearing hinges.

2.1.4 All hinges shall be supplied with wood screw for timber doors and machine screw for metal doors.

2.1.5 The centre pin of the hinges shall be fixed so that it will not be moved out-of-place from the hinges due to door misalignment.

2.2 LOCK SETS

2.2.1 Cylindrical type of weight, design, function and materials as specified. Faces shall be rabbeted, beveled or rounded as required.

2.2.2 They shall pass the fire tests of BS476 Part. Manufactured according requirements to EN12209, dimensions according to DIN 18251-1, class 3, classification 3H110B2KC20.

2.2.3 Locks shall have all functions available in one size case, manufactured from heavy gauge steel.

2.2.4 The mortice lockcases are to be tested in overseas or locally to be suitable for usage on fire-rated doors up to 4-hours irregardless of the function of the locks.

2.2.5 Detailed specification of locksets are as follows :-

- Heavy duty able to withstand heavy usages.
- Heavy duty spring follower for lever handles to prevent any form of sagging. The force exerting on the lever handle in order to activate the latch must be at least 1.5kg.
- Available in 60mm backset.
- 8mm square follower.
- Minimum 22mm throw (Double throw) for deadbolt.
- Single sided lever handle fixing if necessary.
- 17mm profile or 22mm profile cylinder hole, 72mm centre-to-centre distance from lever to cylinder.
- As for high security mortise lock, the latch must be non-reversible and should be complete in one piece latch. Reversible latch is to be use in low security area.
- Forend to be in single piece of thickness 3.4mm and material in stainless steel Grade 316.
- Gauged case to be welded directly onto forend of lockcase for security purposes.
- Forend shall be in modular size for all lock functions for easy maintenance.

2.2.6 Locksets shall be supplied complete with strike plate, cylinder escutcheon and roses, in stainless steel Grade 316, as required for the function requirement.

2.2.7 Stainless steel materials of the forend of the lockcases and lever handle must be of Grade 316 and tested accordingly to the standards DIN 50021/ASTM/B 117/JIS Z2371. The tests are to be tested by local test laboratory for the corrosion resistance of the stainless steel Grade 316 for the period of 4 years. The stainless steel materials must not rust or corrode during the first 4 years after completed installation. Proof of the test for corrosion resistance to be submitted.

2.2.8 The follower and latch of the proposed lockcase shall be tested for at least 600,000 cyclic movements, and proof of testings by independent institution shall be submitted as proof.

2.2.9 Rebated kits and striking plates shall be provided for all double leaves doors.

2.2.10 The possible functions of the locksets are :-

- ❖ Mortice Night Latch (Silent Action)
- ❖ Mortice Deadbolt
- ❖ Mortice Sashlock (A Lock With Deadbolt And A Latch)
- ❖ Mortice Nightlatch With Anti-Thrust Bolt
- ❖ Mortice Bicentric Lockset
- ❖ Narrow Mortice Deadlock
- ❖ Narrow Mortice Sashlock
- ❖ Mortice Panic Lock

2.2.11 Curved Strike Lips: Length to protect jamb trim.

2.2.12 All lock-strikes shall be with box, stainless steel dust covers and a lip of sufficient length to protect door trim and jamb.

2.2.13 Locksets shall have removable core keying and cylinder.

2.2.14 Material: All levers and handles must be of stainless steel; finish to be selected from manufacturer standard range.

2.3 DOOR CLOSERS

2.3.1 Closer Construction shall be heavy-duty type available in regular slide arm and channel. All parallel arm brackets shall be provided for door swings towards the opposite direction.

2.3.2 Door closers must not install on the outside of any exterior door.

2.3.3 Door Closer shall be fully intelligent back-check feature providing a cushion effect to prevent uncontrolled opening of the door beyond 70^{o} with adjustable closing speed control and latching action function from 180-70^{o} to allow easy access to handicapped person, electromagnetic hold open device, smoke detectors and concealed sequence door selector.

2.3.4 Door closer shall have an adjustable latching force to ensure that door is properly closed and latched. Door Closer and door coordinator/selector shall be approved by relevant authority

2.3.5 Door Closer shall be totally reversible without adjustment.

2.3.6 Door Closer shall match the lever/pull handle/push plate finishes of the door.

2.3.7 Provide surface units which have been independently certified to a minimum of 10,000,000 cycles, in accordance with ANSI testing procedures.

2.3.8 Conforms to most recognized International Standards such as EN 1154 and certified to ISO9001.

2.3.9 The closer shall be approved by FSSB and PSB to be used on fire doors and certified to PSB SS 332 standard.

2.3.10 Fasten all closers with through bolts

2.4 EXIT DEVICES

2.4.1 Exit Devices: UL listed for purpose intended. Operating device shall be touchbar style. Finish, function, design, lever, and trim as indicated in Hardware Sets.

2.4.2 Provide extended rods as required for each particular opening.

2.4.3 Material: Device body and components must be of stainless steel; finish to be selected from manufacturer standard range.

2.5 FLUSH BOLTS & DUST PROOF STRIKE SOCKET

2.5.1 Flush Bolt shall be of lever action type or self latching PSB approved type.

2.5.2 Provide extended rods as required for each particular opening.

2.5.3 Dust proof spring loaded strikes shall be used when the door locks into floor, except where metal threshold is used.

2.5.4 Material: Flush Bolts and Dust Proof Strikes must be of stainless steel; finish to be selected from manufacturer standard range.

2.6 DOOR STOPS

2.6.1 Door stop for doors adjacent to drywall shall be floor mounted type.

2.6.2 Door stop for doors adjacent to masonry/concrete wall shall be wall mounted type.

2.6.3 Material: door stop body must be of stainless steel; finish to be selected from manufacturer standard range. Bumper shall be of approved neoprene or rubber component.

2.7 DOOR SELECTOR

2.7.1 Door selector shall be on a non-handed type, fully automatic and available in vrying lengths.

2.7.2 Proprietary stainless steel strike plate shall be provided.

2.7.3 Material: door selector arm and body must be of stainless steel; finish to be selected from manufacturer standard range. Roller shall be of approved neoprene type.

2.8 FLOOR SPRING & GLASS DOOR IRONMONGERY

2.8.1 Floor Spring shall be of double action type.

2.8.2 All patch fittings and accessories shall come from single-supply source as the floor spring.

2.8.3 Lockset shall allow for the same cylinder profile as the rest of the whole project and form part of the master - keying schedule.

2.8.4 Stainless steel handle shall be designed and coordinated with door/curtainwall contractor.

2.8.5 Depth of floor spring shall not be more than 60mm. The Contractor shall ensure that the top level of floor spring completed is of the same level as the adjacent finished floor level (with finished).

2.8.6 All floor spring shall be provided with pressure relief valve to prevent over-loading and oil leaking.

2.8.7 Floor spring shall be provided with adjustable hold open/back check from 75 degree to 175 degree.

2.8.8 Floor spring shall have delayed closing up to 45 seconds.

2.8.9 Floor spring shall be available in closing force of 53NM, 35NM or 15NM.

2.8.10 Floor spring shall be available with interchangeable spindle from 5mm to 50mm suitable for timber, metal and glass doors.

2.9 CYLINDER & MASTERKEY SYSTEM

2.9.1 Provide “Kaba” keyway or equivalent to match Owners requirements. Furnish all locks construction. Master keyed. Provide core type as required by owners system.

2.9.2 Cylinders shall comply with ANSI A156.6 and conform to DIN 18252 or its equivalent.

2.9.3 All cylinders proposed shall meet the degree of security desired for the installation.

2.9.4 The plug shall be made of solid brass. Cylinder shell shall be made of solid brass and finish to match the appearance of the lock which the cylinder is fitted.

2.9.5 All cylinders shall be available in at least 22 or more pins with tumblers. Each of the 22 positions consists of a security pin, a security tumbler and a spring. For added security the cylinder shall possess multi-part construction of the pin mechanism coupled with the rotation factor and off centre pin to key alignment features, and in 4 multiple rows for security reasons. Single row of pin is not acceptable.

2.9.6 The cylinders shall have detainer pins to protect against picking.

2.9.7 Cylinders shall be designed for tensile loading of 12800 Newton against wrenching and pulling of the plug within the cylinder.

2.9.8 The cylinder shall suit regular door thickness of 40 - 45mm but incremental increases shall be available for doors of thickness more than 60mm.

2.9.9 The cylinder's bodies and plugs are machined from extruded brass to a diameter of 17mm or 22mm round profile unique as compared to the conventional cylinder.

2.9.10 It is finished in nickel silver plating as standard to match most door furniture, however, other finishes are available upon request.

2.9.11 The standard length of a double cylinder with both sides keyed is 65mm which suits most doors up to 50mm thick. Extended length is available upon request for extra thick doors.

2.9.12 Where external security is vital, cylinder can be surface hardened to prevent drilling. The pins in such cylinders are also hardened.

2.9.13 The range of cylinders must be very wide. A cylinder can be found to suit most applications from door locks, roller shutter locks, furniture locks, key switches, or in certain cases special application.

2.9.14 All cylinders are factory sealed making it impossible to tamper with the permutation inside the cylinder.

2.9.15 Since a cylinder could be found to suit most applications, it is possible to master key systems comprising a variety of cylinder locks, eg. mortice locks, roller shutter locks, knobsets, padlocks, furniture locks, key switches and others being integrated into a master key system.

2.9.16 All cylinders supplied shall be under grand masterkey complete with optional construction key system. The Contractor shall liaise with his sub-contractor responsible for producing a key chart in master key system for S.O.'s approval prior to installation.

2.9.17 Cylinders shall be available in construction key system, which is incorporated into the permanent cylinder, if requested. The construction key system can be invalidated by using a special U-key or change code key and only the mastered keys will be able to activate the cylinder. Alternatively, temporary cylinders should be supplied at no costs. The main contractor shall resume the responsibility to change the temporary cylinder to the actual cylinders during handling-over stage.

2.9.18 The inserts of the master keyed cylinders should be interchangeable for replacement and security purposes.

2.9.19 The inserts of the master keyed cylinders must be suited to other cylinder types, namely rim cylinder, 17 mm profile cylinder, 22 mm profile cylinder, 36 mm profile cylinder, etc.

2.9.20 The housing of the cylinder shall be recyclable and interchangeable. These as well as other components could be kept by the user for maintenance purposes.

2.9.21 The listed security patented cylinders and padlock would be:

- ❖ Security patented thumb turn cylinder in nickel plated, come in minimum 22 individual pins with tumblers positions, suited to the overall master keyed system with minimum 5 levels of hierarchies.

- ❖ Security patented double cylinder in nickel plated, come in minimum 22 individual pins with tumblers positions, suited to the overall master keyed system with minimum 5 levels of hierarchies
- ❖ Security patented single cylinder in nickel plated, come in minimum 22 individual pins with tumblers positions, suited to the overall master keyed system with minimum 5 levels of hierarchies
- ❖ Security patented padlock, come in minimum 22 individual pins with tumblers positions, suited to the overall master keyed system with minimum 5 levels of hierarchies

2.9.22 The Subcontractor shall rekey construction cylinders as required to secure portions of the project for his use.

2.9.23 Provide 40 construction master keys for distribution to other trades during course of work.

2.9.24 Provide 3 change keys per lockset / cylinder.

2.9.25 Provide wall mounted key cabinet with hooks, labels, and index.

2.9.26 Provide stainless steel tamper proof key rings for each set of keys with 25% additional rings and required fastening tool.

2.10 KEYING AND MASTERKEYING (MECHANICAL LOCKSETS)

2.10.1 All cylinders shall be able to be furnished with built-in construction key system, individual key, sub-master key, master key, grand master key, great grand master key under the same system, with minimum 5 levels of master key hierarchy.

2.10.2 All keys are to be made of nickel silver, are flat, reversible and can be inserted both ways.

2.10.3 Keys shall have special key blanks and keyways for difficult unauthorised reproduction and shall have copyright for the period 2022. Patent protection shall be registered both worldwide and locally in India and the region.

2.10.4 Keys production can only be executed through authorised request from owner and the indentations on the keys are produced by CNC machine.

2.10.5 All cylinders shall be finished with 3 keys sealed with a tagged special chastity clip to be handed over to client/architect.

2.10.6 Key alike cylinders shall be furnished with 12 keys sealed with a special chastity clip.

2.10.7 6 nos each of the sub-master keys, master keys and grand master keys are to be provided in a sealed chastity clip and tagged.

2.10.8 It shall be deemed that the contractor has priced for the provision of keys and master keying system specified (minimum 5 hierarchy) in the unit rates for cylinders.

2.10.9 Each key shall have the option of including various different colours, up to 12 different colours, to the key bow as means of identification by the client. The colour to the key bow shall be able to be interchangeable with special tooling by the client themselves.

The supplier shall made provision to supply the fixture to change the colour coding on the key bow.

2.10.10 The key duplication method must be by special milling method with special and controlled tool bits by the supplier. Drilling method and any other methods of key duplication is not acceptable and will be rejected. The supplier must submit samples and proof of the required key milling method in the duplication the security key.

2.10.11 Provision must be made to allow an intelligent SMART RFID chip to be incorporated into the key bow of all keys supplied.

2.10.12 The keys to the mechanical locking system should be able to be upgraded in future to incorporate and integrate with mechatronic locking system or a full electronic access control system that make use of RFID or Legic technology, without changing the existing mechanical master key system and locking hardwares, except cylinders.

2.10.13 The listed security key system to the master keyed cylinders would be:

- Security patented thumbturn cylinder in nickel plated, come in minimum 22 individual pins with tumblers positions, suited to the overall master keyed system with minimum 5 levels of hierarchies
- Security patented double cylinder in nickel plated, come in minimum 22 individual pins with tumblers positions, suited to the overall master keyed system with minimum 5 levels of hierarchies
- Security patented single cylinder in nickel plated, come in minimum 22 individual pins with tumblers positions, suited to the overall master keyed system with minimum 5 levels of hierarchies
- Security patented padlock, come in minimum 22 individual pins with tumblers positions, suited to the overall master keyed system with minimum 5 levels of hierarchies

2.11 HANDLING/DUPLICATION OF KEYS (MECHANICAL)

2.11.1 The Contractor shall maintain an updated record on site of keys issued and a copy of such record shall be submitted to client/architect. The cylinder lock shall be replaced prior to handing over for anyone of those keys reported lost at the Contractor's expense. No duplication of keys shall be permitted without prior approval of client/architect.

2.11.2 The supplier must be present to hand over the sealed keys to the owner’s representative in the presence of the main contractor, owner’s representative and S.O. All documentation of the handing over process must be properly recorded.

2.11.3 Temporary or construction keys should be properly controlled by the main contractor to be issued to sub-contractors, and proper records of key withdrawals are to be maintained. These records would be requested and inspected by the end-users at any time.

2.11.4 If temporary or construction cylinders are used during the construction phase(s) of the building, the main contractor are to be solely responsible and accountable for the proper changing over of the temporary or construction cylinders to the actual master keyed cylinders. The costs of the change-over of cylinders are deemed to be part of the costs

and scope of works under the main contractor. The end-user's keys are to be handed over to the end-user directly by the supplier of the master keyed system.

2.12 HANDLES

2.12.1 All levers/pull handles and accessories shall be of the same manufacturer and supplier.

2.12.2 All roses and escutcheon shall have a snap on cover of more than 8 mm in height.

2.12.3 All levers/pull handles, roses and escutcheon shall be provided with a bolt through fixing and shall be supplied with a special fixing system. This is to prevent from becoming loose after prolong usages.

2.12.4 Approved level handles bolted to rose or backplate shall open smoothly, softly and silently and yet be strong enough to prevent any form of sagging.

2.12.5 All backplates, roses and escutcheons shall be concealed fixings and squarely aligned with door leaf. The fixing screws shall be installed from behind the door or from inside the room.

2.12.6 All lever handles shall be available with the option of incorporating with radial needle bearings and not ball bearings, which is in the roses itself, for heavy duty door and excellent handle operation. The needle-bearings, integrated in the lever handles, is fixed rotating on a ground plate in stainless steel and provided with the special fixing system.

2.12.7 Wherever required, lever handle and knobs can be intermixed for inside/outside trim.

2.12.8 Specified lever handles is able to withstand very heavy weight and pressure exerting on the handles.

2.12.9 Stainless steel materials of the forend of the lockcases and lever handle must be of Grade 316 and tested accordingly to the standards DIN 50021/B 117/JIS Z2371. The tests are to be tested for the corrosion resistance of the stainless steel Grade 304 shall simulate the corrosion environment within the period of 4 years. The test certificate of the test by an independent institution shall be submitted a proof of the test. The stainless steel materials must not rust or corrode during the first 4 years after completed installation.

2.12.10 More than 5 designs of the handles should be made available for customer's selection. Designer hollow and solid handles shall be made available for the client's final selection.

2.13 PRODUCT AND FINISH

2.13.1 All appropriate hardware shall be of satin **stainless steel grade 316** uniform throughout.

2.13.2 Finish hardware shall be tarnish resistance.

2.13.3 All mortise locksets, high security cylinders, handles, exit devices, door closers, floor springs and other accessories and components shall be from the same approved supplier.

2.14 MANUFACTURER/SUPPLIER

2.14.1 Ebco

2.14.2 Godrej

PART 3 – EXECUTION

3.1 PREPARATION & INSPECTION

3.1.1 Verify that doors and frames are ready to receive work and dimensions are as instructed by the manufacturer.

3.1.2 Do not commence installation until unsatisfactory conditions have been rectified

3.1.3 Beginning of installation means acceptance of existing conditions.

3.2 DELIVERY, STORAGE, AND HANDLING

3.2.1 Deliver products to site, store and protect products in storage until installed.

3.2.2 Each individual item must be individually labeled and identify package with door number code to match hardware schedule.

3.2.3 Deliver permanent keys to client/architect direct form lock manufacturer.

3.2.4 Protect hardware from theft by cataloging and storing in secure area.

3.2.5 Install hardware only upon approval of client/architect.

3.3 SEQUENCING

Coordinate order of installation for all hardware items to eliminate conflicts of operating mechanisms. Provide general notes as to the order of installation.

3.4 INSTALLATION

3.4.1 Mount all Ironmongery units at height indicated in the drawings, except if shown or specified otherwise or to comply with requirements of governing regulations & handicapped requirements.

3.4.2 Install each ironmongery item in compliance with manufacturer's instructions, recommendations, and templates. Securely fasten all parts to be attached. Fit faces of mortised items snug and flush. Make sure all operating parts move freely and smoothly without binding, sticking, or excessive clearance.

3.4.3 Whenever cutting and fitting is required to install ironmongery onto or into surfaces which are later to be painted or finished in other way, remove and store ironmongery prior to painting or finishing. Reinstall item only when the finishes have been completed on the surface to which the ironmongery is to be installed. All buts, locks, plates, strikes, etc., shall be neatly and accurately mortised flush, properly placed and accurately aligned for smooth and quiet operation without sticking, binding, hanging, or ratting. All doors shall be hung with equal clearance at jambs and heads. Adjust all hardware properly and leave in smooth operating condition.

3.5 ADJUSTING AND CLEANING

3.5.1 Adjust and check each operating ironmongery item to ensure correct operation and function.

3.5.2 Replace units that can not be adjusted to operate as intended for the installation made.

3.5.3 Final Adjustments:

- Where ironmongery is installation is made more than 1 month prior to building acceptance or occupancy of room or area, the supplier/installer shall return to work area 1 week prior to acceptance or occupancy and make final check and adjustment of all ironmongery items.
- Clean grease, dirt or item marks and as necessary restore correct operation, function and finish.
- Adjust door control device to compensate for final balancing of the heating and ventilating equipments and difference in room air pressure.

3.6 MAINTENANCE & TRAINING

3.6.1 Prior to handing over for inspection, all projected parts and surfaces such as door levers, pull handles and others shall be properly wrapped and sealed. Should any serious scratches or other defects on the surfaces of the ironmongery be found, THE Contractor shall replace the ironmongery at his own cost.

3.6.2 Submit operation and maintenance data, Include data on operating hardware, adjustments, lubrication requirements, inspection procedures related to preventative maintenance and cleaning procedures of finishes.

3.6.3 Provide special wrenches and tools applicable to each different or special hardware components.

3.6.4 Provide maintenance tools and accessories supplied by hardware component manufacturer.

3.6.5 Training Program: The Ironmongery supplier/installer shall conduct a training program to client technical/maintenance staff within 3 months of the application of Temporary Occupation Permit. The training program should be hands-on oriented with appropriate reference to operations and maintenance training manuals to be provided. The training shall focus on the following items

- To assemble and disassemble all items supplied
- To replace faulty parts within all parts supplied
- To configure lock cylinder pinning for keys supplied
- To perform routine maintenance on all items supplied

3.6.6 This training requirement does not relieve the supplier/installer and the contractor from any warranty obligations already provided in the contract.

Y. ROLLER SHUTTERS

1.0 PART 1 - GENERAL

1.1 SECTION INCLUDES: This section includes

- ❖ Fire rated roller shutters, motorised, powder coated.
- ❖ Non fire rated roller shutters, motorised, powder coated.

1.2 REFERENCES/PROJECT REQUIREMENTS:

- ❖ Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to this section.
- ❖ Requirements of the following Project Specification Sections apply to this section:
  - Section 09900 - Painting
  - M&W/EES/0021 – General Electrical Materials & Workmanships
- ❖ Additional project requirements:
  - ANSI/ASTM B221 - Aluminum-Alloy Extruded Bar, Rod, Wire, Shape, and Tube.
  - ANSI/UL 325 - Door, Drapery, Gate, Louver, and Window Operators and Systems.
- ❖ Design Requirements: Design door assembly to withstand wind / suction load of 30 psf (1.44 kpa), without undue deflection or damage to door or assembly components.

1.3 SYSTEM DESCRIPTION

Electric motor operated unit with manual override in case of power failure. Fire rated doors with fusible link activated with automatically governed closing speed.

1.4 SUBMITTALS: Submit the following in accordance with Conditions of Contract and Section 01340, Shop Drawings:

- ❖ Submit shop drawings and product data under provisions of DIVISION 1.
- ❖ Provide pertinent dimensioning, general construction, component connections and details, anchorage methods, hardware location, and installation details.
- ❖ Submit manufacturer's installation instructions under provisions of DIV. 1.
- ❖ Samples: Submit two, 6" (15 cm) long samples of each type slat specified showing each type finish specified.
- ❖ Shop Drawings
  - Submit shop drawings showing elevations, locations, jamb conditions, methods of assembling and clearances required.
  - Indicate hardware installation data, thickness of materials, methods of anchoring and details of construction.
  - Note and mark sufficiently to indicate compliance with requirements of these Specifications.
  - Indicate location of motor, switches and controls.

❖ Operations and Maintenance Data

- Submit manufacturer's operation and maintenance data under provisions of DIVISION 1.
- Maintenance Data: Indicate lubrication requirements and frequency, periodic adjustments required.

1.5 QUALITY ASSURANCE:

❖ Verify that field measurements are as indicated on shop drawings.

❖ Furnish roller shutters by one manufacturer for entire project.

❖ Manufactures warranty: Furnish manufactures 5 years warranty against defect in product workmanship and materials.

1.6 PROJECT/SITE CONDITIONS OR SPECIAL CONDITION:

Regulatory Requirements:

❖ Provide SIRIM label / rated frame and assembly. Conform to applicable code for indicated hourly fire rated opening.

❖ Electrical Components: ULI listed.

1.7 SEQUENCING: Coordinate the work with installation of electric power, locations and size of conduit, and locations of devices.

2.1 MATERIALS

2.2.1 Curtain

❖ Slats: Minimum 20 gage (1.0 mm) thick slats of steel, ANSI/ASTM A526; for fire rated shutters and 1.4 mm thick Alum slats for non-fire rated shutters.

❖ Slat Ends: Ends of alternate slat fitted with end locks to act as wearing surface in guides and to prevent lateral movement.

❖ Curtain Bottom: Bottom fitted with 2 mild steel angles (not less than 38X38X3 mm) bolted together as T-shape section to provide reinforcement and positive contact with floor in closed position.

2.2.2 Side Guides: Formed steel angles for required sizes and configurations with groove 75 mm depth minimum complying with JIS G3141 SPCC-SD slot bolt holes for track adjustment.

2.2.3 DRIVE BARREL: Steel pipe complying with BS 1387 or JIS 63452 and helical steel spring system capable of producing sufficient torque to assure easy operation of curtain from any position; adjustable spring tension.

2.2.4 Housing: Min 22 gage (0.85 mm) powder coated m.s. internally reinforced to maintain rigidity and form. Provide closed end for surface mounted hoods and any portion of jamb projecting beyond wall face. Provide intermediate support brackets as required to prevent sag. Galvanised self driving screws applied for easy access maintenance.

2.2.5 Hardware

❖ Handle: Inside side mounted, adjustable keeper, spring activated latch bar with feature to keep in locked or retracted position, interior handle.

❖ Cylinder: Furnished in DIVISION 8.

- Weather-stripping: Water and rot proof, resilient type; located along jamb edges, bottom of curtain, and within housing.
- Provide fire fly release mechanism and fusible link at rated doors.

2.2 MANUFACTURED UNITS

2.3.1 Electric Operator:

- Descriptions: UL approved in accordance with ANSI/UL 325; wall mounted.
- Electrical Requirements: Non-Fire rated doors: 230 volt, single phase, 50 Hz supply to 1/2 hp electric motor. 415 Volts, three phase, 50 Hz supplying for fire rated shutters. 24 v dc solenoid release for fire rated roller shutters to close upon receiving fire signal when there is a power failure.
- Brake: Adjustable friction clutch, double shoe brake system actuated by independent full line voltage solenoid controlled by motor starter.
- Limit Switch: Fully enclosed positive gear driven limit switch.
- Motor Controller: Fully enclosed magnetic cross line reversing starter.
- Control Station: Standard three button (open-close-stop) control for each operator; 24 volt circuit; surface mounted.
- Safety Device: Located at bottom of doors, full width; wired to reverse door upon striking object; neoprene covered to provide weather seal.
- Provide wall mounted bracket.
- Operating speed of 3m per minute (2" per second).
- Safety standard to IP54, IP55 and insulation class A.
- Manual override chain for emergency manual operation.

2.3 FINISHES:

- Curtain Slats: Powder coated.
- Steel Guides and Hood Enclosure: Powder coated.

2.0 PART 3 – EXECUTION

3.1 EXAMINATION:

- Verify surfaces and conditions are ready to receive work of this section.
- Notify Architect of any existing conditions which will adversely affect execution.
- Beginning of execution will constitute acceptance of existing conditions.

3.2 INSTALLATION:

- Install door unit assembly in accordance with manufacturer's instructions.
- Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.
- Secure guides to structural members only.
- Fit, align, and adjust door assemblies' level and plumb; provide smooth operation.
- Coordinate installation of electrical service.

- ❖ Coordinate installation of sealants and backing materials at frame perimeter.
- ❖ Install perimeter trim and closures.

3.3 FIELD QUALITY CONTROL: Tolerances

- ❖ Maintain dimensional tolerances and alignment with adjacent work.
- ❖ Maximum Variation From Plumb: 1/16 inch (0.16 mm).
- ❖ Maximum Variation From Level: 1/16 inch (0.16 mm).
- ❖ Longitudinal or Diagonal Warp: Plus or minus 1/8 inch (3.2 mm) per 10 ft. (3 m) straight edge.

3.4 ADJUSTING:

- ❖ Adjust work under provisions of DIVISION 1.
- ❖ Adjust door hardware and operating assemblies.

3.5 CLEANING:

- ❖ Clean work under provisions of DIVISION 1
- ❖ Clean door and components.
- ❖ Remove labels and visible markings.

Z. SANITARY FIXTURES

1.0 PART 1 - GENERAL

1.1 WORK INCLUDED:

- ❖ Water closets.
- ❖ Urinals.
- ❖ Wash basins.
- ❖ Sinks.
- ❖ Mop basins.
- ❖ Electric water coolers
- ❖ Shower

1.2 RELATED WORK:

- ❖ This Section shall be used in conjunction with, but not limited to, the other relevant specifications, drawings and Contract Documents to establish the total requirements.

- ❖ CAUTION: Use of this Section without including all of the above-listed items will result in omission of basic requirements.

- ❖ In accordance with the General Conditions of Contract, the aforesaid documents shall be taken as mutually explanatory, and any ambiguities or discrepancies shall be resolved by the Purchaser, who shall then instruct the Contractor thereon. In the event of conflict regarding requirements between this Section and any other

document, the more stringent requirement shall apply unless specifically instructed by the Purchaser in writing otherwise.

1.3 REFERENCES:

- ANSI A112.6.1 - Supports for Off-the-Floor Plumbing Fixtures for Public Use.
- ANSI A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.
- ANSI A112.19.1 - Enameled Cast Iron Plumbing Fixtures.
- ANSI A112.19.2 - Vitreous China Plumbing Fixtures.
- ANSI A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
- ANSI A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals.
- ANSI Z358.1 - Emergency Eye Wash and Shower Equipment.
- ARI 1010 - Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.
- ANSI A117.1 - Requirements for the Physically Challenged.
- Americans with Disabilities Act Guidelines.

1.4 QUALITY ASSURANCE

- Refer to General Conditions.
- Comply with product data.
- Fixtures: By same manufacturer for each product specified throughout.
- Trim: By same manufacturer for each product specified throughout.

1.5 SUBMITTALS

- Refer to General Conditions.
- Submit shop drawings and product data.
- Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, furnished specialties and accessories; and installation instructions. Include fixtures, sizes, utility sizes, trim and finishes.
- Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, roughing-in requirement, required clearances and methods of assembly of components and anchorages.

1.6 OPERATION AND MAINTENANCE DATA

- Refer to General Conditions.
- Submit operation and maintenance data.
- Maintenance Data: Submit maintenance data for each type of plumbing fixture and accessory; including troubleshooting maintenance guide. Include this data, product data and shop drawings in maintenance manual.
- Include fixture trim exploded view and replacement parts lists.

1.7 DELIVERY, STORAGE AND HANDLING

- Refer to General Conditions.

- Deliver products to site.
- Deliver plumbing fixtures individually wrapped in factory-fabricated containers.
- Handle plumbing fixtures carefully to prevent breakage, chipping and scoring fixture finish. Do not install damaged plumbing fixtures; replace and return damaged units to equipment manufacturer.

1.8 WARRANTY

- Refer to General Conditions.
- Provide five year manufacturer's warranty.
- Warranty: Include coverage of electric water cooler compressor.

2.0 PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - FIXTURES

1.1.1 Water closets, Urinals, Wash basins, Sinks (vitreous china/enameled cast iron).

- As Per BOQ

1.1.2 Sinks, Wash basins (stainless steel).

- As Per BOQ

2.2 ACCEPTABLE MANUFACTURERS - FAUCETS AND DRAINS (INSTITUTIONAL)

- AS Per BOQ

2.3 ACCEPTABLE MANUFACTURERS - WATER CLOSET SEATS

- As per BOQ

2.4 ACCEPTABLE MANUFACTURERS - MOP BASINS, SHOWER RECEPTORS

- Not Used

2.5 ACCEPTABLE MANUFACTURERS - ELECTRIC WATER COOLERS

- As per BOQ

2.6 WATER CLOSET (WC-1)

- Bowl: ANSI A112.19.2; wall hung siphon jet vitreous china closet bowl, with elongated rim, 1-1/2" top spud, china bolt caps; white. Model as per BOQ/Approved brand.
- Flush System: Dual flush system; Concealed Cistern with Flush Panel; Model as per BOQ/Approved brand.
- Seat: Solid white plastic, open front, extended back, self-sustaining hinge, stainless steel bolts, with cover Manufactured by approved brand. Anti-microbial plastic.

- Wall Mounted Carrier: ANSI A112.6.1; adjustable cast iron frame, integral drain hub and vent, adjustable spud. Lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

2.7 WATER CLOSET (WC-2) - FOR THE PHYSICALLY CHALLENGED:

- Bowl: ANSI A112.19.2; wall hung siphon jet vitreous china closet bowl, with elongated rim, 1-1/2" top spud, china bolt caps; white. Model as per BOQ/Approved brand.
- Flush System: Dual flush system; Concealed Cistern with Flush Panel; Model WH003/MB001 Manufactured by approved brand.
- Seat: Solid white plastic, open front, extended back, self-sustaining hinge, stainless steel bolts, with cover Manufactured by approved brand. Anti-microbial plastic.
- Wall Mounted Carrier: ANSI A112.6.1; adjustable cast iron frame, integral drain hub and vent, adjustable spud. Lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

2.8 URINAL (UR):

- Urinal: ANSI A112.19.2; vitreous china, wall hung syphon jet urinal with shields, integral trap, removable stainless steel strainer, 3/4" top spud, steel supporting hangers; white color. Model as per BOQ/Approved brand.
- Flush Valve: ANSI A112.18.1; exposed, battery powered, sensor operated flush meter, escutcheon, integral screwdriver stop, vacuum breaker, metal cover. Model as per BOQ/Approved brand.
- Wall Mounted Carrier: ANSI A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs

2.9 WASH BASIN (WB):

- Basin: ANSI A112.19.2; vitreous china Counter top WASH BASIN 650mm x 455mm x 200mm minimum, with single hole, D-shaped basin with front overflow, Model LW909KS Manufactured by approved Company.
- Grid strainer; provide chrome plated grid strainer and tail piece.
- P-Trap: Adjustable chrome plates 17 gauge 1-1/4" x 1-1/2" brass with cleanout plug and deep escutcheon. P-trap is pre-insulated. Manufactured by approved Company.
- Supply Fittings: Chrome plated rigid supplies with loose key angle stops.

2.10 LABORATORY SINKS (LS):

- Basin: To be supplied by others.
- Faucet: Deck mounted laboratory mixing faucet with rigid/ swing gooseneck with wrist blade handle. .
- Drain: Type 316 stainless steel with flat strainer and 4" tail piece.
- Trap: Chrome plated 17 gauge 1-1/2” x 1-1/2” brass with cleanout plug and deep escutcheon.
- Supply Fittings: Chrome plated rigid supplies with loose key angle stops.

2.11 SINK (Break Room):

- Double compartment 36" x 20" O.D ,depth 7.5", 18 gauge , stainless steel, self-rimming with undercoating, 1-1/2" side flanges, 4-1/2" faucet ledge, punched with three holes 1-1/2" diameter @ 4" O.C. Model Elegance Unique manufactured by Nirali.
- Faucet: ANSI A112.18.1; chrome plated brass supply with rigid/swing spout, water economy aerator 4" wrist blade handles. Model Z-831C4 manufactured by Nirali.
- Drain: stainless steel with removable crumb cup strainer, rubber seat stopper, 4" long tail piece and double compartment chrome plated continuous waste with center outlet.
- Trap: Chrome plated 17 gauge 1-1/2" x 1-1/2" brass with cleanout plug and deep escutcheon.
- Supply Fittings: Chrome plated rigid supplies with loose key angle stops. Frame: Provide mounting kit for counter top with seals.

2.12 SHOWER (SH-1)

- Base: Tiled walls and floor.
- Showerhead and valve: ANSI A112.18.1; Nickel Chrome finished hand and wall shower with 69" of flexible rubber-lined metal hose, hand spray and 48" chrome adjusting bar with hand shower slide bracket, wall spout with vacuum-breaker 2.5 gpm flow restrictor, internal check stops. Model Fixed shower head: GB 101C, Mixing valve with diverter: GB 204, Bath Spout: GB 101"Temptrol" manufactured by approved Company.
- MOP BASIN (MB-1) – Provide a Mop basin at every Janitor Closet as shown on drawings.
- Bowl: 36" x 24" x 10" white molded stone, floor mounted, with 1" wide shoulders, vinyl bumper guard and stainless steel strainer.
- Faucet: ANSI A112.18.1; built-in exposed wall type supply with 3" diameter cross handles, wall brace, riser supports pail hook 3/4" hose end spout, vacuum breaker.
- P-Trap: Cast iron deep seal where buried below floor slabs.
- Stops: Two chrome plated straight way valves with loose key, 1/2" I.P.S. inlet and outlet and wall escutcheon plates.
- Accessories: 2'-6" long flexible heavy duty 5/8" rubber hose, cloth reinforced with 3/4" chrome coupling at one end. Hose bracket shall be stainless steel with rubber grip. Stainless steel mop hanger with three rubber tool grips and stainless steel splash catcher.

2.13 ELECTRIC WATER COOLER (EWC-1)-FOR THE PHYSICALLY CHALLENGED

Water cooler with full stainless steel body, of size 460x580 height 1215, weight without water 50kg refrigerated with integral air cooled condenser; capacity of 40 ltrs/hr, Max. Current 3.1 amps. Refrigerant R-22, condenser: propeller type(quiet type), with thermo stat , inlet: 12.7mm BSP connection, Drain:25.4, 12.7mm BSP connection, CFC free refrigerant by Voltas

3.0 PART 3 - EXECUTION

3.1 INSPECTION

- Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation. Special attention shall be given to cabinet recessed openings for foot valve faucets. Coordinate these openings with Millwork Contractor by providing exact dimensions for proper mounting.
- Verify adjacent construction is ready to receive rough-in work of this Section.
- Examine floors and substrates and conditions under which fixture work is to be accomplished. Correct any incorrect locations of piping and other unsatisfactory conditions for installation of plumbing fixtures. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.
- Inspect fixtures and accessories that are to be removed and relocated. Damaged or blemished items shall be brought to Construction Manager's attention before reinstalling.

3.2 INSTALLATION

- Install each fixture with trap, easily removable for servicing and cleaning.
- Provide chrome plated rigid or flexible supplies to fixtures with loose key stops reducers and escutcheons.
- Piping exposed to view shall be chrome plated.
- Install components level and plumb.
- Install and secure fixtures in place with wall supports or wall carriers and bolts.
- Seal fixtures to wall and floor surfaces with sealant, color to match fixture.
- Mount fixtures to the following heights above finished floor: Refer to Architectural Drawings.
- Protect installed fixtures from damage during remainder of construction period.

3.3 ADJUSTING AND CLEANING

- Adjust stops or valves for intended water flow rate to fixtures without splashing, noise or overflow.
- At completion clean plumbing fixtures and equipment.
- Adjust or replace washers to prevent leaks at faucets and stops.
- Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

3.4 FIELD QUALITY CONTROL

- Upon completion of installation of plumbing fixtures and after units are water pressurized, test fixtures to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.
- Inspect each installed unit for damage to finish. If feasible, restore and match finish to original at site; otherwise, remove fixture and replace with new unit. Feasibility and match to be judged by the Construction Manager. Remove cracked or dented units and replace with new units.

3.5 FIELD INSPECTION AND REPORT

- Provide report, in accordance with Section 01400, prepared by manufacturer=s representative, stating that systems installed and services provided under this Section are in accordance with manufacturer=s recommendations and are properly operating.

3.6 FIXTURE ROUGH-IN SCHEDULE

- Refer to schedule on Drawings.

THIS PAGE LEFT

INTENTIONALLY

BLANK

TECHNICAL SPECIFICATION

FOR

CIVIL & STRUCTURAL WORKS

TABLE OF CONTENT

A GENERAL

A.1 PREAMBLE

2.0 GENERAL

These Specifications cover the items of work in structural parts coming under preview of this document. All work shall be carried out in conformation with this. These specifications are not intended to cover the minute details. All codes, standard and good construction practice shall be referred to this specification be the latest thereof.

These specifications shall be read in conjunction with the Technical Specifications for various items of work. The General Contractor shall carefully acquaint himself with the general specifications, coordinate the same with any other specifications forming a part of the Contract Document and determine his contractual obligations for the execution of various items of work in accordance with good engineering practices.

2.0 REFERENCE TO THE STANDARD CODES OF PRACTICE:

2.1 All standards, tentative specifications, specifications, code of practice referred shall be the latest editions including all applicable official amendments and revisions. The contractor shall make available at site all relevant Indian Standard Codes of Practice as applicable.

2.2 In case of discrepancy between standards, codes of practice, tentative specifications, and specifications referred to, the specifications of Indian Standard Codes of practice shall govern.

3.0 SUPREMACY OF TENDER

In case of contradiction between/among two or more clauses given separately in two or more different documents, conditions of acceptance clause will be in following preference:

General Conditions of contract. Shall prevail over Drawings

Drawings shall prevail over BOQ

BOQ shall prevail over shall prevail over technical specification

4.0 DIMENSIONS

4.1 Written dimensions on drawings shall supersede measurement by scale; and drawings to a large scale shall take precedence over those to a smaller scale. Special dimensions or directions in the specifications shall supersede all others. All dimensions shall be checked on site prior to execution.

4.2 The dimensions where stated do not allow for waste, laps, joints, etc. but the General Contractor shall provide at his own cost sufficient labour and materials to cover such waste, laps, joints, etc. and the rate quoted is inclusive of such provision and no separate payment will be made for the same.

4.3 The levels, measurements and other information concerning the existing site as shown on the drawings are believed to be correct, but the Contractor should verify them by himself and also examine the nature of the ground as no claim or allowance whatsoever will be entertained on account of any errors or omissions in the levels or the description of the ground levels or strata turning out different from what was expected or shown on the drawings.

5.0 MATERIALS

5.1 QUALITY

All materials used in the Works shall be of the best quality of their respective kinds as specified herein, obtained from sources and suppliers approved by the Engineer-in-Charge and shall comply strictly with the tests prescribed hereafter, or where tests are not laid down in the specifications, with the requirements of the latest issues of the relevant Indian Standards.

5.2 SAMPLING AND TESTING

All materials used in the works shall be subjected to inspection and tests in addition to test certificates. Samples of all materials proposed to be employed in permanent works shall be submitted to the Engineer-in-Charge for approval before they are brought to the site.

Samples provided to the Engineer-in-Charge for their retention are to be labeled in boxes suitable for storage. Materials or workmanship not corresponding in character and quality with approved samples will be rejected by the Engineer-in-Charge.

Samples required for approval and testing must be supplied sufficiently in advance to allow for testing and approval, due allowance being made for the fact that if the first samples are rejected further samples may be required. Delay to the works arising from the late submission of samples will not be acceptable as a reason for delay in completion of the works.

Materials shall be tested before leaving the manufacturer's premises, quarry or source, wherever possible. Materials shall also be tested on the site and they may be rejected if not found suitable or in accordance with the specifications, notwithstanding the results of the tests at the manufacturer's works or elsewhere or test certificates or any approval given earlier.

The contractor will bear all expenses for sampling and testing, whether at the manufacturer's premises at source, at site or at any testing laboratory or institution as directed by the Engineer-in-Charge. No extra payment shall be made on this account.

5.3 DISPATCH OF MATERIALS

Materials shall not be dispatched from the manufacturer's works to the site without written authority from the Engineer-in-Charge.

5.4 TEST CERTIFICATES:

All manufacturer's certificates of test, proof sheets, etc. showing that the materials have been tested in accordance with the requirement of this specifications and of the appropriate Indian Standard are to be supplied free of charge on request to the Engineer-in-Charge.

5.5 REJECTION

Any materials that have not been found to conform to the specifications will be rejected forthwith and shall be removed from the site by the General Contractor at his own cost.

The Engineer-in-Charge shall have power to cause the General Contractors to purchase and use such materials from any particular source, as may in his opinion be necessary for the proper execution of the work.

5.6 STORING OF MATERIALS AT SITE

All materials used in the works shall be stored on racks, supports, in bins, under cover etc. as appropriate to prevent deterioration or damage from any cause whatsoever to the entire satisfaction of the Engineer-in-Charge. The storage of materials shall be in accordance with IS 4082 "Recommendation on stacking and storage of construction materials on site" and as per IS 7969 "Safety code for handling and storage of building materials". This shall include the safe custody of all materials until they are required on the works and till the completion of the works. The same shall be applicable for the materials supplied by the owner or materials supplied by any specialized firms.

The materials shall be stored in a proper manner at places at site approved by the Engineer-in-Charge. Should the place where material is stored by the General Contractor be required by the owner for any other purpose, the General Contractor shall forthwith remove the material from that place at his own cost and clear the place for the use of the owner.

5.7 WATER

5.7.1. Water for Construction

Clean fresh water (potable water) only shall be used for the works. The water shall be free from any deleterious matter in solution or in suspension.

The quality of water shall conform to IS 456.

5.7.2 Storage of water

The General Contractor shall make his own arrangements for storing water, if necessary, in drums or tanks or cisterns, to the approval of the Engineer-in-Charge. Care shall be exercised to see that water is not contaminated in any way.

6.0 WORKMANSHIP

6.1 All works shall be true to level, plumb and square and the corners, edges and corners in all cases shall be unbroken and neat.

6.2 Any work not to the satisfaction of the Engineer-in-Charge or his representative will be rejected and the same shall be rectified, or removed and replaced with work of the required workmanship at no extra cost.

7.0 INCLUSIVE DOCUMENTS

The provision of Special Conditions of Contract, General Conditions of Contract, those specified on the tender as well as execution drawings and notes or other specifications issued in writing by the Engineer-In-Charge shall from part of these specifications.

8.0 MEASUREMENT AND PAYMENTS

The methods of measurement and payment shall be as described under various items and in the bill of quantity. Where specific definitions are not given, the methods described in IS code will be followed. Should there be any detail of construction or materials which has not been referred to in specification or in the bill of quantities and drawings, but the necessity for which may be implied or inferred wherefrom, or which are usual or essential to the completion of the work in the trades, the same shall be deemed to be included in the rates and prices quoted by the contractor in the bill of quantities.

9.0 UN-ACCEPTABLE WORK

All defective works are liable to be demolished, rebuilt and defective materials replaced by the General Contractor at his own cost. In the event of such works being accepted by carrying out repairs etc. as specified by the Engineer-in-Charge, the cost of repairs will be borne by the General Contractor.

In the event of the work being accepted at the sole discretion of Engineer-in-Charge or owner by giving 'Design Concession', arising out of, but not limited to under-sizing, under-strength, shift in location and alignment, etc. and accepting design stresses in members which are higher than those provided for in the original design or by accepting materials not fully meeting the specifications etc. and if the item is so acceptable without substantially affecting the utility of the item and the structure, then the General Contractor will be paid for the works actually carried out by him at the suitable reduced rate of the tendered rates for the portion of the work thus accepted, as the Engineer-in-Charge or owner or the authority may consider reasonable.

10.00 DEWATERING SYSTEM

General Contractor shall arrange to clear water from excavation area before starting work, during execution & after completion of excavation. The excavated area shall be dewatered before pouring concrete in it. The arrangement shall be made by General Contractor to pump out the water from the area before placing reinforcement & pouring concrete for structural & non structural items as well. No extra claims shall be entertained for dewatering.

It shall be the sole and undisputed responsibility of the contractor to keep the basement dry till the completion of the project. Suitable dewatering system by pumping etc. may be required for execution of items of work below the ground level so as to keep the basement dry till the completion of the waterproofing works and till the completion of the project. The rates of all such items shall include the cost of dewatering by suitable measures as required and nothing extra whatsoever will be paid towards the cost of dewatering. The dewatering, whenever necessary shall be carried out by the General Contractor till the completion of the work.

11.0 PREPARATION OF SITE

11.1 The land described or shown on the site plan shall be cleared of all obstruction, rubbish, brush wood, jungle, mud and bamboo clumps as directed by the Engineer-in-Charge. No trees are to be cut down without the orders of the Engineer-in-Charge. Where trees or bamboo are to be cut down the roots shall be grubbed up and the excavation leveled and consolidated with good earth.

11.2 The products of the site clearing are the property of Indian Bank and unless the General Contractor is ordered to dispose of those at his own expense are to be stacked as directed by the Engineer-in-Charge.

11.3 All hollows or depressions, where existing or caused by grubbing up roots or through any other cause, shall be carefully filled up with well-rammed earth and leveled up as required.

12.0 PROTECTION OF THE ENVIRONMENT

12.1 General:

This section of the Specification sets out limitations on the Contractor's activities specifically intended to protect the environment.

The Contractor shall take all necessary measures and precautions and otherwise ensure that the execution of the works and all associated operations on site or off-site are carried out in conformity with statutory and regulatory environmental requirements including (hose prescribed elsewhere in this document.

The Contractor shall take all measures and precautions to avoid any nuisance or disturbance arising from the execution of the Works. This shall wherever possible be achieved by suppression of the nuisance at source rather than abatement of the nuisance once generated.

In the event of any spoil, debris, waste or any deleterious substance from the Site being deposited on any adjacent land. the Contractor shall immediately remove ail such material and restore the affected area so its original state to the satisfaction of the Engineer.

12.2 Water Quality

The Contractor shall prevent any interference with the supply to or abstraction from and prevent any pollution of, water resources (including underground percolating water) as a result of the execution of the Works.

Areas where water is regularly or repetitively used for dust suppression purposes shall be laid to fall lo specially constructed settlement tanks to permit sedimentation of particulate matter. After settlement, the water may be re-used for dust suppression and rinsing.

All water and other liquid waste products arising on the Site shall be collected and disposed of at a location on or off the Site and in a manner that shall not cause either nuisance or pollution.

The Contractor shall not discharge or deposit any matter arising from the execution of the Works into any waters except with the permission of the Engineer and the regulatory authorities concerned.

The Contractor shall at all times ensure that all existing stream courses and drains within, and adjacent to, the Site are kept safe and free from any debris and any materials arising from the Works.

The Contractor shall protect all watercourses, waterways, ditches, canals, drains, lakes and the like from pollution as a result of the execution of the Works.

12.3 Air Quality

The Contractor shall devise and arrange methods of working to minimise dust, gaseous or other air-borne emissions and carry out the Works in such a manner as to minimise adverse impacts on air quality.

The Contractor shall utilise effective water sprays during delivery manufacture, processing and handling of materials when dust is likely to be created, and to dampen stored materials during dry and windy weather.

Stockpiles of friable materials shall be covered with clean tarpaulins, with application of sprayed water during dry and windy weather. Stockpiles of material or debris shall be dampened prior to their movement, except where this is contrary to the Specification.

Any vehicle with an open load-carrying area used for transporting potentially dust producing material shall have properly fitting side and tail boards.

Materials having the potential to produce dust shall not be loaded to a level higher than the side and tail boards, and shall be covered with a clean tarpaulin in good condition. The tarpaulin shall be properly secured and extend at least 300 mm over the edges of the side and tail boards.

In the event that the Contractor is permitted to use gravel or earth roads for haulage, he shall provide suitable measures for dust palliation, if these are, in the opinion of the

Engineer, necessary. Such measures may include spraying the road surface with water at regular intervals.

12.4 Noise

The Contractor shall consider noise as an environmental constraint in his planning and execution of the Works.

The Contractor shall take all necessary measures so that the operation of all mechanical equipment and construction processes on and off the Site shall not cause any unnecessary or excessive noise, taking into account applicable environment requirements. The Contractor shall use all necessary measures and shall maintain all plant and silencing equipment in good condition so as to minimise the noise emission during construction works.

12.5 Control of Wastes

The Contractor shall control the disposal of all forms of waste generated by the construction operations and in all associated activities. No uncontrolled deposition or dumping shall be permitted. Wastes to be so controlled shall include, but shall not be limited to, all forms of fuel and engine oils, all types of bitumen, cement, surplus aggregates, gravels, bituminous mixtures etc. The Contractor shall make specific provision for the proper disposal of these and any other waste products, conforming to local regulations and acceptable to the Engineer.

12.6 Emergency Response

The Contractor shall plan and provide for remedial measures to be implemented in the event of occurrence of emergencies such as spillages of oil or bitumen or chemicals.

The Contractor shall provide the Engineer with a statement of the measures he intends to implement in the event of such an emergency which shall include a statement of how he intends to provide personnel adequately trained to implement such measures.

12.7 Measurement

No separate measurement shall be made in respect of compliance by the Contractor with the provisions of this Section of the Specification. The Contractor shall be deemed to have made allowance for such compliance with these provisions in the preparation of his prices for items of work included in the Bills of Quantities and full compensation for such compliance will be deemed to be covered by them.

A.2 MATERIALS TO BE USED IN THE WORK

GENERAL

Materials to be used in the work shall conform to the specifications mentioned on the drawings, the requirements laid down in this section and specifications for relevant items of work covered under these specifications.

If any material, not covered in these specifications, is required to be used in the work, it shall conform to relevant Indian Standards, if there are any, or to the requirements specified by the Engineer-in-Charge.

SOURCES OF MATERIAL

The General Contractor shall notify the Engineer-in-Charge of his proposed sources of materials to be used in the work with relevant test data sufficiently in advance of commencement of work and the approval of the Engineer-in-Charge obtained. If the General Contractor later proposes to obtain materials from a different source, he shall

notify the Engineer-in-Charge furnishing the relevant test data, for approval by the Engineer-in-Charge of the changed source; the General Contractor shall furnish acceptable material from any source at his own expense.

1.0 BRICKS

Burnt clay bricks shall conform to the requirements of IS:1077. except that the minimum compressive strength when tested flat shall not be less than 8.4 MPa for individual bricks and 10.5 MPa for average of 5 specimens. They shall be free from cracks and flaws and nodules of free lime. The brick shall have smooth rectangular faces with sharp comers and emit a clear ringing sound when struck. The size may be according to local practice with a tolerance of ± 5 per cent.

2.0 STONES

Stones shall be of the type specified. It shall be hard, sound, free from cracks, decay and weathering and shall be freshly quarried from an approved quarry. Stone with round surface shall not be used.

The stones, when immersed in water for 24 hours, shall not absorb water by more than 5 per cent of their dry weight when tested in accordance with IS:1124.

The length of stones shall not exceed 3 times its height nor shall they be less than twice its height plus one joint. No stone shall be less in width than the height and width on the base shall not be greater than three-fourth of the thickness of the wall nor less than 150 mm.

3.0 CAST IRON

Cast iron shall conform to IS:210. The grade number of the material shall not be less than 14.

4.0 CEMENT

Cement to be used in the works shall be any of the following types with the prior approval of the Engineer-in-Charge

a) Ordinary Portland Cement, 33 Grade, confirming. to IS:269.

b) Rapid Hardening Portland Cement, conforming to IS:8041.

c) Ordinary Portland Cement, 43 Grade, conforming to IS:8112.

d) Ordinary Portland Cement, 53 Grade, conforming to IS: 12269.

e) Sulphate Resistant Portland Cement, conforming to IS: 12330.

Cement conforming to IS:269 shall be used only after ensuring that the minimum required design strength can be achieved without exceeding the maximum permissible cement content of 540 kg / cum. of concrete.(for Prestressed concrete) and 450 kd/cum for OPC.

Cement conforming to IS:8112 and IS:12269 may be used provided the minimum cement content mentioned elsewhere from durability considerations is not reduced. From strength considerations, these cements shall be used with a certain caution as high early strengths of cement in the 1 to 28-day range can be achieved by finer grinding and higher constituent ratio of C_3S/C_2S, where C_3S is Tri calcium Silicate and C_2S is Di calcium Silicate. In such cements, the further growth of strength beyond say 4 weeks may be much lower than that traditionally expected. Therefore, further strength tests shall be carried out for 56 and 90 days to fine tune the mix design from strength considerations.

Cement conforming to IS: 12330 shall be used when sodium sulphate and magnesium sulphate are present in large enough concentration to be aggressive to concrete. The recommended threshold values as per IS:456 are sulphate concentration in excess of 0.2 per cent in soil sub-strata or 300 ppm (0.03 per cent) in ground water.

Tests to confirm actual values of sulphate concentration are essential when the structure is located near the sea coast, chemical factories, agricultural land using chemical fertilizers and sites where there are effluent discharges or where soluble sulphate bearing ground water level is high. Cement conforming to IS: 12330 shall be carefully selected from strength considerations to ensure that the minimum required design strength.

Cement conforming to IS:8041 shall be used only for pre-cast concrete products after specific approval of the Engineer-in-Charge.

Total chloride content in cement shall in no case exceed 0.05 per cent by mass of cement Also, total sulphur content calculated as sulphuric anhydride (SO,) shall in no case exceed 2.5 per cent and 3.0 per cent when tri-calcium aluminate per cent by mass is up to 5 or greater than 5 respectively.

5.0 COARSE AGGREGATES

For plain and reinforced cement concrete (PCC and RCC) or pre-stressed concrete (PSC) works, coarse aggregate shall consist of clean, hard, strong, dense, non-porous and durable pieces of crushed stone, crushed gravel, natural gravel or a suitable combination thereof or other approved inert material. They shall not consist of pieces of disintegrated stones, soft, flaky, elongated particles, salt, alkali, vegetable matter or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the steel reinforcement. Coarse aggregate having positive alkali-silica reaction shall not be used. All coarse aggregates shall conform to IS:383 and tests for conformity shall be carried out as per IS:2386, Parts I to VIII.

No aggregate which has water absorption of more than 2 % shall be used in the concrete mix. In test for soundness in accordance with IS:2386 (Part 5) after 5 cycles of testing the loss shall not be more than 12 per cent if sodium sulphate solution is used or 18 % if magnesium sulphate is used, the General Contractor shall submit for the approval of the Engineer-in-Charge, the entire information indicated in Appendix A of IS:383.

Maximum nominal size of coarse aggregate for various structural components in PCC, RCC or PSC, shall conform to Section 1700.

The maximum value for flakiness index for coarse aggregate shall not exceed 35 per cent. The coarse aggregate shall satisfy the requirements of grading given in the following table:

REQUIREMENTS OF COARSE AGGREGATE

IS Sieve Size	Per cent by Weight Passing the Sieve		
	40mm	20mm	12.5mm
63 mm	100	—	—
40 mm	95-100	100	—
20 mm	30-70	95-100	100
12.5 mm	—	—	90-100
10 mm	10-35	25-55	40-85
4.75 mm	0-5	0-10	0-10

6.0 SAND/FINE AGGREGATES

For masonry work, sand shall conform to the requirements of IS:2116. For plain and reinforced cement concrete (PCC and RCC) or pre-stressed concrete (PSC) works, fine aggregate shall consist of clean, hard, strong and durable pieces of crushed stone, crushed gravel, or a suitable combination of natural sand, crushed stone or gravel. They shall not contain dust, lumps, soft or flaky, materials, mica or other deleterious materials in such quantities as to reduce the strength and durability of the concrete, or to attack the embedded steel. Where so required by the Engineer-in-Charge, sand shall be washed to remove impurities from sand. Fine aggregate having positive alkali-silica reaction shall not be used. All fine aggregates shall conform to IS:383 and tests for conformity shall be carried out as per IS:2386, (Parts I to VIII). The General Contractor shall submit to the Engineer-in-Charge the entire information indicated in Appendix A of IS:383. The fineness modulus of fine aggregate shall neither be less than 2.0 nor greater than 3.5.Sand/fine aggregate for structural concrete shall conform to the following grading requirements:

Requirements of Sand

IS Sieve Size	Per cent by Weight Passing the Steve		
	Zone I	Zone II	Zone III
10 mm	100	100	100
4.75 mm	90-100	90-100	90-100
2.36 mm	60-95	75-100	85-100
1.18 mm	30-70	55-90	75-100
600 micron	15-34	35-59	60-79
300 micron	5-20	8-30	12-40
150 micron	0-10	0-10	0-10

M -SAND:

Manufactured sand M-Sand) shall be approved grade as per the instructions of the Architect/ Site engineer /Employer. M Sand Should be strictly free from Quarry Dust. Contractor should provide sample prior to supply of M sand for the Specific works.

TYPE OF M SAND	IS CODE
Concrete M Sand	IS - 383: 1970
Brick/ Block Work M Sand	IS - 2116: 1980
Plastering M Sand	IS - 1542: 1992

II. Particulars	III. Concrete M Sand	IV. Brick/ Block Work M Sand	V. Plastering M Sand

7.0	Granule Thickness	0 - 4.75 mm	0 - 3.55 mm	0 - 2.36 mm
	Usage	RCC, Block works flooring/ Tiling	Specially formulated for Brick & Block Laying	Internal and External Plastering
	Quantity per metric ton (1000 kgs)	21.5 cft/ metric ton	21.5 cft/ metric ton	22 cft/ metric ton

REINFORCING STEEL

7.1 Cast Steel

The use of cast steel shall be limited to bearings and other similar parts. Steel for castings shall conform to Grade 280-520N of IS: 1030. In case where subsequent welding is unavoidable in the relevant cast steel components, the letter N at the end of the grade designation of the steel casting shall be replaced by letter W. 0.3 per cent to 0.5 per cent copper may be added to increase the corrosion resistance properties.

7.2 Reinforcement / Un-tensioned Steel

For plain and reinforced cement concrete (PCC and RCC) or pre-stressed concrete (PSC) works, the reinforcement / un-tensioned steel as the case may be shall consist of the following grades of reinforcing" bars.

GRADE DESIGNATION	BAR TYPE CONFORMING TO GOVERNING IS SPECIFICATION	CHARACTERISTIC STRENGTH FY MPA	ELASTIC MODULUS GPA
S 240	IS:432 Part 1 Mild Steel Bar	240	200
S 415	IS: 1786 High Yield Strength Deformed	415	200
Fe 500	IS: 1786 High Yield Strength Deformed	As per IS code	As per IS code

Other grades of bars conforming to 13:432 and IS: 1786 shall not be permitted.

All steel shall be procured from original producers, no re-rolled steel shall be incorporated in the work.

Only new steel shall be delivered to the site. Every bar shall be inspected before assembling on the work and defective, brittle or burnt bar shall be discarded. Cracked ends of bars shall be discarded.

Fusion-bonded epoxy coated reinforcing bars shall meet the require-ments of IS: 13620. Additional requirements for the use of such reinforcement bars have been given below:

(a) Patch up materials shall be procured in sealed containers with certificates from the agency who has supplied the fusion bonded epoxy bars.

(b) PVC coated G.I. binding wires of 18G shall only be used in conjunction with fusion bonded epoxy bars.

(c) Chairs for supporting the reinforcement shall also be of fusion bonded epoxy coated bars.

(d) The cut ends and damaged portions shall be touched up with repair patch up material.

(e) The bars shall be cut by saw-cutting rather than flame cutting.

(f) While bending the bars, the pins of work benches shall be provided with PVC or plastic sleeves.

(g) The coated steel shall not be directly exposed to sunrays or rains and shall be protected with opaque polyethylene sheets or such other approved materials.

(h) While concreting, the workmen or trolleys shall not directly move on coated bars but can move on wooden planks placed on the bars.

When specified in the contract, protective coating prescribed by CECRI shall be provided in conformance to specifications given in Appendix . The CECRI coating process shall be allowed to be implemented at the site of works provided a representative of the Institute is present throughout the duration of the coating process who shall certify that the materials and workmanship are in accordance with prescribed specifications developed by the Institute.

8.0 Structural Steel

Unless otherwise permitted herein, all structural steel shall before fabrication comply with the requirements of the following Indian Standards:

IS:226 : Structural Steel (Standard Quality)

IS:961 : Structural Steel (High Tensile)

IS:2062 : Weldable Structural Steel

IS:8500 : Weldable Structural Steel (medium & high strength qualities)

IS: 1148 : Hot rolled rivet bars (upto 40mm dia) for structural purposes

IS:1149 : High tensile rivet bars for structural purposes

IS:1161 : Steel tubes for structural purposes

IS:4923 : Hollow Steel sections for structural use

IS:11587 : Structural weather resistant steel

IS:808 : Specifications for Rolled Steel Beam, Channel and Angle Sections

IS: 1239 : Mild Steel Tubes

IS: 1730 : Dimension for Steel Plate, sheet and strip for structural and general engineering purposes

IS:1731 : Dimension for Steel flats for structural and general engineering purposes

IS: 1732 : Dimension for round and square steel bars for structural and general engineering purposes

IS:1852 : Rolling and cutting tolerances for hot rolled steel products

STAINLESS STEEL

Stainless steel shall be austenitic chromium-nickel steel, possessing rust, acid and heat resistant properties conforming to IS:6603 and IS:6911. Mechanical properties/grade for such stainless steel shall be as specified by the accepting authority, but in no case be inferior to mild steel. Generally, stainless steel is available as per AISI grades. AISI 304 which is equivalent to grade 04Crl8NillO of IS:6911 satisfies the requirements of mechanical properties of structural steel. Other grades of stainless steel for specific purposes may be provided as per specific requirements. For application in adverse/ corrosive environment, stainless steel shall conform to AISI 316L or 02G17 Ni Mo2 of IS:6911.

9.0 WATER

Water shall be from the source approved by the Architect / Employer and shall be in accordance with clause 4.3 of IS:456.

Before starting any concreting work and wherever the source of water changes, the water shall be tested for its chemical and other impurities to as certain its suitability for use in concrete for approval of the Architect / Employer No water shall be used until tested and found satisfactory. Cost of all such tests shall be borne by the contractor.

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel.

Potable water is generally considered satisfactory for mixing concrete. Mixing and curing with sea water shall not be permitted.

As a guide, the following concentrations represent the maximum permissible values:

(a) To neutralise 200 ml sample of water, using phenolphthalein as an indicator, it should not require more than 2 ml of 0.1 normal NaOH.

(b) To neutralise 200 ml sample of water, using methyl orange as an indicator, it should not require more than 10 ml of 0.1 normal HCl.

(c) The permissible limits for solids shall be as follows when tested in accordance with IS:3025:

SUBSTANCES	PERMISSIBLE LIMITS (MAX)
Organic	200 mg/lit
Inorganic	3000 mg/lit
Sulphates (SO,)	500 mg/lit

Chlorides (Cl)	500 mg/lit *
Suspended matter	2000 mg/lit

*In case of structures of lengths 30m and below, the permissible limit of chlorides may be increased upto 1000 mg/lit.

All samples of water (including potable water) shall be tested and suitable measures taken where necessary to ensure conformity of the water to the requirements stated herein.

(d) The pH value shall not be less than 6.

TIMBER

The timber used for structural purposes shall conform to IS:883.

10.0 CONCRETE ADMIXTURES

10.1 General

Admixtures are materials added to the concrete before or during mixing with a view to modify one or more of the properties of concrete in the plastic or hardened state.

Chemical admixtures are not to be used until permitted by the Architect / Employer. In case their use is permitted, the type, amount and method of use of any admixture proposed by the contractor shall be submitted to the Architect / Employer for approval.

Concrete admixtures are proprietary items of manufacture and shall be obtained only from established manufacturers with proven track record, quality assurance and full fledged laboratory facilities for the manufacture and testing of concrete.

The General Contractor shall provide the following information concerning each admixture after obtaining the same from the manufacturer:

(a) Normal dosage and detrimental effects, if any, of under dosage and over dosage.

(b) The chemical names of the main ingredients in the admixtures.

(c) The chloride content, if any, expressed as a percentage by the weight of the admixture.

(d) Values of dry material content, ash content and relative density of the admixture which can be used for Uniformity Tests.

(e) Whether or not the admixture leads to the entertainment of air when used as per the manufacturer's recommended dosage, and if so to what extent

(f) Where two or more admixtures are proposed to be used in any one mix, confirmation as to their compatibility.

(g) There would be no increase in risk of corrosion of the reinforcement or other embedments as a result of using the admixture.

10.2 Physical and Chemical Requirements

Admixtures shall conform to the requirements of IS:9103. In addition, the following conditions shall be satisfied :

(a) "Plasticisers" and "Super-Plasticisers" shall meet the requirements indicated for "Water reducing Admixture".

(b) Except where resistance to freezing and thawing and to disruptive action of de-icing salts is necessary, the air content of freshly mixed concrete in accordance with the pressure method given in IS: 1199 shall not be more than 2 percent higher than that of the corresponding control mix and in any case not more than 3 per cent of the lest mix.

(c) The chloride content of the admixture shall not exceed 0.2 per cent when tested in accordance with IS:6925. In addition, the maximum permissible limit of chloride content of all the constituents as indicated in Section 1700 shall also be observed.

(d) Uniformity tests on the admixtures are essential to compare qualitatively the com-position of different .samples taken from batch to batch or from the same batch at different times.

The tests that shall be performed along with permissible variations in the same are indicated below:

Dry Material Content shall be within 3 per cent and 5 per cent of liquid and solid admixtures respectively of the value stated by the manufacturer.

Ash content shall be within 1 per cent of the value stated by the manufacturer.

Relative Density (for liquid admixtures) shall be within 2 per cent of the value stated by the manufacturer.

(e) All tests relating to the concretes admixtures shall be conducted periodically at an independent laboratory and compared with the data given by the manufacturer.

Retarding admixtures when used shall be based on lignosulphonates with due consideration to clause 5.2 and 5.3 of IS:7861.

Waterproofing admixtures shall comply with IS:2645.

11.0 REINFORCED CONCRETE PIPES

Reinforced concrete pipes for highway structures shall be of NP4 type conforming to the requirements of IS:458.

11.1 Pre-moulded joint filler:

Joint filler board for expansion joints which are proposed for use only at some abutting structures like bridges and culverts shall be of 20-25 mm thickness within a tolerance of ± 1.5 mm and of a firm compressible ' material and complying with the requirements of IS: 1838, or BS Specification Clause No. 2630. It shall be 25 mm less in depth than the thickness of the slab within a tolerance of ± 3 mm and provided to the full width between the side forms. It shall be in suitable lengths which shall not be less than one lane width. Holes to accommodate dowel bars shall be accurately bored or punched out to give a sliding fit on the dowel bars.

11.2 Joint sealing compound:

The joint sealing compound shall be of hot poured, elastomeric type or cold polysulphide type having flexibility, resistance to age hardening -and durability. If the sealant is of hot poured type it shall conform to AASHTO M282 and cold applied sealant shall be in accordance with BS 5212 (Part 2).

12.0 STORAGE OF MATERIALS

12.1 General

All materials may be stored at proper places so as to prevent their deterioration or intrusion by foreign matter and to ensure their satisfactory quality and fitness for the work.

The storage space must also permit easy inspection, removal and restorage of the materials. All such materials, even though stored in approved godowns/places, must be subjected to acceptance test prior to their immediate use.

12.2 Aggregates

Aggregate stockpiles may be made on ground that is denuded of vegetation, is hard and well drained. If necessary, the ground shall be covered with 50 mm plank. Coarse aggregates, unless otherwise agreed by the Engineer-in-Charge in writing, shall be delivered to the site in separate sizes (2 sizes when nominal size is 25 mm or less and 3 sizes when the nominal size is 32 mm or more).

Aggregates placed directly on the ground shall not be removed from the stockpile with in 30 cm of the ground until the final cleaning up of the work, and then only the clean aggregate will be permitted to be used.

In the case of fine aggregates, these shall be deposited at the mixing site not less than 8 hours before use and shall have been tested and approved by the Engineer-in-Charge.

12.3 Cement

Cement shall be transported, handled and stored on the site in such a manner as to avoid deterioration or contamination. Cement shall be stored above ground level in perfectly dry and water-tight sheds and shall be stacked not more than eight bags high. Wherever bulk storage containers are used their capacity should be sufficient to cater to the requirement at site and should be cleaned at least once every 3 to 4 months.

Each consignment shall be stored separately so that it may be readily identified and inspected and cement shall be used in the sequence in which it is delivered at site. Any consignment or part of a consignment of cement which had deteriorated in any way, during storage, shall not be used in the works and shall be removed from the site by the General Contractor without charge to the owner.

The General Contractor shall prepare and maintain proper records on site in respect of delivery, handling, storage and use of cement and these records shall be available for inspection by the Engineer-in-Charge at all times.

The General Contractor shall make a monthly return to the Engineer-in-Charge on the date corresponding to the interim certificate date, showing the quantities of cement received and issued during the month and in stock at the end of the month.

Cement shall be stored on a raised floor in dry weather proof and draught free but well ventilated shed.

Cement bags shall be stacked close together away from external walls and in stacks not more than ten bags to avoid lumping under pressure.

Cement of different types shall be stored in separate sheds or separate compartment of a shed. If different types of cement are mixed, the Architect / Employer will have the discretion to condemn all the cement concerned.

The contractor shall be responsible for the storage of cement at the site and no claim will be entertained in the event of any damage occurring to cement due to faulty storage by the contractors or on account of his negligence.

Cement stored on site for a period longer than eight weeks shall be tested to the satisfaction of the Architect / Employer before it is used in the works.

12.4 Reinforcement / Un-tensioned Steel

The reinforcement bars, when delivered on the job, shall be stored above the surface of the ground upon platforms, skids, or other supports, and shall be protected from mechanical injury and from deterioration by exposure.

12.5 Water

Water shall be stored in containers/tanks covered at top and cleaned at regular intervals in order to prevent intrusion by foreign matter or growth of organic matter. Water from shallow, muddy or marshy surface shall not be permitted. The intake pipe shall be enclosed to exclude silt, mud, grass and other solid materials and there shall be a minimum depth of 0.60 m of water below the intake at all times.

. B SITE CLEARANCE & EARTHWORK

1.0 GENERAL

1.1 All earth work shall generally comply with this specification and relevant local code of practice & standard. Unless otherwise specified, following codes/standards shall be used for earth work

IS:1200 (Part I) 1992	– Method of measurement of earthwork (Fourth revision)
IS:3764 1992	– Code of practice for excavation works (First revision)
IS:4082 1996	– Recommendation on stacking and storage of construction materials and components at site (Second revision)
IS:13416 (Part 3) 1994	– Recommendation for preventive measures against hazards at work places; disposal of debris
SP 62:1992	– Handbook on building construction practices
SP 70:2001	– Handbook on construction safety practices
IRC codes	

1.2 All earthworks shall be finished to uniform surfaces which shall conform to the following limits for the lines, grades and widths shown in the approved construction drawing:

Formation width of drains, trenches, roads & foundation pits
The widths measured on earth side from the centre line to the toe of cut and/or the top edge of fill shall not be less than the width specified in the drawings and no portion of the cut slope shall encroach within the formation width.

Formation Level of drains, trenches, roads & foundation pits
The finished surface shall not vary by more than 25mm above or below the specified levels and no points in the general surface shall vary by more than 12mm from a 3 metre straight edge laid parallel to the centre line of the drain/trench/road/foundation pit or from a template placed at right angles to the centre line.

Slopes of platform levels
At all levels, the average slope shall not be steeper than the slopes specified and no point on the completed slope shall vary from the average plane by more than 150mm in the case of earth slope in cut or 300mm in the case of fill slope.

Drainage at excavation site
The Contractor shall at all times keep the site free of standing water by means of temporary drainage. Before the conclusion of each day's work, the Contractor shall grade the site to prevent ponding of water should it rain during the night.

2.0 SITE CLEARANCE

2.1 The Construction site shall be cleared from all kind of rubbish/debris, loose rocks/boulders, trees, shrubs, stumps, grass, brush wood, undergrowth and all other vegetation including superficial earth etc. as directed by Engineer-in-Charge.

2.2 All materials arising from site clearance shall be the property of the Owner and shall not be removed from site until written approval shall be given by Owner / Engineer-in-Charge. All usable /serviceable materials shall be temporarily stacked in separate lots at the site as directed by Engineer-in-Charge and shall be transported to designated place.

2.3 All other materials from site clearance which, in opinion of Engineer-in-charge are not useable shall be carted away by General contractors to approved disposal areas.

2.4 The site clearance shall cover all operations required in full for clearing the site and its surroundings, including providing labour, materials, tools, equipments and incidentals necessary to complete the work. It will also include handling, salvaging, piling or stacking or collecting and disposing off cleared materials.

3.0 PRE-CONSTRUCTION SURVEY

3.1 Upon completion of site clearance General Contractor shall carry out a joint pre-computation survey to establish the site boundaries, global grids, existing roads, drains and other elements prior to any excavation work. Surveying work should be carried out by nominated licensed surveyor by client and survey plan need to be endorsed by licensed surveyor and submitted to client and Engineer-in-charge.

4.0 TOPOGRAPHICAL SURVEY OF SITE

4.1 General contractor shall carry out an independent topographical survey and compare the existing site levels and contours against the topographical survey plan furnished with construction drawings. Any discrepancies should be brought to Engineer-in-charge prior to commence any earth work.

5.0 CLASSIFICATION OF EXCAVATION MATERIALS

The work to be done under this section comprise supply of all labour, plant and materials and the performance of all work necessary for excavation with necessary shoring, strutting, including disposing of all surplus excavated material from the site as directed by the Architect/Employer.
All materials involved in excavation shall be classified “all sorts of soil” and “rock” as under, by the Engineer-in-charge and his decision shall be final and binding on the Contract, for measurement of excavation and payment.
“All sorts of soil” shall include dry and wet soil, sand, gravel, soft / hard compact murrum, ordinary / stiff clay, rubble soling, metalling, lime concrete, brick stone & other masonry, small size stones and other similar materials which can be excavated by excavators, spade, pick, shovel, etc. without resorting to barring, wedging, chiseling, etc. (This item includes all types of materials to be excavated excluding “Rock” as defined below). The macadam surfaces of any description (water-bound, grouted tarmac, etc.) shall also be included in this classification and measured under this item.

"Rock" shall include weathered rock or solid rock, plain cement concrete, reinforced cement concrete and all boulders, which can only be removed by barring, wedging, chiseling and blasting.

6.0 EXCAVATION

6.1 All excavation work shall include excavation, removal and satisfactory disposal of all materials from within the limits of the works. It shall also include all excavation, shaping and sloping for the construction, preparation and completion of the sub-grade, shoulders, batters, drains, intersections, approaches, ramps, etc to the required alignments, grade and cross section as designed/shown in the approved construction drawings.

The Contractor may encounter soft rock during excavation with an expectation of some hard rock in the area. The contractor shall verify at site and make himself aware of the site conditions before pricing the tenders. No additional amount would be admissible later on this account.

6.2 Unless otherwise specified or shown in the approved construction drawings, maximum slopes to cuttings shall conform to the following:

Materials	Maximum Slope (Horizontal Distance to Vertical Rise)
Sand	(3 : 1)
Loose gravel or medium clay, loam	(1½ : 1)
Shale or similar soft rock	(1 : 1)
Jointed laminated or soft rock	(½ : 1)
Massive rock	(¼ : 1)

6.3 When according to the Engineer-in-charge assessment of the type of materials at the cut site, the slopes as proposed on the approved drawings have to be re-determined, General Contractor shall cut the slope as instructed and General Contractor shall not be entitled to claim for additional work except when the re-determination is made for purposes other than to ensure the stability of the cutting. If however, the General Contractor excavates the slope of a cutting beyond the specified line and the tolerance applicable thereto, the General Contractor may be instructed to fill and make up the cutting to the required slope, in the manner as directed by Engineer-in-charge, all at General Contractor's own expense. Such a change shall not be regarded as a re-determination of the slope and no payment shall be made.

6.4 Excavation for foundation, trenches, drain pipes, etc. shall be carried out to the dimensions, depth levels as indicated in the drawing. If General Contractor excavates to any greater widths or depths than shown on the drawings for the above, then General Contractor shall fill in such depths or widths of excavation with grade M15 concrete at his own cost.

6.5 The bottoms of all excavations shall be free from mud and water, trimmed clean protected from the effects of weather and thoroughly consolidated & compacted to the satisfaction of Engineer-in-charge by rollers, rammers or other approved methods before placing any constructional material. All soft or defective portions shall be cut out and filled in with selected excavated material well consolidated in layers not exceeding 150mm-200mm thick, except for foundation which is covered in Clause above.

6.6 Where required, General Contractor shall design and provide all necessary planking, strutting and sheet piles if necessary to uphold the face of the excavation, necessary staging, etc without any additional cost. General Contractor shall ensure the safety from slips, bows and damage to adjacent work and property or injury to persons. All such shoring shall be removed after all the items of work for which it is required are completed.

6.7 All kind of excavated materials shall be placed at a distance more than two metres away from the excavation, or as directed by the Engineer-in-charge. Materials suitable for back filling or other usage shall be sorted and stacked at suitable & appropriate location as decided by Engineer-in-charge. General Contractor shall include all cost for any additional handling, lift, lead, transportation and all other operations required for utilizing such material for back filling in the final place of back fill or other use in the work.

6.8 Unsuitable and surplus materials, which in the opinion of the Engineer-in-charge should not be intended for any use in the premises; it should be carted away and disposed off outside the site by the General Contractor at his own cost.

6.9 All water, which may be accumulated in excavation during the progress of the work, from springs, rains or other causes, shall be bailed/ pumped out or otherwise removed at no extra cost till the work is completed and all such operations towards dewatering for the entire duration of the work shall be included in Excavation.

6.10 If there are any slips and bows in excavation, these shall be removed by General Contractor at his own cost. Any overhang of existing pavements, existing foundations, etc., arising due to undermining or any other causes shall be removed by General Contractor at his own cost and any damages to existing pavements etc. due to additional excavation carried out by General Contractor or due to undermining, or due to any other reason, shall be made good to the original condition by General Contractor at his own cost, as instructed by the Engineer-in-Charge.

6.11 If pipes, cables and any underground services encountered during excavation, it shall be properly supported by General Contractor at his own cost without any damaging to such services. During excavation General Contractor should provide particular care to avoid injury to personnel from live cables, etc. and to avoid damage to drains, water mains, cables and underground services. All damage shall be made good by General Contractor, at his own cost, to the satisfaction of Engineer-in-Charge.

6.12 Any live or abandoned services encountered during excavation, it should be brought to the attention of the Engineer-in-Charge immediately. All abandoned services in excavation shall be removed by General Contractor; any extra excavation involved due to such operations, which are carried out with the prior permission of the Engineer-in-Charge shall be measured under the respective items and paid as per the schedule of rates in the contract. All materials removed out by such operations shall be treated as excavated materials and disposed off by General Contractor at his own cost, as directed by Engineer-in-charge, in the same manner as specified for excavated materials.

6.13 The General Contractor shall, at his own expense, ensure that the area under excavation is securely fenced with proper warning / caution signs and illuminate with red lights at nights to avoid accidents. He shall also at his own cost take all necessary protective measures, and ensure that excavation for foundations, basements, etc. does not affect or damage any services, adjoining structures, etc. General Contractor shall be entirely responsible for any injury to lives or damage to property caused by his negligence or any accident due to his constructional operations.

7.0 REMOVAL OF ROCK AND OTHER BLASTING OPERATIONS

7.1 Should rock be met in the course of excavation, it must be removed by approved means.

7.2 Blasting will not be allowed without written permission from the Engineer-in-charge. If explosives are to be used, General Contractor shall obtain all necessary licenses from the appropriate local authorities and shall inform to all Government regulations relating to transport storage, handling and use of the explosives and shall also confirm to the rules set out by the Officer-in-Charge of respective local authority related to Arms and Explosives.

7.3 Rock is material, which in the opinion of Engineer-in-charge, can only be excavated by use of wedges or compressed air plant. Rock is to be stacked on site for measurement before being carted away. Rocks removed without prior measurement will not be paid later.

7.4 Excavation in solid rock shall mean excavation in rock found in ledges, large bounders or masses in its original position which would normally have to be loosened by pneumatic tools or if excavated by hand, by wedges and sledge hammers. All solid boulders or detached pieces or rock exceeding 0.38m^3 in volume in trenches or exceeding 0.76m^3 in general excavation but not otherwise shall be regarded as solid rock.

7.5 Material other than rock including but restricted to earth gravel and also such hard and complex material which can be removed by ordinary excavating machines and also boulders or detached pieces of solid rock not exceeding 0.38m^3 in volume in trenches or 0.76m^3 in general excavation shall be regarded as ordinary materials.

7.6 On encountering rock, General Contractor shall notify to Engineer-in-charge the existence of such material. Engineer-in-charge shall reserve the right to decide whether such material is rock or otherwise and his decision shall be final.

Ordinary Rock:

Ordinary rock may be defined as that which may be quarried or split with crow bars or picks such as lime stone, sand stone, hard laterite, hard conglomerate and un-reinforced cement concrete below ground level.

If required, light blasting may be resorted to, for loosening the materials, but this will not in any way entitle the material to be classified as Hard Rock.

Hard Rock

Hard Rock may be defined as : any rock or boulder for the excavation of which blasting is required such as Quartzite stone, granite, basalt reinforced cement concrete (reinforcement to be cut through but not separated from concrete) below ground level and the like. Hard rock requiring blasting as described above but where blasting is prohibited for any reasons and excavation has to be carried out by chiseling, wedging or any other agreed method will also be regarded as Hard Rock.

In the case of hard rock, if required by the Architects, the excavated stuff shall be properly stacked or disposed of in places as directed. The quantity of these stacks shall be measured and payment will be based if necessary on the net quantities after deducting 50% of for voids from the measured quantities.

Support of Excavation

The Contractor shall adequately support the sides of excavation as may be necessary to prevent subsidence or movement of the material in which the excavation is being carried out and to ensure the safety of persons and nearby structures.

Slips

The Contractor shall take all necessary precautions to prevent slips in excavations and shall at his own expense make good any damage or defect and remove top soil dumps and any surplus material caused by slips.

8.0 REMOVAL OF SOFT SOIL AREAS OR UNSUITABLE MATERIAL

8.1 In cuttings where soft and unsuitable materials occur within one metre below the design platform levels of the sub-grade, such materials shall be removed and replaced with approved stable materials in layers not exceeding 150mm-200mm loose thickness, compacted as elsewhere specified.

9.0 APPROVAL OF EXCAVATION

9.1 General Contractor shall report to Engineer-in-charge when secured bottoms have been obtained in the excavations and are ready to receive the foundations. Any concrete or other work put in before Engineer-in-charge's approval shall be removed and replaced at General Contractor's own expense.

10.0 DISPOSAL OF SURPLUS EXCAVATED MATERIAL

10.1 Surplus excavated material arising from excavation and not required for filling, etc. shall be removed, deposited, spread, leveled and mechanically rammed and consolidated on site where directed by the Engineer-in-charge or removed off the site. General Contractor shall find his own area for dumping, which has to be approved by the Engineer-in-charge.

11.0 EARTH FILL

11.1 Approved material shall be used for fill of site, construction including embankments, and shall be free from logs, stumps, weeds and organic matter or any other deleterious matter. The filling material shall consist of suitable material all of which shall pass a125mm IS sieve and at least 95% shall pass the 75mm IS sieve.

11.2 The coefficient of uniformity shall be greater than 10. The fraction passing a 75 μm IS sieve shall be less than 20% by weight and shall have the following characteristics:

Liquid limit not exceeding 35;
Plasticity index not exceeding 12

11.3 Areas and embankments on which fills will be constructed shall first be cleared and grubbed as specified. Top soil to full depth including turf, grass, bushes shall be removed; estimated depth of top soil at various part of construction site are furnished in tender drawings. Filling shall not be placed until the approval of Engineer-in-charge has been obtained.

11.4 Embankments & site filling shall be constructed in such an order and manner that adequate drainage of the working areas is maintained throughout the construction period.

11.5 Surfaces with slopes steeper than one vertical to four horizontal shall be cut into a series of level benches before filling. Filling shall be placed in horizontal layers beginning at the lowest point in the natural surface and shall be constructed to the full dimensions of the embankment at each layer. Materials which have been loosened shall be compacted together with the filling placed in the succeeding layer. The loose thickness including the newly placed fill of the layers shall not exceed 200mm.

11.6 All fills shall be constructed in layers of uniform thickness not exceeding 200mm and each layer shall be compacted as specified in Clause "compaction of earth work". Layers of filling may be formed by equipment which will spread the material as it is dumped, or by blade or spreading by other acceptable methods so that the material is uniformly distributed.

11.7 Before beginning compaction, the material in each layer of the embankment shall be uniform in composition and moisture content. Clods of material shall be broken and the material mixed by blade, harrowing, disking or by other methods. Oversized rocks shall be broken to the specified maximum dimension of 125mm. Rock shall be placed, spread and compacted in such a manner that the interstices between the larger pieces are filled with compacted finer materials.

11.8 Unless otherwise specified or shown on the drawings, the maximum slopes for fill will conform to the following:

Material	Maximum Slope (Horizontal Distance to Vertical Rise)
Sandy loam, clay and loose sand	(3 : 1)
Ordinary lateritic earth	(1½ : 1)
Rock	(1¼ : 1)
Rock filling-hand pitched	(1 : 1)

11.9 When Engineer-in-charge re-determines a slope, the Contractor shall not be entitled to claim whatsoever, unless such re-determination is for the purpose other than to ensure the stability of the slope.

12.0 FILL ADJACENT TO CULVERTS ABUTMENTS, WING AND RETAINING WALLS

12.1 Materials adjacent to weep-holes in abutments, wing and retaining walls shall consist of clean, hard and durable broken stone, graded from 50mm to 9mm sizes of particles. The larger particles shall be placed adjacent to the weep-holes and the small particles behind and above the larger particles.

12.2 The graded broken stone shall extend horizontally at least 300mm from each weep-hole and at least 450mm vertically above the weep-hole.

12.3 In addition to the graded broken stone at weep-holes, selected fill consisting of granular material having a maximum size of 50mm, a Plasticity Index of not more than twelve (12) and having at least sixty (60) per cent retained on a No. 7 IS. Sieve (2.40mm) shall be placed adjacent to bridges, culverts and walls in accordance with the following tables:

Structure	Minimum Width of Selected Fill
Bridge abutment and wing walls	2.0 m

Culvert wing walls	H/3
Retaining walls	H/3
Barrels of box culverts	H/3
Barrels of pipe culverts	600 mm
(Where H = Height of Structure)	

12.4 Engineer-in-charge shall determine whether the material proposed by General Contractor or excavated from the site is suitable for use as selected fill. If in the opinion of the Engineer-in-charge selected material of the required quality is unobtainable from the excavation under the Contract, he may give authority for the material to be obtained from other borrowed sites with no extra payment to General contractor.

12.5 The selected fill shall be placed in layers of 150mm-200mm up to the sub-grade level. Compaction shall start at the wall and proceed away from it and shall be carried out as specified in Clause “Compaction of Earthworks”.

12.6 Where the slope of the natural surface behind abutment walls and wing walls exceeds one (1) vertical to four (4) horizontal, the slope shall be cut in the form of successive horizontal terraces at least 600mm in width.

12.7 No fill shall be placed against abutments or wing walls of concrete structures within 14 days after placing concrete in the abutments or walls and in the superstructure of the adjacent span, unless the walls are properly strutted to the approval of Engineer-in-charge.

12.8 In the case of spill-through abutments, rock fill shall not be dumped against the columns but shall be built up evenly by hand placing around individual columns.

12.9 In the case of framed structures, fill at both ends of the structures shall be brought up simultaneously, the difference between the levels of the fills at the respective abutments not to exceed 600mm.

Dewatering

Generally the rate quoted shall include bailing of all remaining water which may accrue in excavation. While execution of works, if so encountered, the Contractor shall provide for the purpose of excavation under water, all the necessary dewatering equipment, like well points, pumps (including stand byes), pipes, conduits etc and make necessary arrangements for proper drainage of the pumped water from the well points and its easy disposal without affecting the site and the adjoining areas. Any permission required for such disposal of water to other areas, shall be taken from the respective authorities by the Contractor. The Contractor shall engage the dewatering equipment in such a way that the excavated pit should always remain dry while the excavation and concrete work for column and wall foundation, slabs, column and wall upto ground floor level are carried out. The dewatering process shall be carried out till the concrete or other structures in works as mentioned above has set sufficiently and backfilling on sides of foundation including ramming, compaction by 20cm layers is completed to satisfaction and approval of Architect / Employer, at no extra cost to the Employer. Dewatering by pumps as required at site shall be included in the rate wherever specified in the item(s) of Excavation.

13.0 COMPACTION PLANT

13.1 Compaction methods and compaction plants/machinery used shall be in accordance with the recommendation given in IRC code or equivalent local standard.

13.2 General Contractor shall provide and operate sufficient compaction plants of suitable type which shall be approved by Engineer-in-charge to compact site area, embankments, sub-grades and pavement courses in accordance with these specifications.

13.3 Any type of compacting equipment which the General Contractor may desire to use shall first have to be approved by the Engineer-in-charge before being put into service. If it fails to produce the specified compaction, it's use shall be discontinued and other approved rollers shall be provided immediately.

14.0 COMPACTION OF EARTHWORKS

14.1 Sub-grade in cuttings, areas upon which fills are to be placed and all fill material shall be compacted to the standards indicated hereunder. All compaction shall be carried out using approved mechanical plants in accordance with the recommendation given in IRC code or any other equivalent local standards.

14.2 The depth of each compacted layer shall not be greater than the maximum depth of the compacted layer stipulated for each type of compaction plant.

14.3 Earthmoving plant shall not be accepted as compaction equipment.

14.4 Alternative methods or plants may be accepted if it can be demonstrated to the satisfaction of the Engineer-in-charge at site trials that the required field density can be achieved.

14.5 Before commencement of any filling, each class of fill material to be compacted shall be tested by an accredited laboratory to establish the maximum value of the dry density that can be achieved and the optimum moisture content for compaction.

14.6 Each layer of material placed (including sub-base layers), the natural surface in areas to be occupied by fills, the natural surface at the junction of cuts and fills, materials backfilled in cutting and material replacing unstable portions of the natural surface with selected material shall be trimmed as construction proceeds and shall be uniformly compacted to the required density before the laying of the next layer is commenced. The compaction of undisturbed natural ground shall be to the required density for a depth of not less than 200mm.

14.7 The in-situ field densities of all compacted materials calculated as a percentage of the maximum dry density shall not be less than:

Within 300mm of formation level - 95 %
Below 300mm of formation level - 90 %

14.8 Notwithstanding compliance with the recommendation given in IRC code, the General Contractor shall carry out site tests at a rate of 1 test per 400 m^2 of surface area of each compacted layer to verify that the required field density is achieved, and make any adjustments to the compaction methods if necessary.

14.9 At the time of compaction of each layer, the moisture content of the material shall be adjusted so as to obtain the degree of compaction specified. When directed by the Engineer-in-charge, water shall be added to material which contains insufficient moisture

for compaction. The added water shall be sprayed uniformly and thoroughly mixed with material until a homogenous mixture is obtained. Material containing excessive moisture shall not be compacted until the material has dried out sufficiently to obtain the required compaction.

14.10 Compaction shall be undertaken by any means necessary to obtain the specified compaction for the full depth of each layer in fills and for the full width of the formation over the entire length of the work. At locations where it would be impracticable to use mobile power compacting equipment, fill layers shall be compacted to the specified requirements by any means approved by the Engineer-in-charge that will obtain the specified compaction.

14.11 Construction equipment and traffic shall not be allowed on the sub-grade or fill while it is in a wet condition. Material which has become excessively wet shall be dried or removed from the site and replaced by material of suitable moisture content for compaction at the General Contractor's expense.

14.12 Filling over and around pipes, culverts, bridges and other structures shall be compacted in such a manner that will avoid unbalanced loading and that will not cause movement or place strain on any structures.

14.13 General contractor shall compact the sub-grade under the building column foundations, machine foundations and slab-on-grade to the following requirement
Compaction ratio for the final layer shall be 98%, CBR of 25% and E > 80 Mpa
Compaction ratio for the intermediate layers shall be 95%

The Contractor shall carry out following recommended tests to demonstrate that adequate compaction in accordance with the above Specifications has been carried out to the sub-grade or fill layers.

Dry Density - Moisture content of sub-grade or fill material.
In-situ Field density tests
California Bearing Ratio Tests / Proctor
Plate bearing test to ensure the design soil bearing capacity as stated in drawings.

All tests need to be carried out every 400m^2 area of compacted sub-grade at each stages of compaction for building foundation and slab-on-Grade. Number of tests shall be increased to every 400m^2 for machine foundation base.

15.0 MEASUREMENT AND RATES

15.1 Volume of consolidated filling shall be measured. The dimensions shall be measured correct to the nearest cm and cubical contents worked out in cubic metres correct to two places of decimal. The rate shall include the cost of materials and labour involved in all the operations described above.

15.2 The classification of excavated material for measurement purposes shall be as given in specification above. Excavation shall be measured in cubic meters for each class of material encountered.

15.3 Fixing & removing of shoring, strutting, planking, bracing, timbering shall not be paid separately and should be included in excavation.

15.4 Additional width excavated including for basement walls, and its waterproofing treatment for convenience of working space or for any other reason shall be considered in the pricing and additional payment shall not be claimed for such excavations.

15.5 Back-filling with selected excavated material, watering, consolidation of the sub-grade base and filling, etc. shall be measured in volume.

15.6 The driving of sounding bars or jumping small drill holes to expose the nature of sub-stratum up to a total depth one meter below the bed of excavation and distribution in 2 or 3 locations in each foundation, if required by the Engineer-in-Charge, shall be considered included in the item of work and will be paid separately.

15.7 In particular, excavation shall be measured limited to the dimensions shown on the drawings or as directed by the Engineer-in-charge. Trenches with “Grips” for sockets of pipes shall be measured up to the depth exclusive of “Grips”. In case of rock, the measurement shall be on stack basis less 33% for voids.

15.8 Where excavation is in trenches or in fairly uniform ground “Dead Men” or “Tell Tales” shall be left at suitable intervals, as instructed by Engineer-in-charge, to determine the average depth of excavation. Where the ground is not uniform, levels shall be taken before the start, after the site clearance and after completion of the work and the quality of excavation shall be computed from these levels.

15.9 For backfill of spaces excavated for foundations, trenches etc. using selected excavated material which shall also include mixture of broken pieces of rock and fine material, no additional payment shall be made. The excavation rate shall be inclusive of such back fill including back fill beyond the payable volume of excavation. If instead of fully back filling with the selected excavated material, the General Contractor is instructed to backfill with approved material brought from outside, the measurement of such filling shall be the volume of payable excavation above less the volume of soling, metalling, concrete or masonry or basement construction, etc if any, provided within the excavation and also less the volume of filling executed with selected excavated materials.

15.10 Measurement of the volume of filling in plinth, below floor, sub-grade and similar locations whether with selected excavated materials or approved materials brought from outside shall be specified area multiplied by actual consolidated depth of fill. The fill shall be leveled / finished to the profile as directed. The quoted rates for excavation and filling shall include the cost of labour, plant and equipments, tools, safeguards and incidentals necessary to complete the work to the specifications.

16.0 DRAINAGE OF EXCAVATIONS

16.1 The General Contractor shall arrange for the rapid dispersal of water shed on to the site from any source. Where practicable, the water shall be discharged into the permanent outfall for the drainage system. Adequate means for trapping silt on temporary systems discharging into permanent drainage systems shall be provided.

16.2 Where necessary, temporary water courses, ditches, drains, pumping or other means of maintaining the earthworks free from water shall be provided. The General Contractor shall also maintain a sufficient minimum surface cross fall at all times and, where practicable, a sufficient longitudinal gradient to enable them to shed water and prevent ponding.

17.0 POST-CONSTRUCTION SURVEY

17.1 The Contractor shall submit post-construction survey plan certified by a registered surveyor showing as-constructed levels of roads, platforms, embankments, drainage, etc. of earthwork carried out at 10m grids.

17.2 After the site clearance operations have been carried out the limits of excavation shall be set to true levels, lines, curves, slopes, grades and sections, etc. as shown on the drawings or as directed by the Engineer-in-Charge.

18.0 SITE/POLLUTION CONTROL MEASURES

18.1 General Contractor shall implement effective erosion and sediment control measures (ECM) in accordance with the local authority requirements. ECM proposals shall be prepared by General Contractor and approved by the local Authority or Engineer-in-charge and implemented prior to commencement of site works. The ECM shall be regularly maintained to ensure their effectiveness during the course of construction works.

18.2 General Contractor shall implement comprehensive pest, Dogs, birds control, and surveillance for the site, including all necessary measures to prevent the site from being favorable to the breeding or harbouring of vectors and mosquito or other harmful to human. These shall be carried out regularly throughout the construction period in accordance to the local Authority requirements.

19.0 QUALITY ASSURANCE / QUALITY CONTROL / QUALITY DOCUMENTS

General contractor shall submit the following documents before commencement of any work

19.1 **Method Statement**

General Contractor shall prepare and submit a method statement including at least the following information as relevant to the Engineer-in-Charge prior to commencement of work:

Proposed excavation method, machinery and compaction plant
Maximum depth of each compacted layer
Minimum number of passes per layer
Method of slope protection & treatment
Proposed temporary works for deep excavation
Dewatering control
Inspection & test plan

19.2 **Sequence of cut & fill earth work**

General contractor shall submit a detail plan showing the zoning of earthwork with sequence and duration of earth works to Engineer-in-Charge for approval prior to the start work unless otherwise agreed.

19.3 **Additional Site Investigation and Factual Report**

General contractor shall study the site soil investigation report enclosed with contract and request to carry out additional borelogs if required with valid reason to Engineer-in-Charge's review and approval. There shall be no additional time given for conducting such extra soil investigation work and it should be within the contract period and General Contractor's own expense.

19.4 **Temporary Work design and details**

Before commencement of Work, General Contractor should submit a design calculation and detail drawings of proposed shoring system including shoring material, waler sizes & levels, strut size & level, connection detail of strutting elements, etc with sequence of excavation and backfilling to Engineer-in-Charge's review and approval.

If open cut shall be proposed General Contractor shall submit a calculation showing the stability of the slope with suitable soil parameters.

19.5 **Fill Material Samples**

At least 04 days before filling work commences, General Contractor shall submit full details of the sources and types of the proposed filling materials together with 25kg representative samples of each type from each source.

General contractor shall deliver the samples to an accepted accredited laboratory, with sufficient representative of samples of each material for the specified tests, at a rate of one set of tests per sample.

19.6 **Testing of Fill Materials**

General Contractor shall arrange for the following tests on all proposed fill materials at the rate of one test for each representative samples to be carried out at approved testing agency:

Soil Classification

Determination of the particle size distribution

Determination of the plasticity index (of material passing the 425 micron IS sieve; % of material retained to be reported)

Determination of the dry density / moisture content relationship of granular soil (vibrating hammer method)

Determination of the California Bearing Ratio

When directed, tests need to be carried out for all imported fill for compliance with specified limits on contamination to ensure that material is 'clean' relative to the proposed end use. General Contractor shall propose and submit the specific criteria, schedule and timing of tests required to Engineer-in-Charge's acceptance.

C ANTI TERMITE TREATMENT

1.0 SCOPE

1.1 The work of pre-constructional anti-termite treatment covered under this specification consists of the soil treatment with approved chemicals in water emulsion in foundation trenches for columns, plinth beams, brick wall, lift pits, machine foundation, trenches, steps, ramps etc. and on top surface of plinth filling, slab on grade, at junction of walls and floors, in expansion joints etc. in stages as detailed in this specification and drawing.

2.0 APPLICABLE CODES & SPECIFICATIONS

2.1 The relevant I.S specifications, standards and codes given below are made a part of this specification. All standards, specifications, code of practices referred to herein shall be the latest edition including all applicable amendments, revisions and additional publications.

2.2 List of Indian Standards

IS: 6313 (Part I)	- Code of Practice for Anti-termite Measures in Buildings Constructional Measures
IS: 1200 (Part I)	- Method of measurement of buildings and civil engineering works.
IS: 6313 (Part II)	- Pre-constructional Chemical Treatment Measures
IS: 8944	- Specification for Chloropyrifos Emulsifiable Concentrates
IS: 4015 (Part I)	- Guide for Handling cases of Pesticide Poisoning First Aid Measures
IS: 4015 (Part II)	- Symptoms, Diagnosis and Treatment

3.0 GENERAL

3.1 Pre-constructional anti-termite treatment is a process in which soil treatment is applied to a building in early stages of its construction. The purpose of anti-termite treatment is to provide the building with a chemical barrier against the sub-terranean termites.

3.2 Anti-termite treatment being a specialized job, calls for thorough knowledge of the chemicals, soils, termite to be dealt with and the environmental conditions. In order to give effective treatment and lasting protection to the properly underground treatment, it is, therefore, imperative that the works of anti-termite treatment should be got executed through specialized agencies only. The specialized agency should be preferably a member of the Indian Pest Control Association and shall have sufficient experience of carrying out similar works of magnitude envisaged in this tender.

3.3 The pre-constructional soil treatment is required to be applied during the construction stages of the sub-structure up to plinth level. The contractor has to be watchful of the various stages of sub-structure works and arrange to carry out the soil treatment in time after proper co-ordination with inter-discipline and other contractors if any, working at site.

3.4 Unless otherwise stipulated, the anti-termite treatment will be carried out as per IS 6313 (Part-II) and / or as per direction of Engineer-in-Charge.

4.0 SITE PREPARATION

4.1 In order to ensure uniform distribution of the chemical emulsion and to assist penetration, the following site preparation shall be carried out:

4.1.1 Remove all trees, stumps, logs or roots from the building site.

4.1.2 Remove all concrete formwork if left anywhere, leveling pegs, timber off cuts and other building debris from the area to be treated.

4.1.3 If the soil is to be treated is sandy or porous, preliminary moistening will be required to fill capillary spaces in and in order to prevent the loss of emulsion through piping or excess percolations.

4.1.4 In the event of water logging of foundation, the water shall be pumped out before application of chemical emulsion and it should be applied only when the soil is absorbent.

4.1.5 On clays and other heavy soil where penetration is likely to be slow and on sloping sites, where runoff of the treating solution is likely to occur, the surface of the soil should be scarified at least to a depth of 25mm.

4.1.6 All sub-floor leveling and grading should be completed, all cutting, trenches and excavation should be completed with backfilling in place. Borrowed fill must be free from

organic debris and shall be well compacted. If this is not done, supplementary treatments should be made to complete the barrier.

5.0 CHEMICAL TO BE USED

5.1 The effectiveness of chemical depends upon the choice of the chemical, the dosage adopted and the thoroughness of application. The chemical solutions or emulsions are required to be spread uniformly in the soil and to the required strength so as to form an effective chemical barrier that is lethal and repellent to termites.

6.0 MOUND TREATMENT

6.1 For a mound volume of about one cubic metre, four litres of an emulsion in water with 0.50 percent Chloropyrifos shall be used. Other chemicals with technical data sheet shall be submitted to Engineer-in-Charge if General Contractor desires to use any other brands.

7.0 SOIL TREATMENT

7.1 Chlorpyriphos emulsifiable concentrates chemical (IS: 8944) with 1.0 % in water emulsion shall be effective when applied uniformly over the area to be treated. General Contractor may propose alternate to Engineer-in-Charge.

8.0 MODE AND RATE OF APPLICATION

8.1 The chemical emulsion as stated above will be applied uniformly by spraying at the prescribed rates as detailed below in all the stages of the treatment unless follow the manufactures' recommendation:

8.1.1 **Treatment in Foundation Trenches:**
In case of normal wall load bearing structure, column pits, wall trenches and basement, the treatment shall be @ 5 (five) litres per square metre of surface area of the bottom and sides to a height of at least 300 mm. After the foundation works, the sides shall be treated @ 15 (fifteen) litres per square metre at vertical surface of sub-structure on each side.

After the earth filling is done, treatment shall be done by rodding the earth at 150 mm center to center close to wall surface and spraying the chemical with the above dose i.e., 15 (fifteen) litres per square metre. In case of framed structure, the treatment shall start at a depth of 500 mm below ground level. From this depth the backfill around the columns, beams and R.C.C basement walls shall be treated @ 15 (fifteen) litres per square metre of the vertical surface and @ 5 (five) litres per square metre for the horizontal surface at the bottom in the trenches/pits.

8.1.2 **Treatment on Top Surfaces of Plinth Filling:**
The top surface of the filled earth within plinth walls shall be treated with chemical emulsion at the rate of 5 (five) litres/square metre of the surface area before sub-base to floor is laid. If filled earth has been well rammed and the surface does not allow the emulsion to seep through; holes up to 50 mm to 75 mm deep 150mm centre to centre both ways shall be made with crowbars on the surface to facilitate saturation of the soil with the emulsion.

8.1.3 **Treatment at Junction of Walls and Floors:**

Special care shall be taken to establish continuity of the vertical chemical barrier on the inner wall surfaces from the finished ground level (or from level where the treatment had stopped) up to the level of the filled earth surface. To achieve this a small channel 30 x 30 mm shall be made at all the junctions of wall / column with floor (before laying sub-grade) and rod holes made in the channel up to the finished ground level at 150 mm apart and the iron rod moved backward to forward to break the earth and chemical emulsion poured along the channel @ 15 (fifteen) litres (or as recommended quantity) per square metre of the vertical wall / column surfaces so as to soak the soil right up to the bottom. The soil shall be tamped back into place after this operation.

8.1.4 **Treatment of Soil along External Perimeter of Building**

After the building is complete, provide holes in the soil with iron rods along the external perimeter of the building at intervals of about 150 mm and depth 300 mm and filling these holes with chemical emulsion at the rate of 7.5 litres per sqm.

8.1.5 **Vertical Surface**

In the event of the depth of the wall filling being more than 300 mm, the external perimeter treatment shall be extended to the full depth of filling upto the G.L. so as to ensure continuity of the chemical carrier. Treatment of soil under apron (plinth protection) along external perimeter
of building, to surface of the consolidated earth over which the apron is to be laid shall be treated with chemical emulsion at the rate of 5 litre per sqm. of the vertical surface before the apron is laid. if consolidated earth does not allow the emulsion to soak through, holes upto 50 to 75 mm centre both ways may be made with 12mm diameter mild steel rod on the surface to facilitate saturation of the soil with the chemical emulsion.

8.1.6 **Treatment for Expansion Joints:**
The soil beneath the expansion joints shall receive special attention when the treatment under 8.1.1 above is in progress. This treatment shall be supplemented by treating through the expansion joint after sub-grade has been laid at the rate of 2 (two) litres per metre length of expansion joint.

8.1.7 **Treatment of soil surrounding pipes and conduits**

When pipes and conduits enter the soil inside the area of the foundations, the soil surrounding the points of the entry shall be loosened around each such pipe, or conduit for a distance of 150 mm and to a depth of 75mm before treatment is commenced when they enter the soil external to the foundations, they shall be similarly treated unless they stand clear of the walls of the building by about 75 mm for the distance of over 300mm from ground level.

9.0 PRECAUTIONS DURING TREATMENT

9.1 Utmost care shall be taken to see that the chemical barrier is complete and continuous. Each part of the area shall receive the prescribed dosage of chemical emulsion.

9.2 The treatment should not be carried out when it is raining or when the soil is wet with rain or sub-soil water.

9.3 Once formed, the treated soil barrier shall not be disturbed. If by chance, treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and completeness of the barrier system.

10.0 PRECAUTIONS FOR HEALTH HAZARDS AND SAFETY MEASURES

10.1 All the chemicals mentioned above are poisonous and hazardous to health. These chemicals can have an adverse effect upon health when absorbed through the skin, inhaled as vapors or spray mist or swallowed. Persons handling or using these chemicals should be warned of these dangers and advised that absorption through the skin is the most likely source of accidental poisoning. They should be cautioned to observe carefully the safety precautions given by the manufacturer particularly when handling these chemicals in the form of concentrates.

10.2 These chemicals are usually brought to the site in the form of emulsifiable concentrates. The containers should be clearly labeled and should be stored carefully so that workers cannot get at them. They should be kept securely closed.

10.3 Particular care should be taken to prevent skin contact with concentrates. Prolonged exposure to dilute emulsions should also be avoided. Workers should wear clean clothing and should wash thoroughly with soap and water especially before eating and smoking. In the event of severe contamination, clothing should be removed at once and the skin washed with soap and water. If chemicals splash into the eyes, they shall be flushed with plenty of water and immediate medical attention should be sought.

10.4 The concentrates are oil solutions and present a fire hazard owing to the use of petroleum solvents. Flames should not be allowed during mixing.

10.5 Care should be taken in the application of soil toxicants to see that they are not allowed to contaminate wells or springs, which serve as sources of drinking water.

11.0 GUARANTEE

11.1 The contractor has to furnish the guarantee for 10 (ten) years from the date of completion of work stating that in case of re-appearance of termites within the building area due to defective materials or workmanship or due to any other reasons, the contractor will carry out the necessary post constructional treatment to keep the entire area free from termite once again, without any extra cost to the client during the guarantee period. Such a guarantee shall be directly given by the specialist agency to the employer in all forms approved by the Engineer

12.0 MODE OF MEASUREMENT

12.1 The payment will be made on the basis of plinth area measurements at ground floor only for all the stages of treatment in square metre rounded off to two places of decimals.

12.2 Rate includes the cost of materials, labour and all tools, consumables, spares for complete operation.

D REINFORCED CONCRETE

1.0 GENERAL

1.1 The quality of materials, method, control of manufacture and transportation of all concrete work in respect of mix whether reinforced or otherwise shall confirm to the applicable portion of these specification.

1.2 Engineer-In-Charge shall have the right to inspect the source of materials, layout and operation of procurement and storage of materials, the concrete batching and mixing equipments and the quality control system.

Such an inspection shall be arranged by General Contractor and Engineer-In- Charge's approval shall be obtained prior to starting of concrete work.

2.0 SCOPE

2.1 This specification covers the general requirements for concrete to be used in this project using on-site production facilities including requirements in regard to the quality, quantity, handling, storage of ingredients, proportioning, batching, mixing, and testing of concrete and also requirements in regard to the quality, storage, cutting, bending and fixing of reinforcement in position.

This also covers the transportation of concrete from mixer to the place of final deposit and placing, curing, protecting, repairing and finishing of concrete.

3.0 APPLICABLE CODES & SPECIFICATION

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

3.2 List of Indian Standards

IS: 269	- Specification for ordinary, rapid hardening and low heat Portland cement
IS: 383	- Specification for coarse & fine aggregate from natural source or concentrate
IS: 456	- Code of practice for plain and reinforced concrete
IS: 515	- Specification for natural and manufactured aggregate for use in mass concrete
IS: 516	- Method of test for strength of concrete
IS: 650	- Specifications for standard sand for testing of cement
IS: 1199	- Method of sampling and analysis of concrete
IS: 1200 (Part-II)	- Method of measurement of building works
IS: 1791	- Specification for batch type concrete mixers.
IS: 2386 (Part-I)	- Method of test for aggregates for concrete; Particle size and shape.
IS: 2386 (Part-II)	- Method of test for aggregates for concrete: Estimation of deleterious materials and organic impurities
IS: 2386 (Part-III)	- Method of test for aggregates for concrete: Specific gravity, density, voids, absorption and bulking.
IS: 2386 (Part-IV)	- Method of test for aggregates for concrete: Mechanical properties.

IS: 2386 (Part-V)	- Method of test for aggregates for concrete: Soundness.
IS: 2386 (Part-VI)	- Measuring mortar making properties of fine aggregates.
IS: 2386 (Part-VII)	- Method of test for Alkali aggregates reactivity.
IS: 2438	- Specification for roller pan mixer.
IS: 2505	- Specification for immersion type concrete vibrators.
IS: 2506	- Specification for screed board concrete vibrators.
IS: 2514	- Specification for concrete vibrating table.
IS: 2645	- Specification for integral cement water proofing compound.
IS: 3025	- Methods of sampling and test (physical and chemical) for water used in industry.
IS: 3366	- Specification for pan vibrator.
IS: 3370 (Part-I)	- Code of practice for concrete structures for the storage of liquids: General.
IS: 3370 (Part-II)	- Code of practice for concrete structures for the storage of liquids: Reinforced concrete structure.
IS: 3385	- Code of practice for measurement of Civil Engineering works
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: 3935	- Code of practice for composite construction
IS: 4031	- Method of physical test for hydraulic cement
IS: 4656	- Specification for form vibrator.
IS: 7861 (Part-I)	- Code of practice for extreme weather concreting (for hot weather concreting).
IS: 8112	- Specifications for high strength ordinary Portland cement (Grade 43).
IS: 10262	- Code of practice for design mix
IS: 12269	- Specifications for high strength ordinary Portland cement (Grade 53)
IS: 13311 (Part-I)	- Non-destructive testing of concrete: Method of test for ultrasonic pulse velocity.
IS: 13311 (Part-II)	- Non-destructive testing of concrete: Method of testing by rebound hammer.

4.0 MATERIALS FOR STANDARD CONCRETE

4.1 The ingredients to be used in the manufacture of standard concrete shall consist solely of a standard type Portland cement; clean sand, natural coarse aggregate, clean water, ice, an admixture, if specifically called for on drawings or schedule of quantities.

4.2 **Cement**

4.2.1 Unless otherwise specified or called for by Engineer-In-Charge cement The cement used shall be one of the following types:

a. Ordinary Portland Cement conforming to IS : 269

b. Portland Pozzolana Cement conforming to IS : 1489

(Fly ash based meeting the 28 day strength requirement of OPC 53 grade cement) in 50 kg bags. The use of bulk cement will be permitted only with the approval of Engineer-In-Charge. Changing of brand or type of cement within the same structure will not be permitted. In case it is required to change the brand of cement in the same structure, prior permission shall be obtained from the Engineer-In-Charge.

4.2.2 If demanded a certified report attesting to the conformity of the cement to IS specifications by the cement manufacturer's chemist shall be furnished to Engineer-In-Charge.

4.2.3 General Contractor will have to make his own arrangements for the storage of adequate quantity of cement. Cement in bulk may be stored in bins or silos, which will provide complete protection from dampness, contamination and minimize cracking and false set. Cement received in torn bags shall not be used. Moreover bags of cement which vary in weight by more than 3% shall not be accepted.

4.2.4 All cement shall be fresh when delivered and at ambient atmospheric temperature. Cement bags shall be stored in dry enclosed shed (storage under tarpaulins will not be permitted), well away from the outer walls and insulated from the floor to avoid contact with moisture from ground and so arranged as to provide ready access. Damaged or reclaimed or partly set cement will not be permitted to use and shall be removed from site.

4.2.5 The storage bins and storage arrangements shall be such that there is no dead storage. Not more than 12 bags shall be stacked in any tier. The storage arrangement shall be approved by the Engineer-In-Charge. Consignment of cement shall be stored as received and shall be consumed in the order of their delivery.

4.2.6 Cement held storage for a period of Ninety (90) days or longer shall be tested before use in work. Should at any time the Engineer-In-Charge have reason to consider that any cement is defective, then irrespective of its origin and / or manufacturer's test certificate, such cement shall be tested immediately at a National Test Laboratory or such approved laboratory and until the result of such test are found satisfactory, it shall not be used in any work.

4.2.7 In fare faced elements, the cement used in the concrete for any complete element shall be from a single consignment. All cement for exposed concrete shall be from the same approved source and uniform in colour.

4.2.8 With each and every delivery of cement the contractor shall provide the manufacturers certificate that the cement conforms to the relevant Indian Standard.

4.3 Aggregates

4.3.1 Aggregate in general designates both fine and coarse inert materials used in the manufacture of concrete. Fine Aggregate is aggregate most of which passes through 4.75 mm IS sieve. Coarse Aggregate is aggregate most of which retained on 4.75 mm IS sieve.

4.3.2 All fine and coarse aggregate proposed for use in the work shall be subjected to Engineer-In-Charge's approval and after specific materials have been accepted the source of supply of such materials shall not be changed without prior approval of the Engineer-In-Charge.

4.3.3 Aggregates shall consist of natural sand, crushed stone and gravel from source known to produce satisfactory aggregate for concrete and shall be chemically inert, strong, hard, durability against weathering, of limited porosity and free from deleterious materials that may cause corrosion of the reinforcement or may impair the strength and/ or durability of concrete.

4.3.4 The grading of aggregate shall be such as to produce a dense concrete of specified strength and consistency that will work readily into position without segregation and shall be based on the "mixed design" and preliminary test on concrete specified herein after.

4.4 Sampling and Testing

4.4.1 Samples of the aggregates for mixed design and determination of suitability shall be taken under the supervision of the Engineer- In-Charge and delivered to the laboratory, well in advance of the scheduled placing of concrete.

4.4.2 Records of tests, which have been made on proposed aggregates and on concrete made from this source of aggregates, shall be furnished to the Engineer- In-Charge in advance of the work for use in determining the aggregate suitability.

4.5 Storage of Aggregates

4.5.1 All coarse and fine aggregates shall be stacked separately in stock piles in the material yard near the work site in bins properly constructed to avoid inter mixing of different aggregates.

4.5.2 Contamination with the foreign materials and earth during storage and while heaping the materials shall be avoided. The aggregate must be specified quality not only at the time of receiving at site but more so at the time of loading into mixer. Rakers shall be used for lifting the coarse aggregates from the bins or stock piles.

4.5.3 Coarse aggregate shall be piled in layers not exceeding 1.20 metres in height to prevent coning or segregation. Each layer shall cover the entire area of the stock pile before succeeding layers are started.

4.5.4 Aggregates that have become segregated shall be rejected. Rejected material after re-mixing may be accepted, if subsequent tests demonstrate conformity with required gradation.

4.6 Specific Gravity

Aggregate having a specific gravity below 2.60 (saturated surface dry basis) shall not be used without special permission of the Engineer- In-Charge.

4.7 Fine Aggregate

4.7.1 Fine aggregate except as noted above and for other than lightweight concrete shall consist of natural river sand (suitable for concrete), crushed stone sand or crushed gravel sand stone dust confirming to IS 383. The sand shall be clean, sharp, hard, durable, chemically inert and free from dust, vegetable substances, adherent coating, clay, organic matter, alkalis, mica, salt or other deleterious substances which can be injurious to the setting qualities / strength/ durability of concrete. No creek / sea sand shall be allowed.

4.7.2 Machine made sand will be acceptable provided the constituent rock / gravel composition is sound, hard, dense, non-organic, uncoated and durable against weathering.

4.7.3 Sand shall be prepared for use by such screening or washing or both as necessary to remove all objectionable foreign matter while separating the sand grains to the required size fractions. Sand with silt content more than 3 % will not be permitted for use unless the same is washed and silt content is brought within 3% by weight.

4.7.4 The percentage of deleterious substances in sand delivered to the mixer shall not exceed the following:

Sl. No	Substances Percent by weight	Uncrushed : Crushed
1.	Material finer than 75 micron I.S. sieve	3.00% : 15.00%
2.	Shale	1.00% ---
3.	Coal and Lignite	1.00% : 1.00%
4.	Clay lumps	1.00% : 1.00%
5.	Total of all above substances including items 1 to 4 for uncrushed sand and items 3 & 4 for crushed sand.	5.00% : 2.00%

4.7.5 Unless otherwise directed or approved, the grading of sand shall be within the limits indicated hereunder:

Sl No	I.S. Sieve Designation	Percentage passing for			
		Zone I	Zone II	Zone III	Zone iV
1	10 mm	100	100	100	100
2	4.75 mm	90-100	90-100	90-100	95-100
3	2.36 mm	60 -95	75-100	85-100	95-100
4	1.18 mm	30-70	55-90	75-100	90-100
5	600 micron	15-34	35-59	60-79	80-100
6	300 micron	5-20	8-30	12-40	15-50
7	150 micron	0-10	0-10	0-10	0-15

4.7.6 Where the grading falls outside the limits of any particular grading zone of sieves, other than 600 micron IS sieve by total amount not exceeding 5% (five percent), it shall be regarded as falling within the grading zone. This tolerance shall not be applied to percentage passing the 600-micron IS sieve or to percentage passing any other sieve size on the coarser limit of Grading Zone-I or the finer limit of Grading Zone-IV. Fine aggregates confirming to Grading Zone-IV shall not be used unless mix designs and preliminary tests have shown its suitability for producing concrete of specified strength and workability.

4.7.7 The sand shall have a fineness modulus of not less than 2.2 or more than 3.2. The fineness modulus is determined by adding the cumulative percentage retained on the IS sieve (4.75 mm, 2.36 mm, 1.18mm, 600 micron, 300 micron and 150 micron) and dividing the sum by 100.

4.8 **Coarse Aggregate**

4.8.1 Coarse aggregate for concrete except as noted above and for other than lightweight concrete shall confirm to IS 383. This shall consist of natural or crushed stone and gravel, and shall be free from elongated, flaky or laminated pieces, adhering coatings, clay lumps, coal residue, clinkers, slag, alkalis, mica, organic matter or other deleterious matter.

4.8.2 The coarse aggregate and fine aggregate shall be tested from time to time as required by the Engineer- In-Charge to ascertain its suitability or use in construction and the charges for testing aggregate shall be borne by the General Contractor as specified herein after.

4.8.3 Crushed rock shall be screened and/or washed for the removal of dirt or dust coating if so demanded by the Engineering- In-Charge.

4.8.4 Coarse aggregates shall be either in single size or graded. In both cases grading shall be within the following limits

Sl No	IS sieve Designation	Percentage passing for single sized aggregate of nominal size				
		40 mm	20 mm	16 mm	12.5 mm	10 mm
1	63 mm	100	-	-	-	-
2	40 mm	85-100	100	-	-	-
3	20 mm	0-20	85-100	100	-	-
4	16 mm	-	-	85-100	100	-
5	12.5 mm	-	-	-	85-100	100
6	10 mm	0-5	0-20	0-30	0-45	85-100
7	4.75 mm	-	0-5	0-5	0-10	0-20
8	2.36 mm	-	-	-	-	0-5

Sl No	IS sieve Designation	Percentage passing for graded aggregate of nominal size			
		40 mm	20 mm	16 mm	12.5 mm
1	63 mm	100	-	-	-
2	40 mm	95-100	100	-	-
3	20 mm	30-70	95-100	100	100
4	16 mm	-	-	90-100	-
5	12.5 mm	-	-	-	90-100
6	10 mm	10-35	25-55	30-70	40-85
7	4.75 mm	0-5	0-10	0-10	0-10
8	2.36 mm	-	-	-	-

4.8.5 The pieces shall be angular in shape and shall have granular or crystalline surfaces. Friable, flaky and laminated pieces, mica and shale if present shall be only in such quantities that will not in the opinion of Engineer-In-Charge affect adversely the strength and / or durability of concrete.

4.8.6 The maximum size of coarse aggregate shall be the maximum size specified above but in no case greater than ¼ of the minimum thickness of the member provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of form.

4.8.7 Plums above 160 mm and up to any reasonable size can be used in plain mass concrete work of large dimensions up to a maximum limit of 20% by volume of concrete when specially approved by the Engineer-In-Charge.

4.8.8 For heavily reinforced concrete members the nominal maximum size of the aggregate shall be 5 mm less than the minimum clear distance between the main reinforcing bars or 5 mm less than the minimum cover to the reinforcement whichever is smaller.

4.8.9 The amount of fine particles occurring in the free state or as loose adherent shall not exceed 1% when determined by laboratory sedimentation tests as per IS 2386. After 24 hours immersion in water, a previously dried sample shall not have gained more than 10% of its oven dry weight in air as determined by IS 2386.

4.8.10 The percentage of deleterious substances in the coarse aggregate delivered to the mixer shall not exceed the following:

Sl No	Substances	Percentage by weight of aggregates	
		Uncrushed	Crushed
1	Material finer than 75 micron I.S. sieve.	3.00	3.00
2	Coal and lignite.	1.00	1.00
3	Clay lumps.	1.00	1.00
4	Sift fragments.	3.00	-
5	Total of all above substances.	5.00	5.00

4.9. **Water**

4.9.1 Water used for both mixing and curing shall be free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel.

4.9.2 Potable water is generally satisfactory for mixing and curing of concrete. In case of doubt the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time test specified in IS 456.

4.9.3 The sample of water taken for testing shall be typical for the water proposed to be used for concrete, due account being paid to seasonal variation. The sample shall not receive any treatment before testing other than that envisaged in the regular supply of water proposed for use in concrete. The sample shall be stored in a clean container previously rinsed out with similar water.

4.9.4 Average 28 days compressive strength of at least three 150 mm size concrete cubes prepared with water to be used shall not be less than 90% of the average strength of three similar concrete cubes prepared with distilled water. The cubes shall be prepared, cured and tested in accordance with the requirements of IS 516.

4.9.5 The initial setting time of test block made with the appropriate test cement and the water proposed to be used shall not be less than 30 minutes and shall not differ by more than + 30 minutes from the initial setting time of control test block prepared with the appropriate test cement and distilled water. The block shall be prepared and tested in accordance with the requirements of IS 4031 (Part 5).

4.9.6 Where water can be shown to contain an excess of acid, alkali, sugar or salt, Engineer-In-Charge may refuse to permit its use. As a guide the following concentration represent the maximum permissible values

4.9.7 To neutralize 100 ml sample of water, using Phenolphthalein as an indicator, it should not require more than 5 ml of 0.02 normal NaOH. The details of test shall be as given in 8.1 of IS: 3025 (Part 22).

4.9.8 To neutralize 100 ml sample of water, using Methyl Orange as an indicator, it should not require more than 25 ml of 0.02 normal H2SO4. The details of test shall be as given in 8 of IS 3025 (Part 23).

4.9.9 The percentage of solids, when tested in accordance with the IS 3025 shall not exceed the following

Sl No	Substances	Tested as per	Permissible percentage
1	Organic	IS: 3025 (Part 18)	0.02% (200 mg/litre)
2	Inorganic	IS: 3025 (Part 18)	0.30% (3000 mg/litre)
3	Sulphates (as SO3)	IS: 3025 (Part 24)	0.04% (400 mg/litre)
4	Chlorides (as Cl)	IS: 3025 (Part 32)	0.20% (2000 mg/litre) for concrete not containing embedded steel and 0.05% (500 mg/litre) for reinforced concrete works.
5	Suspended matter	IS: 3025 (Part 17)	0.20% (2000 mg/litre)

4.9.10 P.H. value of water shall generally be not less than 6.

5.0 DESIGN MIX CONCRETE

5.1 All reinforced concrete in the work shall be “Design Mix Concrete” as defined in IS 456 considering as ‘severe’ environment and cost of design mix shall be included in the item rate and no separate payment shall be made on account of this. All “Design Mix Concrete” work to be carried out under these specifications shall be in grades designated as per table below.

Use of mineral admixtures like fly ash, GGBFS, etc. shall not be permitted in the design mix unless otherwise special permission is given by the Engineer-in- Charge. Cement shall be Ordinary Portland Cement – 43 grade or Portland Pozzolana Cement (Fly ash based meeting the 28 day strength requirement of OPC 43 grade cement) only.

Group	Grade Designation	Specified Characteristic Compressive Strength of 150 mm Cube at 28 days in N/mm2
Ordinary Concrete	M-10	10
	M-15	15
	M-20	20
Standard Concrete	M-25	25
	M-30	30
	M-35	35
	M-40	40
	M-45	45
	M-50	50
	M-55	55
High Strength Concrete	M-60	60
	M-65	65
	M-70	70
	M-75	75
	M-80	80

Notes

1. The Characteristic strength is defined as the strength of material below which not more than 5% of the test results are expected to fall.

2. In the designation of a concrete mix, letter 'M' refers to the mix and the number to the specified characteristic compressive strength of 150 mm size cube at 28 days in N/mm2.

3. The mix shall be designed to produce the grade of concrete having the required workability and characteristic strength not less than appropriate value given in the table above.

5.2 **Mix Design**

5.2.1 Mix design is to investigate the grading of aggregates, water cement ratio, workability and the quantity of cement required to give works cubes of the characteristic strength specified. The proportions of the mix shall be determined by weight. Adjustment of aggregate proportions due to moisture present in the aggregate shall be made. Mix proportioning shall be carried out according to the ACI standard designation 'ACI-613' or Design of concrete mixes - Road Research Note No.4, Department of Scientific and Industrial Research U.K. or IS 10262.

5.2.2 Since different cements and aggregates of different maximum size, grading, surface texture, shape and other characteristics may produce concretes of different compressive strength for the same free water cement ratio, the relationship between strength and free water cement ratio should preferably be established for the materials actually to be used. In the absence of such data, the preliminary free water cement ratio (by mass) corresponding to the target strength at 28 days may be selected from the relationship shown in Fig.1 of IS 10262 at page 7.

5.2.3 Alternately, the preliminary free water cement ratio (by mass) corresponding to the target average strength may be selected from the relationship in Fig. 2 of IS 10262 page at 8, using the curve corresponding to the 28 days cement strength to be used for the purpose. Other relevant items to the used with design of mix should strictly confirm to the relevant clauses and appendices of IS 10262. The calculated mix proportions shall be checked by means of trial batches. The contractor should refer to the item No.4 at page 12 and the Appendix 'D' (clause No. 4.1) of IS 10262 for neat illustration. The contractor may refer Appendix 'C' (clause 3.8) at page 16 of IS 10262 for an example illustrating the mix design of M-20. The free water cement ratio selected as above should be checked against the limiting water cement ratio for the requirement of durability and the lower of the two values should be adopted.

5.2.4 Whenever there is a change either in required strength of concrete or water cement ratio or workability or the source of aggregates and/ or cement fresh tests shall be carried out to determine the revised proportion of the mix to suit the altered conditions. While designing mix proportions over wet mixes shall always be avoided.

5.2.5 While fixing the value for water cement ratio for 'Design Mix' assistance may be derived from the standard graph showing the relationship between the 28 days compressive strength of concrete mixes with different water cement ratios and the 7 days compressive strength of cement tested in accordance with IS 269 and IS 8112.

5.2.6 It will be contractor's sole responsibility to establish the concrete mix designs for different grades of concrete specified in the work consistent with the workability required for nature of work an also taking into consideration the assumed standard deviation which will be expected at site or by establishing the standard deviation based on 30 test results at site for each grade of concrete so as to produce concrete of required strength, durability and surface finish. The materials and proportions used in making the tests to be carried out

either at site or under laboratory, conditions shall be similar in all respects to those to be actually employed in the works as the object of these tests is to determine the proportions of cement, aggregates and water necessary to produce the concrete of the required consistency to give such specified strength.

5.2.7 Minimum cement content in the concrete shall be 300kg/m^3

5.3 **Standard Deviation**

5.3.1 Standard deviation of concrete of each grade shall be determined separately. When results of sufficient number of tests (at least 30) are not available, then the value of standard deviation given in the table below may be assumed for design mix in the first instance. As soon as the results of the samples are available, actual calculated standard deviation shall be used and the mix designed properly.

5.3.2 Assumed Standard Deviation:

Sl No	Grade of concrete	Assumed Standard Deviation in N/mm2
1	M-10	3.5
2	M-15	
3	M-20	4.0
4	M-25	
5	M-30	5.0
6	M-35	
7	M-40	
8	M-45	
9	M-50	

Note:- the above values correspond to the site control having proper storage of cement; weigh batching of all materials; controlled addition of water; regular checking of all materials; aggregate grading and moisture content; and periodical checking of workability and strength. Where there is deviation from the above, the values given in the above table shall be increased by 1 N/mm2.

5.3.3 Standard Deviation Based On Test Results

The total number of test results required to constitute and acceptable record for calculation of standard deviation shall be not less than 30. Attempts should be made to obtain the 30 test results as early as possible when a mix is used for the first time.

The calculation of the standard deviation shall be brought up to date after every change of mix design and at least once in a month.

5.3.4 Determination Of Standard Deviation

Concrete of each grade shall be analyzed separately to determine its standard deviation.

The standard deviation of concrete of given grade shall be calculated using the following formula from the results of individual tests of concrete of that grade obtained as specified for test strength of sample:

Estimated Standard Deviation (S) = $\{X^2 / (n-1)\}^{½}$

Where X = Deviation of the individual test strength from the average strength of a sample and

n = Number of sample test results.

When significant changes are made in the proportion of concrete (for example changes in materials used, mix design, equipments or technical control), the standard deviation value shall be separately calculated for such batches of concrete.

5.4 Proportioning

5.4.1 The proportions which shall be decided by conducting preliminary tests, shall be by weight. These proportions of cement, fine and coarse aggregates shall be maintained during subsequent concrete batching by means of weigh batchers confirming to IS 2722, capable of controlling the weights within one percent of the desired value. Except where it can be shown to the satisfaction of the Engineer-In-Charge that supply of properly graded aggregate of uniform quality can be maintained over the period of work, the grading of aggregate shall be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportions. The different sizes shall be stacked in separate stock piles. The grading of coarse and fine aggregates shall be checked as frequently as possible, as determined by the Engineer-In-Charge, to ensure maintaining of grading in accordance with samples used in preliminary mix design. The material shall be stock piles well in advance of use.

5.4.2 The cement shall be measured by weight for design mix. Every facility should be provided to the Engineer-In-Charge for sampling and inspection of stored cement at site of work.

5.4.3 Only such quantity of water shall be added to the cement and aggregate in the concrete mix as to ensure dense concrete, specified surface finish, satisfactory workability, consistent with strength stipulated for each class of concrete. The water added to the mix shall be such as not to cause segregation of materials or the collection of excessive free water on the surface of the concrete.

5.4.4 **The water cement ratio (W/C)** is defined as the weight of water in mix (including the surface moisture of the aggregate) divided by the weight of cement in the mix. The actual water cement ratio to be adopted shall be determined in each instance by the General Contractor and approved by the Engineer-In-Charge.

5.4.5 The water cement ratio specified for use by the Engineer-In-Charge shall be maintained. The contractor shall determine the water content of the aggregate as frequently as directed by the Engineer-In-Charge as the work progresses and as specified in IS 2386 (Part-III) and the amount of mixing water added at the mixer shall be adjusted as directed by the Engineer-In-Charge so as to maintain the specified water cement ratio. To allow for the variation in their moisture content, suitable adjustments in the weights of aggregates shall also be made.

5.5 Consistency and Slump

5.5.1 Concrete shall be of a consistency and workability suitable for the conditions of the job. After the amount of water required is determined the consistency of mix shall be maintained throughout the progress of the corresponding parts of the work and approved

tests e.g. slump tests, compacting factor test etc. in accordance with IS 1199, shall be conducted from time to time to ensure the maintenance of such consistency.

5.5.2 The following tabulation gives a range of workability which shall generally be used for various types of construction unless otherwise instructed by the Engineer-In-Charge

5.5.2.1 Workability of Concrete:

Sl No	Placing conditions	Degree of workability	Value of workability
1	Blinding concrete' shallow sections, pavements using pavers.	Very low	0.75 - 0.80 compacting factor
2	Mass concrete; lightly reinforced sections in slabs, beams, walls, columns, floors, hand placed pavements, canal lining; strip footings	Low	Slump of 25 – 75 mm
3	Heavily reinforced sections in slabs, beams, walls, columns, Slip form work; Pumped concrete	Medium	Slump of 50– 100 mm. Slump of 75 – 100 mm
4	Trench fill; In-situ piling. Tremie concrete	High / Very high	Slump of 100 – 150 mm

5.6 Batching and Mixing of Concrete

5.6.1 The material and proportions of concrete ingredients as established by the preliminary tests for the mix design shall be rigidly followed for all concrete works on the project and shall not be changed except when specifically permitted by Engineer-In-Charge.

5.6.2 Concrete shall be produced only by weigh batching the ingredients. The mixer and weigh batcher shall be maintained in clean serviceable condition. The accuracy of weigh batcher shall be periodically checked. They shall be set up in level on a firm base and the hopper shall be loaded evenly. The needle shall be adjusted to zero when the hopper is empty. Fine and coarse aggregates shall be weighed separately unless otherwise stated.

5.6.3 Volume batching will not be permitted. However Engineer-In-Charge may permit volume batching by subsequent conversion of weights of ingredients into their equivalent volumes in respect of their bulk densities only in the case of small and less important pours involving concrete of not more than 0.25 cubic metre on the day when other pours involving weigh batching are not likely to be taken up.

5.6.4 The concrete shall be of strength as stipulated in the respective items. All concrete shall be mixed in mechanically operated batch mixers complying with IS 1791 and of approved make with suitable provision for correctly controlling the water delivered to the drum.

5.6.5 The quantity of water actually entering the drum shall be checked with the reading of the gauge or valve setting when starting a job. The test should be made while the mixer is running.

5.6.6 The volume of the mixed material shall not exceed the manufacturer's rated mixer capacity. The batch shall be charged into the mixer so that some water will enter the drum in advance of cement and aggregate. All water shall be in the drum by the end of the first 15 seconds of the specified mixing time.

Each batch shall be mixed until the concrete is uniform in colour for a minimum period of two minutes after all ingredients are in the drum.

5.6.7 The entire contents of the drum shall be discharged in one operation before the raw materials for the succeeding batches are fed into the drum.

5.6.8 Each time the work stops the mixer shall be cleaned out and when next commencing the mixing the first batch shall have 10% addition cement to allow for sticking in the drum.

6.0 SAMPLING AND TESTING OF CONCRETE

6.1 If the Engineer-In-Charge desires facilities required for sampling materials and concrete in the field shall be provided by the General Contractor at no extra cost. The following equipments (in serviceable condition) with operator shall be made available at Engineer's request

No.	Equipments	Requirement
1.	Cast Iron cube moulds of 150 mm size	As required
2.	Slump cone complete set with tamping rod	1 set
3.	Laboratory balance to weight up to 5 kg. With sensitivity of 10 gm.	1 No.
4.	Laboratory balance of 2 kg. Capacity and sensitivity of 1 gm.	1 No.
5.	IS sieves for coarse and fine aggregates	1 set.
6.	A set of measure from 0.1 litre to 5 litres.	1 set.
7.	Electric oven with thermostat up to 120 degree centigrade.	1 No.
8.	Flakiness gauge	1 No.
9.	Elongation index gauge	1 No.
10.	Sedimentation pipette	1 No.
11.	Pyconometer	1 No.
12.	Calibrated glass jar of 1 litre capacity	2 Nos.
13.	Glass flasks and metal containers	As required.
14.	Chemical reagents like Sodium Hydroxide, Tannic Acid, Litmus papers etc.	As required.

6.2 The concrete test cubes will be tested at approved laboratory. The contractor shall make all arrangements to cure, store of concrete cubes and transport the same to the laboratory at his own cost as directed by the Engineer-In-Charge.

6.3 Sampling and Strength Test of Concrete

6.3.1 The samples from fresh concrete shall be taken as per IS 1199 and cubes shall be made, cured and tested at 28 days in accordance with IS 516.

6.3.2 In order to get a relatively quicker idea of the quality of concrete optional test on beams for modulus of rupture at 72 (+/-)2 hrs. or at 7 days or compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength tests. For this purpose the value given in table below may be taken for general guidance in case of concrete made with ordinary Portland cement. In all cases, the 28 days compressive strength specified shall alone be the criterion for acceptance or rejection of the concrete. If however, from test carried out in particular job over a reasonably long period, it has been established to

the satisfaction of the Engineer-In-Charge that a suitable ratio between 28 days compressive strength and the modulus of rupture at 72 (+/-)2 hrs. or 7 days or compressive strength at 7 days may be accepted. The Engineer-In-Charge may suitable relax the frequency of 28 days compressive strength, provided the expected strength values at the specified early age are consistently met.

Test cubes shall be made as, where and when the Architect / Employer may require.

Test cubes shall be made under the direct supervision of the competent person appointed by the contractor to supervise all stages of the preparation and placing of concrete. They shall be made by the contractor in the presence of the Architect / Employer generally from concrete taken at the point of discharge from the mixer and hut or other covered protection as agreed with or directed by the Architect / Employer for the storing and curing of the test cubes during the first 24 hours after making them and until they are dispatched to the testing laboratory.

Test cubes shall be marked and dated in such a manner that the trade and the part of the works in which the concrete they represent has been placed can be readily identified.

Testing shall be done at an approved laboratory or at the site itself and the results shall be submitted promptly by the contractor to the Architect / Employer.

6.3.3 Optional Test Requirement of Concrete:

Sl No	Grade of Concrete	Minimum Compressive Strength on 150 mm Cube (7 days)	Min. Modulus of Rupture By Beam Test at	
			72 (+/-) 2 hrs.	7 days
1.	M-10	7.00 N/m2	1.20 N/mm2	1.70 N/mm2
2.	M-15	10.00 N/m2	1.50 N/mm2	2.10 N/mm2
3.	M-20	13.50 N/m2	1.70 N/mm2	2.40 N/mm2
4.	M-25	17.00 N/m2	1.90 N/mm2	2.70 N/mm2
5.	M-30	20.00 N/m2	2.10 N/mm2	3.00 N/mm2
6.	M-35	23.50 N/m2	2.30 N/mm2	3.20 N/mm2
7.	M-40	27.00 N/m2	2.50 N/mm2	3.40 N/mm2

6.3.4 Frequency of Sampling

6.3.4.1 A random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested, i.e. the sampling should be spread over the entire period of concreting and cover all mixing units.

6.3.4.2 The minimum frequency of sampling of concrete of each grade shall be in accordance with the following:

No.	(c) Quantity of concrete	(d) Number of Samples
1.	1.00 to 5.00 m3	One
2.	6.00 to 15.00 m3	Two
3.	16.00 to 30.00 m3	Three
4.	31.00 to 50.00 m3	Four
5.	51.00 m3 and above	Four Plus one additional sample for each additional 50 m3 part thereof.

At least one sample shall be taken from each shift. Where concrete is produced at continuous production unit, such as ready-mixed concrete plant, frequency of sampling may be agreed upon mutually by suppliers and Engineer-in-Charge.

6.3.4.3 Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for various purposes such as to determine the strength of concrete at 7 days or at the time of striking the formwork or to determine the duration of curing or to check the testing error. Additional cubes may also be required for testing cubes cured by accelerated methods as described in IS 9013. The specimen shall be tested as described in IS 516.

6.3.5 The test strength of the samples shall be the average of the strength of three specimens. The individual variation should not be more than (+/-) 15 percent of the average.

6.3.6 Slump test shall be carried out as often as demanded by the Engineer-In-Charge and invariably from the same batch of concrete from which the test cubes are made. Slump test shall be done immediately after sampling.

6.3.7 Standard Deviation shall be vide clause '5.3' of this specification.

7.0 ACCEPTANCE CRITERIA

7.1 The concrete shall be deemed to comply with the strength requirement if:

7.1.1 The mean strength determined from any group of four consecutive test results complies with the appropriate limits in col. 2 of table below.

7.1.2 Any individual test result complies with the appropriate limits in col. 3 of table below.

Specified Grade	Mean of the Group of 4 Non-overlapping consecutive test results in N/mm2	Individual Test Results in N/mm2
(1)	(2)	(3)
M15	> fck + 0.825 x established standard deviation (rounded off to nearest 0.5 N/mm2) or, fck + 3 N/ mm2, whichever is greater	> fck – 3 N/mm2
M 20 or above	> fck + 0.825 x established standard deviation (rounded off to nearest 0.5 N/mm2) or, _ fck + 4 N/ mm2, whichever is greater	> fck – 4 N/mm2

7.2 If the concrete is deemed not to comply pursuant to 7.0 above, the structural adequacy of the part affected shall be investigated and any consequential action as needed shall be taken.

7.3 Concrete of each grade shall be assessed separately. Concrete shall be assessed daily for compliance.

7.4 Concrete of each grade shall be liable to be rejected if it is porous or honeycombed, its placing has been interrupted without providing a proper construction joints, the reinforcement has been displaced beyond the tolerances specified or construction

tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer-In-Charge.

CONCRETE MIXING

All concrete, whether ordinary or controlled, shall be mixed in an approved mixer for the minimum time necessary to ensure adequate quality and uniform distribution of the materials. The cement and aggregates shall normally be first mixed dry until all particles of aggregate are coated with cement after which the water shall be added.

Allowance shall be made for the moisture content of the aggregates when calculating the amount of water to be added for each mix.

The temperature of the aggregate, water and cement when added to the mixer shall be such that the temperature of the concrete at the time of placement is less than 40 deg. C and during cold weather it shall not be below 4.5 deg. C. Concrete damaged by frost shall be removed and work redone.

Materials for concrete shall be deposited into the drum while it is in rotation. Mixers shall not be loaded beyond their rated capacity and each batch shall be completely discharged from the drum before recharging takes place.

Facilities shall be provided to spray the mixer drum with cool water between batches and on the completion of concreting the drum shall be washed down. The surface of the mixer drum shall be maintained in a clean condition at all times.

Retempering and/or mixing of concrete which has partially hardened and set will not be permitted under any circumstances.

8.0 ADMIXTURES

8.1 Admixture may be used in concrete only with the approval of the Engineer-In-Charge based upon evidence that with the passage of time neither the compressive strength nor its durability reduced. Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts. When calcium chloride is permitted to be used such as in mass concrete works it shall be dissolved in water and added to the mixing water in an amount not exceed 1.5 percent of the weight of the cement in each batch of concrete. When admixtures are used the designed concrete mix shall be corrected accordingly. Admixtures shall be used as per manufacturer's instructions and in the manner and with the control specified by Engineer-in-Charge. The cost of admixtures shall be included in the item rate and no extra amount shall be paid on this account.

8.2 Where specified and approved by Engineer-In-Charge neutralized vinsol resin or/ and other approved air entraining agent may be used to procedure the specified amount of air in the concrete mix and these agents shall conform to the requirements of ASTM standard 6-260 air entraining admixture of concrete. The recommended total air content in the concrete is 4% + 1%. The method of measuring air content shall be as per IS 1199.

8.3 Retarding Admixtures
Where specified and approved by the Engineer-In-Charge retarding agents shall be added to the concrete mix in quantities specified by Engineer- In- Charge.

8.4. Water Reducing Admixtures

Where specified and approved by Engineer- In-Charge water reducing lignosulfonate mixture shall be added in quantities specified by Engineer- In- Charge. The admixtures shall be added in the form of a solution.

8.5 Water Proofing Agent

Where specified and approved by Engineer-In-Charge chloride and sulphide free waterproofing agent shall be added in the quantities specified by Engineer-In- Charge.

8.6 Other Admixtures

Engineer-In-Charge may at his discretion instruct General Contractor to use any other admixture in the concrete.

9.0 TESTS

If the Engineer-In-Charge desires he may order tests to be carried out on cement, sand, course aggregate, water etc. in accordance with the relevant Indian Standards.

9.1 Tests on cement shall include

(i) Fineness test,
(ii) Test for normal consistency,
(iii) Test for setting time,
(iv) Test for soundness,
(v) Test for compressive strength,
(vi) Test of heat of hydration (by experiment and by calculation) in accordance with IS 269

9.2 Tests on sand shall include :

(i) Sieve test,
(ii) Test for organic impurities,
(iii) Decantation test for determining clay and silt content,
(iv) Specific gravity test,
(v) Test for unit weight and bulkage factor,
(vi) Test for sieve analysis and fineness modulus.

9.3 Tests on coarse aggregate shall include:

(i) Sieve analysis,
(ii) Specific gravity and unit weight of dry, loose and rodded aggregate,
(iii) Soundness and alkali aggregate reactivity,
(iv) Petrographic examination,
(v) Test for deleterious materials and organic impurities,
(vi) Test for aggregate crushing value.

9.4 Tests on aggregate shall be carried out for all the materials in accordance with the specifications and relevant code of practice the contractor at an approved test laboratory.

10.0 INSPECTION AND TESTING OF STRUCTURES

10.1 Immediately after stripping the form work all concrete shall be carefully inspected and any defective work or small defects either removed or made good before the concrete has thoroughly hardened as instructed by the Engineer-In-Charge.

10.2 In case of doubt regarding the grade of concrete used either due to poor workmanship or based on results of cube strength tests the contractor may be asked to carry out compressive strength test of concrete on the basis of core test, ultrasonic test and/ or load test.

10.3 In case of results of cube strength are observed to be lower than the required designed strength at 28 days as per specifications, ultrasonic test shall be carried out by the digital ultrasonic concrete tester by an approved agency at the cost of the contractor.

10.4 In case the ultrasonic test do not satisfy the requirement as above the Engineer-in-Charge will be at liberty to reject the concrete and the contractor has to dismantle and redo the same to the satisfaction of the Engineer-in-Charge at the contractor's own cost.

10.5 The unit rate for concrete shall be all inclusive of making preliminary mix design and test cubes, works cubes, testing them as per specifications, slump test, optional tests etc. However, the Engineer-in-Charge will witness the same and the General Contractor will have to make arrangement for transportation of the cubes to the approved laboratory.

10.6 In case cube tests give unsatisfactory results the General Contractor should also conduct conclusive tests such as ultrasonic pulse test, core test etc. to prove the suitability of concrete. The cost of the conclusive tests shall have to be borne by the contractor.

10.7 If the results of ay test prove unsatisfactory or the structure shows signs of weakness, undue deflection or faulty construction the contractor shall remove and rebuild the member(s) involved or carry out such other remedial measures as may be required by the Engineer-In-Charge. The contractor shall bear the cost of so doing unless the failure of the member(s) to fulfill the test conditions is approved to be solely due to faulty design. The cost of all tests shall be borne by the contractor.

11.0 PREPARATION PRIOR TO CONCRETE PLACEMENT, FINAL INSPECTION AND APPROVAL

11.1 Before the concrete is actually placed in position the insides of formwork shall be inspected to see that they have been cleaned and oiled. Temporary openings shall be provided to facilitate inspection especially at bottom of columns and wall forms to permit removal of saw dust, wood shavings, binding wire, rubbish, dirt etc. Such openings/ holes shall be later suitably plugged.

11.2 The various traders shall be permitted ample time to install drainage and plumbing lines, floor and trench drain, conduits, hangers, anchors, inserts, sleeves, bolts frames and other miscellaneous embedment to be cast in the concrete as indicated on the drawing or as necessary for the proper execution of the work. All such embedment shall be correctly positioned and securely held in the forms to prevent displacement during depositing and vibrating of concrete.

11.3 Slots, openings, holes, pockets etc. shall be provided in concrete work in the positions indicated in the drawings or as directed by the Engineer-In-Charge.

11.4 Reinforcement and other items to be cast in concrete shall have clean surfaces that will not impair bond.

11.5 Prior to concrete placement all works shall be inspected and approved by the Engineer-In-Charge and if found unsatisfactory concrete shall not be poured until all defects have been corrected at contractor's cost.

11.6 Approval of Engineer-In-Charge for any and all materials and work as required herein shall not relieve contractor from his obligations to produce finished concrete in accordance with the drawings and specifications.

11.7 Rain or Wash Water

11.7.1 No concrete shall be placed in wet weather or on a water covered surface. Any concrete that has been washed by heavy rains shall be entirely removed if there is any sign of cement and sand having been washed away from the concrete mixture.

11.7.2 Before leaving unattended the work shall be covered with tarpaulins immediately after the concrete has been placed and compacted to safe guard against damages, which may be caused by rain.

11.7.3 Any water accumulating on the surface of the newly placed concrete shall be removed by approved means and no further concrete shall be placed thereon until such water is removed. To avoid flow of water over / around freshly placed concrete suitable drains and sumps shall be provided.

11.8. Bonding Mortar

Immediately before concrete placement begins prepared surfaces except formwork which will come in contact with the concrete to be placed shall be covered with a bonding mortar of the same strength of concrete.

11.9 Transportation

11.9.1 All buckets, containers or conveyers used for transport the concrete shall be mortar tight. All means of conveyance shall be adopted to deliver the concrete of the required consistency and plasticity without segregation or loss of slump whatever method for transportation is employed.

11.9.2 Chute shall not be used for transport of concrete without the written permission of the Engineer-In-Charge and concrete shall not be re-handled before placing. Maximum height of pour should be limited to 1.0m.

The period between mixing the concrete and placing it in the final position shall be kept to a minimum and the delivery of concrete shall be coordinated with the rate of placement to avoid delays in delivery and placement.

Concrete shall be handled from the place of mixing to the place of final deposit by methods which prevent segregation, loss of ingredients and contamination and maintain the required workability.

Should any segregation have accrued in any batches arriving at the place of deposition, such batches be deposited and thoroughly turned over by hand before placing in the works.
All plant and equipment used in the transportation of concrete shall be thoroughly cleaned before and after each working period and at all changes of concrete mixes. Water used for this purpose shall be discharged well clear of formwork or the concrete already in place.

11.10 Contaminated Concrete

11.10.1 Concrete must be placed in its final position before it become too stiff to work.

11.10.2 On no account water shall be added after the initial mixing.

11.10.3 Concrete which has become stiff or has been contaminated with foreign materials and which has not been placed within half an hour of mixing water with cement shall be rejected and disposed off as directed by the Engineer-In-Charge.

11.10.4 All equipments used for mixing, transporting and placing of concrete shall be maintained in clean condition. All pans, buckets, hoppers, chutes, pipe lines and other equipments shall be thoroughly cleaned after each period of placement.

12.0 PROCEDURE FOR PLACING OF CONCRETE

12.1 Before any concrete is placed the entire placing programme consisting of equipment, layout, proposed procedures and methods shall be submitted to Engineer-In-Charge for approval if so demanded by the Engineer-In-Charge and no concrete shall be placed until Engineer-In-Charge's approval has been obtained. Equipment for conveying concrete shall be of such size and design as to ensure a practically continuous flow of concrete during depositing without segregation of materials considering the size of the job and placement location.

12.2 Concrete shall be placed in its final position before the cement reaches its initial set and concrete shall normally be compacted in its final position within 30 minutes of leaving the mixer and once compacted it shall not be disturbed.

12.3 In all cases the concrete shall be deposited as nearly as practicable directly in its final position and shall not be re-handled or caused to flow in a manner which may cause segregation, loss of materials, displacement of reinforcement, shuttering or embedded inserts or impair its strength. For locations where direct placement is not possible and in narrow forms General Contractor shall provide suitable drop and Elephant Trunks to confine the movement of concrete. Special care shall be taken where concrete is dropped from a height especially if reinforcement is in the way particularly in columns and thin walls.

12.4 Except when otherwise approved by Engineer-In-Charge concrete shall be placed in the shuttering by pumps or cranes or other approved implements and shall not be dropped from a height more than one metre or handle in a manner which will cause segregation.

12.5 The following specification shall apply when placing of concrete by use of mechanical equipment is specifically called for while inviting bids or is warranted considering the nature of work involved:

12.6 Concrete placed in restricted forms by borrows, buggies, cars, sort chutes or hand shoveling shall be subjected to the requirement for vertical delivery of limited height to avoid segregation and shall deposited as nearly as practicable in it's final position.

12.7 Concreting once started shall be continuous until the pour is completed. Concrete shall be placed in successive horizontal layers of uniform thickness ranging from 150 mm to 900 mm as directed by the Engineer-In-Charge. These shall be placed as rapidly as practicable to prevent the formation of cold joints or planes of weakness between each succeeding layers within the pour. The thickness of each layer shall be such that it can be deposited before the previous layer has stiffened. The bucket loads or other units of deposit shall be spotted progressively along the face of the layer with such overlap as will facilitate spreading the layer to uniform depth and texture with a minimum of shoveling. Any tendency to segregation shall be corrected by shoveling stones into mortar rather than mortar onto stones. Such a condition shall be corrected by redesign of mix or other means as directed by Engineer-In-Charge.

12.8 The top surface of each pour and bedding planes shall be approximately horizontal unless otherwise instructed.

13.0 COMPACTION

13.1 Concrete shall be compacted during placing with approved vibrating equipment until the concrete has been consolidated to the maximum practicable density, is free of pockets of coarse aggregate and fits tightly against all form surfaces, reinforcement and embedded fixtures. Particular care shall be taken to ensure that all concrete placed against the form faces and into corners of forms or against hardened concrete at joints is free from voids or cavities. The use of vibrators shall be consistent with the concrete mix and caution is to be exercised not to over vibrate the concrete to the point that segregation results.

13.2 When placing in layers, which are advancing horizontally as the work progresses great care shall be exercised to ensure adequate vibration, blending and melding of the concrete between the successive layers.

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

13.4 Care shall be taken to prevent contact of immersion vibrators against reinforcement steel. Immersion vibrators shall not be allowed to come in contact with reinforcement steel after start of initial set. They shall also not be allowed to come into contact with forms or finished surfaces.

13.5 Formation of stone pockets or mortar pondages in corners and against faces of forms shall not be permitted. Should these occur they shall be dug out, reform and refilled to a sufficient depth and shape for thorough bonding as directed by Engineer-In-Charge.

13.6 Bleeding or free water on top of concrete being deposited into the forms shall be caused to stop the concrete pour and the condition causing this defect corrected before any further concreting is resumed.

The time elapsing between the discharge of the concrete from the mixer and the completion of compaction shall not exceed 30 minutes.

A sufficient number of spare vibrators shall be kept readily accessible to the place of deposition of concrete to assure adequate vibration in case of breakdown of those in use.

14.0 CONSTRUCTION JOINTS AND KEYS

14.1 Concrete shall be placed without interruption until completion of the part of the work between predetermined construction joints as specified therein after. Time laps between the pouring of adjoining units shall be as specified in the drawings or as directed by the Engineer-In-Charge.

14.2 If stopping of concreting becomes unavoidable anywhere a properly formed construction joints shall be made where the work is stopped.

14.3 Joints shall be either vertical or horizontal unless otherwise shown on drawing. In case of an inclined or curved member the joints shall be at right angles to the axis of the member. Vertical joints in walls shall be kept to a minimum.

14.4 Vertical joints shall be formed against a stop board and horizontal joints shall be level and wherever possible arranged so that the joint lines coincide with the architectural features of the finished work.

14.5 Batten shall be nailed to the form work to ensure a horizontal line and if directed shall also be used to form a grooved joint. For tank walls and similar work joints shall be formed as per IS 3370.

14.6 Concrete that is in the process of setting shall not be disturbed or shaken by traffic either on the concrete itself or upon the shuttering.

14.7 Horizontal and vertical joints and shear keys shall be located and shall confirm in details to the requirements of the plans unless otherwise directed by the Engineer-In-Charge.

14.8 Column Joints - In a column, joints shall be formed 75 mm below the lowest soffit of the beam including haunches if any. In flat slab construction the joint shall be 75 mm below the soffit of column capital. At least 2 hours shall elapse after depositing concrete in columns, piers or walls before depositing in beams, girders or slabs supported thereon.

14.9 Beam and Slab Joints - Concrete in beam shall be placed throughout without a joint but if the joint is unavoidable the same shall be vertical and at the centre or within the middle third of the span unless otherwise shown on drawings. The joint 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 unavoidably at right angles to the principal reinforcement the joint shall be vertical and at the middle of the span.

14.10 Vertical construction joints in water tight construction will not be permitted unless indicated on the drawings. Where a horizontal construction joint is required to resist water pressure special care shall be taken in all phases of its construction to ensure maximum water tightness.

15.0 DOWELS

15.1 Dowels for concrete works not likely to be taken up in the near future shall be wrapped in tar paper and burlap.

16.0 MASS FOUNDATIONS

16.1 Mass foundation shall be poured in lifts not exceeding 1.5 m in height unless otherwise indicated on the drawings or approved by Engineer-In-Charge.

17.0 TREATMENT OF CONSTRUCTION JOINTS ON RESUMING CONCRETING

17.1 A dryer mix shall be used for the top lift of horizontal pours to avoid laitance. All laitance and loose stones shall be thoroughly and carefully removed by wire brushing/ hacking and surface wash.

17.2 Just before concreting is resumed the roughened joint surface shall be thoroughly cleaned and loose matter removed and then treated with a thin layer of cement grout of proportion specified by Engineer-In-Charge and worked will into the surface. The new concrete shall be well worked against the prepared face before the grout mortar sets. Special care shall be taken to obtained thorough compaction and to avoid segregation of the concrete along the joint plane.

18.0 CURING, PROTECTING, REPAIRING AND FINISHING

18.1 All concrete shall be cured by keeping it continuously damp for a period of time required for complete hydration and hardening to take place. Preference shall be given to the use of continuous sprays or by ponding of water, continuously saturated coverings of sacking, canvas, hessian or other absorbent materials or approved effective curing compounds (for vertical members and slab-on-Grade) applied with spraying equipment capable of producing a smooth even textured coat. Extra precautions shall be exercised in curing concrete during cold and hot weather as outlined hereinafter.

18.2 Certain type of finish or preparation for overlaying concrete must be done at certain stages of the curing process and special treatment may be required for specific concrete surface finish.

18.3 Curing With Water

18.3.1 Fresh concrete shall be kept continuously wet for a minimum period of 10 days from the date of placing of concrete following a lapse of 10 to 12 hours after laying of concrete in normal weather and in hot weather not more than lapse of 4 hours. Date of casting shall have to be marked, as directed by Engineer-in-charge, on the exposed surfaces of the concrete so as to enable easy monitoring of the curing period.

18.3.2 The curing of horizontal surface exposed to the drying winds shall be however begin immediately after the concrete has hardened. Water shall be applied to unformed concrete surfaces within one hour after concrete has set. Water shall be applied to formed surface immediately upon removal of forms. Quantity of water applied shall be controlled so as to prevent erosion of freshly placed concrete.

18.3.3 The quality of curing water shall be the same as that used for mixing concrete.

18.3.4 Curing shall be assured by use of an ample water supply under pressure in pipes with all necessary appliances of hose, sprinklers and spraying devices. Continuous fine moist spraying or sprinkling shall be used unless otherwise specified or approved by the Engineer-In-Charge.

18.3.5 For curing of concrete in pavements, side-walks, floors flat roofs or other level surfaces the ponding method of curing is preferred. The method of containing the ponded water shall be approved by the Engineer-In-Charge. Special attention shall be given to edges and corners of the slab to ensure proper protection to these areas. The ponded areas shall be kept continuously filled with water during the curing period.

18.3.6 All equipments and materials required for curing shall be on site and ready for use before concrete is placed.

19.0 FINISHING OF CONCRETE

19.1 This specification is intended to cover the treatment of concrete surface for all structures. Areas requiring special finish not covered by this specification shall be clearly indicated on the drawings and special specification shall be furnished.

19.2 When specified on the drawings an integral cement concrete finish of specified thickness for floors and slabs shall be applied either monolithic or bonded as specified on the drawings and as per IS 2571.

19.3 The surface shall be compacted and then floated with double power floating machine. The surface shall be tested with a straight edge to meet the requirement and any high and low spots eliminated.

19.4 Floating or trowelling of the finish shall be permitted only after all surface water has evaporated. Dry cement or a mixture of dry cement and sand shall not be sprinkled directly on the surface of the concrete finish to absorb moisture or to stiffen the mix.

19.5 A rubbed finish shall be provided only on exposed concrete surfaces as specified on the drawings.

19.6 Upon removal of forms all fins and other projections on the surfaces shall be carefully removed, offsets leveled, voids and /or damaged sections immediately saturated with water and repaired by filling with concrete or mortar of the same composition as was used in the concrete.

19.7 The finished surfaces shall present a uniform and smooth appearance.

19.8 All concrete shall be protected against damage until final acceptance by the Engineer-In-Charge.

20.0 CONCRETE FINISHES

20.1 Unless otherwise specified concrete finishes shall confirm to the following specifications

20.1.1 Finish F1, F2 and F3 shall describe formed surfaces.
20.1.2 Finish U1, U2 and U3 shall describe unformed surfaces.
20.1.3 Offsets or fins caused by disposed or misplaced from sheathing, lining or form sections or by defective form lumber shall be referred to as abrupt irregularities.
20.1.4 All other irregularities shall be referred as gradual irregularities. Gradual irregularities shall be measured as deviation from a plane surface with a template 1500 mm long for formed surface and 3000 mm long for unformed surfaces.

20.2 Formed Surfaces

20.2.1 Finish F1 shall apply to all formed surfaces for which finish F2 and F3 or any other special finish is not specified and shall include filling up all form tie holes.
20.2.2 Finish F2 shall apply to all formed surfaces as shown on the drawings or specified by the Engineer-In-Charge. This shall include filling all form tie holes, repair of gradual irregularities exceeding 6 mm removal of ridges and abrupt irregularities by grinding.
20.2.3 Finish F3 shall apply to all formed surfaces exposed to view or where shown in the drawings or specified by the Engineer-In-Charge. Finish F3 shall include all measures specified for Finish F2 and in addition filling air holes with mortar and treatment of the entire surface with sack rubbed finish. It shall also include clean up of loose and adhering debris. Where a sack rubbed finish is specified the surfaces shall be prepared within two days after removal of the forms.
20.2.3.1 The surface shall be wetted and allowed to dry slightly before mortar is applied by sack rubbing. The mortar used shall consist of one part of cement to one and half

parts of fine sand (minus No.16 mesh) by volume. Only sufficient mixing water to give the mortar a workable consistency shall be used.

20.2.3.2 The mortar shall then be rubbed over the surface with a fine burlap or linen cloth so as to fill all the surface voids.

20.2.3.3 The mortar rubbed in the voids shall be allowed to stiffen and solidify after which the whole surface shall be wiped clean so that the surface presents a uniform appearance without air holes, irregularities etc.

20.2.4 Curing of the surface shall be continued for a period of ten days.

20.3 Unformed Surfaces

20.3.1 Finish U1 shall apply to all unformed surfaces for which the finish U2, U3 or any other special finish is not specified and shall include screeding the surface of the concrete to the required slope and grade.

20.3.1.1 Unless the drawing specifies a horizontal surface or shows required the slope the top of the narrow surfaces such as stairs, treads, walls, curbs and parapets shall be sloped approximately 10 mm per 300 mm width.

20.3.1.2 The surfaces to be covered by back fill or concrete sub floors to be covered with concrete topping, terrazzo and similar surfaces shall be smooth screeded and leveled to produce even surface, irregularities not exceeding 6 mm.

20.3.2 Finish U2 shall apply to all unformed surfaces as shown in the drawing or specified by the Engineer-In-Charge and shall include screeding and applying a wood float finish to the surface of the concrete to the required slopes and grade.

20.3.2.1 Repair of abrupt irregularities unless a roughened texture is specified. Repair of gradual irregularities exceeding 6 mm.

20.3.3 Finish U3 shall apply to unformed surfaces for which a high degree of surface smoothness is required where shown on the drawing or as specified by the Engineer-In-Charge. This shall include screeding, floating and applying a steel trowel finish to the surface of the concrete to the required slopes and grade.

20.3.3.1 Repair of abrupt irregularities and gradual irregularities exceeding 6 mm, finishing joints and edges of concrete with edging tools.

21.0 MODE OF MEASUREMENTS

21.1 The concrete as actually done shall be measured for payment. Any work done excess over the specified dimensions for the section shown in the drawing or as required by the Engineer-In-Charge shall not be measured for payment.

21.2 Dimensions of length, breadth and thickness shall be measured correct to nearest centimeters except for the thickness of slab, which shall be measured to nearest 5 mm.

21.3 Areas shall be worked out to nearest 0.01 square metre and the cubic contents of consolidated concrete shall be worked out to nearest 0.001 cubic metres.

21.4 For the purpose of measurements and payments for all concrete works IS 1200 (Part-II) shall be referred.

22.0 MOCK UP & REPAIR METHODS

22.1 General Contractor shall carry out a mock-up Slab-on-Grade not less than 36.0 sqm area with expansion and contraction joints with floor hardener for Engineer-in-Charge & owner's approval.

22.2 General Contractor should maintain the same quality of the work & finishes throughout the construction for all RCC members.

22.3 General Contractor shall submit a proposal for concrete repair method and technical specification of the material intended to be used to Engineer-in-Charge for his approval.

22.4 Approved method should be followed for any concrete repair works including honeycomb and floor cracks if any. Floor cracks more than 0.3mm width and more than one metre long need to be repaired using approved method.

CONTRACTION JOINTS

Contraction joints required will be as shown on the drawings.

Contraction joints shall not be hacked, wetted or mortared before concrete is placed against them.

EXPANSION JOINTS

Expansion joints shall be provided where shown on the drawings. They shall be constructed with an initial gap between the adjoining parts of the works of the width specified in the drawings.

The contractor shall ensure that no debris is allowed to enter expansion joints.

Expansion joints shall be provided with joints filler, a joint sealing compound and in water proof concrete a water bar.

OPEN JOINT FILLERS

Where shown on the drawings, open joints in the structure shall be filled with h one of the following of expansion joint fillers:

a. In internal areas a material conforming to IS:1838 containing bitumen emulsion fibres or cork granules bound together with natural resin.

b. In external areas a material comprising closed cell rubber or containing cork granules bound together with natural resin.

The joints filler shall be easily and uniformly compressible to its original thickness, tampable, easily cut or Sawn, robust, durable, resistant to decay due to termite or weathering, unaffected by water and free of any constituent which will bleed into or stain the concrete.

The joint filler shall be of same thickness of the joint width, it shall extend through the full thickness of the concrete unless otherwise specified and shall be sufficiently rigid during handling and placing to permit the formation straight joints.

JOINT SEALING COMPOUNDS

Joint sealing compounds shall seal joints in concrete against the passage of water, prevent the ingress of grit or other foreign material and protect the joint filler. The compound shall have good extensibility and adhesion to concrete surfaces and shall be resistant to flow and weathering.

Polysulphide joints where specified on the drawings shall be sealed with polysulphide liquid polymer, stored, mixed, handled applied and cured strictly in accordance with the manufacturer's written instructions. Such joints shall be formed to the correct dimensions, thoroughly cleaned and treated with recommended primer strictly in accordance with the manufacturer's written instructions prior to sealing. The contractor shall use only competent personnel experienced in the application of polysulphide for such work.

Where specified in the drawings, rubber/bituminous based sealants shall be of an approved manufacture. The treatment of the joint and the use of sealing compound shall be strictly in accordance with the manufacturer's written instructions.

P.V.C WATER BARS/WATERSTOP

Where water bars are shown on the drawings, the joints shall incorporate an approved PVC external type water bar complete with all necessary moulded or prefabricated intersection pieces assembled in accordance with the drawings with bends and butt joints in running lengths made by heat welding in an electrically heated jig.

Jointing and fixing of water bars shall be carried out strictly in accordance with manufacturer's written instructions.

The water bars shall be installed so that they are securely held in their correct position during the placing and compacting of the concrete.

Where reinforcement is present adjacent to water bars, adequate clearance shall be left between the reinforcement and water bars, to facilitate compaction of the concrete. Double headed nails may be used in the edge of the water bar outside the line of the external grooves for fixing purposes, but no other holes shall be permitted through the water bars.

INSERTS

The contractors shall fix all necessary inserts such as steel plates, pipe sleeves, bolts etc, and make holes, pockets, dowels etc., in the formwork to enable efficient fixing of supports, brackets, ceilings, precast members etc. as indicated on the drawings, called for in the schedule of quantities or as required by the Architect / Employer.

In-situ concrete inserts shall be as per IS:1946 and of a type approved by the Architect / Employer.
Nothing extra over and above the precision as per the priced schedule of quantities shall be paid to the contractor on this account.

With the prior agreement of the Architect / Employer expansion type fasteners may be used by the contractor in hardner concrete.

CRACKS

If any cracks develop in the reinforced concrete construction which in the opinion of the Architect / Employer be detrimental to the strength of the construction, the contractor at his own expense shall test the structural element in questions. If under these test loads the cracks shall develop further the contractor at his own expense shall dismantle the construction. Carry away the debris replace the construction and carryout all construction work there to at no extra cost.

If the cracks are not detrimental to the stability of the construction in the opinion of the Architect / Employer the contractor at his own expense shall grout the cracks with commercially applied mortar or epoxy grout. At his own expense and care shall also make good all other building work such as plaster moulding, surface finish of floors, roofs, ceiling etc, which if the opinion of the Architect / Employer have suffered damage either in appearance of stability owing to such cracks. The repair work shall be carried out as the satisfaction of the Architect / Employer. The decision of the Architect / Employer as to the extent of the liability of the contractor in the matter shall be final and binding on the contractor.

LOAD TESTING ON COMPLETED STRUCTURES

During the period of construction or within the defect liability period the Architect / Employer may at his discharge order the load testing of any completed structure and thereof if he has reasonable doubts about the adequacy of the strength of such structure for any of the following reasons:

a. Results of comprehensive strength on concrete test cubes.

b. Premature removal of formwork.

c. Inadequate curing of concrete.

d. Over loading during the construction of the structure or part thereof.

e. Carrying out concreting of any portion without prior approval of the Architect / Engineer-in-charge.

f. Honey combed or damaged concrete which in the opinion of the Architect / Engineer-in-charge, is particularly weak and will affect the stability of the structure to carry the design load, more so in important or critical areas of the structure.

g. Any other circumstances attributable to alleged negligence of the contractor which in the opinion of the Architect / Engineer-in-charge may result in the structure or any part thereof being of less than the expected strength.

All the loading tests shall be carried out by the contractor strictly in accordance with the instructions of the Engineer-in-charge. Such tests should be carried out only after expiry of minimum 28 days or such longer period as directed by the Architect / Engineer-in-charge.

The structure should be subjected to a super imposed load equal to 1.25 times the specified superimposed load assumed in the design. This load shall be maintained for a period of 24 hours of the removal of the superimposed load, the test loading shall be repeated after a lapse of 72 hours. If the recovery after the second test is less than 80% of the maximum deflection shown during the second test, the structure shall be considered to have failed to pass the test and shall be deemed to be unacceptable.

In such cases the part of the work concerned shall be taken down or cut out and reconstructed to comply with the specifications. Other remedial measures may be taken to make the structure secure at the discretion of the Architect / Employer. However, such remedial measures shall be carried out to the complete satisfaction of the Architect / Employer.

All costs involved in carrying out the tests and other incidental expense thereto shall be borne by the contractor regardless of the result of the tests. The contractor shall take down or cut out and reconstruct the defective work or shall take the remedial measures instructed, at his own cost.

In addition to the above load tests, non destructive test methods such as core test and ultrasonic pulse velocity test shall be carried out by the contractor at his own expense if so desired by the Architect / Employer. Such tests shall be carried out by an agency approved by the Architect / Employer and shall be done under expert guidance using only recommended testing equipment. The acceptance criteria for these tests shall be mutually agreed between the Architect / Employer and the Contractor.

All concreting work shall be done under strict supervision of the qualified and experienced representatives of the Contractor as well as those of the Architect / Employer. The contractor's Architect / Employer and supervisor who are in-charge of concreting work shall be skilled in this class of work and shall personally superintend all the concreting operations.

Special attention shall be paid to the following:

a. Proportioning, mixing and quality testing of the materials with particular control on the water cement ratio.

b. Laying of material in place and thorough compaction of the concrete to ensure solidity and freedom from voids and honeycombing.

c. Proper curing for the requisite period.

Reinforcement position are not to be disturbed during concreting and consolidation by vibration.

E PLAIN CEMENT CONCERTE FOR GENERAL WORK

1.0 For plain cement concrete work, the specifications for materials viz., cement, sand, fine and coarse aggregates and water shall be the same as that specified in reinforced work specification.

2.0 But the proportion of mix will be nominal and the ratio of fine and coarse aggregate may be slightly adjusted within limits keeping the total volume of aggregates to a given volume cement constant, to suit the sieve analysis of the aggregates. Cement shall on no account be measured by volume, both it shall always be used directly from the bags (i.e., 50 Kg/bag).

3.0 The proportion of cement, sand, aggregate for concrete of proportion 1:4:8, 1:3:6, 1:2:4 by volumes shall generally consist of quantities as given below:

Proportion of ingredients	Quantity of materials used per bag of cement			
	Cement	Sand	Coarse aggregate	Water
1:4:8	1	130 ltrs	272 ltrs	39 ltrs
1:3:6	1	102 ltrs	204 ltrs	34 ltrs
1:2:4	1	68 ltrs	136 ltrs	30 ltrs

4.0 The quantity of water used shall be such as to produce concrete of consistency required by the particular class or work and shall be decided by the use of slump cone. Sufficient care should be taken to see that no excess quantity of water is used. The final proportion of the aggregates and the quantity of water shall be decided by the Engineer-in-Charge on the basis of test in each case. The slum shall be specified for each class of work and shall in general be as follows:-

Type of Concrete Mix	slump (Millimetres)
Mass Concrete	50
Roads and pavements, hand finished	100
Roads and pavements, machines finished	25
Floor paving	50

5.0 All plain concrete shall be preferably mixed in a drum type power driven machine with a loading hopper, which will permit the accurate measure of various ingredients. If hand mixing is authorized, it should be done on a watertight platform.

The mixing of each batch in the concrete mixer shall continue for not less than 2 minutes after the materials and water are in the mixer. The volume of mixed materials per batch shall not exceed the manufacturer's rated capacity of the mixer. The mixer shall rotate at a peripheral speed of about 60 metres per minute.

6.0 Concrete shall be poured and consolidated in its final position within half an hour of mixing. The re-tempering of concrete, which has partially hardened, that is remixing with or without additional cement, aggregate or water shall not be permitted.

7.0 Concrete in c.c. 1:2:4 will be required to be vibrated with mechanical vibrators or other means as directed by the Engineer-in-Charge.

8.0 The concrete shall be cured for minimum 10 days. Measurements for the work done shall be exact length, breadth and depth shown or figured on the drawings or as instructed by the Engineer-in-Charge and after the concrete is consolidated. No extra shall be paid for excess quantity resulting from faulty workmanship.

F READY MIXED CONCRETE (R.M.C.)

1.0 SCOPE

Supply of ready-mixed concrete shall be as specified in IS 4926-1976.
Strength of RCC design mix shall be specified in the item.

2.0 TERMINOLOGY

2.1 For the purpose of this standard the definitions in 2.2 to 2.5 shall apply.

2.2 Ready-mixed Concrete
Concrete delivered at site in plastic condition and requiring no further treatment before being placed in the position in which it is to set and harden.

2.3 Agitation
The process of continuing the mixing of concrete at a reduced speed during transportation to prevent segregation

2.4 Agitator
Truck mounted equipment designed to agitate concrete during transportation to the site of delivery.

2.5 Truck–Mixer
A mixer generally mounted on a self-propelled chassis capable of mixing the ingredients of concrete and of agitating the mixed concrete during transportation.

3.0 TYPES OF MIXING

3.1 For the purpose of this standard, the ready-mixed concrete shall be of the following type, according to the method of production and delivery as specified in 3.2

3.2 Centrally Mixed Concrete – Concrete produced by completely mixing cement, aggregates, admixtures, if any and water at a central mixing plant and delivered in containers fitted with agitating devices.

4.0 MATERIALS

4.1 Materials such as cement, coarse & fine aggregates, water & admixture, etc. shall confirm to the specifications mentioned in the RCC works. Use of mineral admixtures like fly ash, GGBFS, etc. shall not be permitted unless otherwise specifically permitted by Engineer-in-charge. Cement shall be Ordinary Portland Cement – 43 grade/ Portland Pozzolana cement (Fly ash based meeting the 28 day strength requirement of OPC 43 grade cement) only.

5.0 BASIS OF SUPPLY

5.1 Ready-mixed concrete shall be manufactured and supplied on the specified strength based on 28 days compressive strength of 15 cm cubes tested in accordance with IS: 456-2000.

5.2 The responsibility for the design of mix shall be that of the manufacturer and the concrete shall confirm to the requirements as specified in 7.

6.0 GENERAL REQUIREMENTS

6.1 Ready-mixed concrete shall generally comply with the requirements of IS: 456 considering as ‘severe’ environment.

6.2 Minimum quantity of cement and the details regarding proportions of aggregates control shall be in accordance with IS: 456.

6.3 Concrete shall be delivered to the site of work and discharge shall be complete within ½ hour (when the prevailing atmospheric temperature is above 20° C) and within 2 hours (when the prevailing atmospheric temperature is at or below 20° C) of adding the mixing water to the mix of cement and aggregate or of adding the cement to the aggregate whichever is earlier.

6.4 Sampling and Testing

6.4.1 Adequate facilities shall be provided by the manufacturer for purchaser to inspect the materials used, the process of manufacture and methods of delivery of concrete. He shall also provide adequate facilities for the purchaser to take samples of the materials used.

6.4.2 Sampling and testing of concrete shall be done in accordance with the relevant requirements of IS: 456-2000, IS: 1199-1959 and IS: 516-1959.

6.4.3 Testes for consistency or workability shall be carried out in accordance with the requirements of IS: 1199-1959 or by such other method as may be agreed between the purchaser and the manufacturer.

6.4.4 The compressive strength and flexural strength tests shall be carried out in accordance with requirements of IS: 516-1959 and the acceptance criteria for concrete supplied on the basis of specified strength shall conform to the requirements of IS: 456.

6.4.5 All cost of the tests carried out in accordance with requirements of this specification shall be borne by the General Contractor.

6.4.6 The manufacturer shall keep batch records of the quantities by mass of all solid materials, of total amount of water used in mixing and of the results of all tests. If required by the purchaser, the manufacturer shall furnish certificate, at agreed intervals, giving this information.

6.4.7 Concrete supplier should send a printed delivery order with the concrete truck for each & every trip showing the grade of concrete, design slump, mixing time, etc. and should not use any pre-printed delivery orders.

7.0 CONCRETE MANUFACTURED AND SUPPLIED ON THE BASIS OF SPECIFIED STRENGTH

7.1 The manufacturer shall supply the following information for guidance of the supplier for approval:

a) Type of cement to be used.
b) Maximum size and type of aggregates.
c) Type of admixtures to be used.
d) Minimum accepted compressive strength or flexural strength or both, determined from samples of plastic concrete taken at the place and time of delivery, in accordance with requirements of IS: 456-2000.
e) Slump or compacting factor or both, or other requirement for consistency or workability at the place and time of delivery of the concrete.
f) Ages at which the test cubes or beams are to be tested and the frequency and number of tests to be made shall be as required by the purchaser.

7.2 Tolerances

Concrete shall be deemed to comply with the requirements of this specification, if the results of the tests where applicable, lie within the tolerances specified in 7.2.1.

7.2.1 Consistency or Workability – The slump (average of two tests) shall not differ from the specified value by + 10 mm for a specified slump of 75 mm or less and + 25 mm when the specified slump is greater than 75 mm. The compacting factor average of two tests shall be within + 0.03 of the value specified. The test for consistency or workability shall be completed within 15 minutes of the time of receipt of the ready-mixed concrete at site.

8.0 PLACING OF READY-MIXED CONCRETE

The ready-mixed concrete shall be placed in the required location/position, level, heights, etc. by using pumping arrangement method/mechanically as directed by the Engineer–in-Charge.

G FORM WORK

1.0 SCOPE

1.1 Formwork shall consists of shores, bracings, side of beams and columns, bottom of slabs, etc. including ties, anchors, hangars, inserts, etc. complete which shall be properly designed and planned for the works.

1.2 Formwork shall be so constructed that up and down vertical adjustments can be made smoothly. Wedges may be used at top or bottom of shores, but not at both the ends to facilitate vertical adjustment for dismantling of the formwork.

2.0 APPLICABLE CODES AND SPECIFICATIONS

2.1 The relevant IS specification, standards and codes given below are made a part of this specification. All standards, specifications, code of practices refer to herein shall be the latest edition including all applicable amendments, revisions and additional publications.

No.	IS No.	IS Particulars
1.	IS: 303	Plywood for general purpose
2.	IS: 1200 (Part V)	Method of Measurement of building and civil engineering work (Form work)
3.	IS: 2750	Specification for steel scaffolding
4.	IS: 3696	Safety code for scaffolds and ladders
5.	IS: 4014 (Part I)	Code of Practice for steel tubular scaffolding
6.	IS: 4014 (Part II)	Code of Practice for steel tubular scaffolding
7.	IS: 4990	Specification for plywood for concrete shuttering work

3.0 DESIGN OF FORMWORK

3.1 Design and engineering of the formwork as well as its construction shall be the responsibility of the General Contractor. If so instructed, the drawings and calculations for the design of the formwork shall be submitted well in advance to the Engineer-in-charge for approval before proceeding with the work at no extra cost. Engineer-in-charge's approval shall not relieve the General Contractor of the full responsibility for the design and construction of the formwork.

3.2 The design shall take into account all the loads vertical as well as lateral that the forms will be carrying including live load and vibration loads.

3.3 Depending upon the height of the staging suitable vertical and horizontal cross bracings shall be provided.

3.4 General Contractor shall note that no concrete work of floor, beam, slab including roof slab will be permitted unless the staging work is inspected and the approval in writing for its soundness is given to the Engineer-in-charge prior to commencement of concrete work.

4.0 TOLERANCES

4.1 Tolerance is a specified permissible variation from lines, grade or dimensions given in the drawings. No tolerance specified for horizontal and vertical building lines or footings shall be considered to permit encroachment beyond the legal boundaries. Unless otherwise specified, following tolerances shall be permitted -

4.1.1 Tolerance for RCC Building

4.1.1.1 Variation from the plumb

No.	Building Members	Tolerances
1.	In the line and surface of columns, piers, walls and buttresses	5 mm per 2.50 M but not more than 25 mm
2.	For exposed corner columns and other conspicuous lines	In any bay or 5 M maximum: (+/-) 5 mm. In 10 M or more: (+/-) 10 mm

4.1.1.2 Variation from the level or frame the grade indicated in the drawings

No.	Building Members	Tolerances
1.	In slab soffits, ceilings, beam soffits and staircases	In 2.50 M : (+/-) 5 mm In any bay or 5 M maximum: (+/-) 8 mm. In 10 M or more: (+/-) 15 mm
2.	For exposed lintels, parapets, horizontal grooves and other conspicuous lines	In any bay or 5 M maximum: (+/-) 5 mm. In 10 M or more: (+/-) 10 mm

4.1.1.3 Variation of the linear building lines from established position in plan and related position of columns, walls and partitions

No.	Building Members	Tolerances
1.	In any bay or 5 M maximum	(+/-) 5 mm
2.	In 10 M or more	(+/-) 20 mm

4.1.1.4

No.	Building Members	Tolerances
1.	Variation in the sizes and locations of sleeves, openings in walls and floors except in the case of anchor bolts	(+/-) 5 mm

4.1.1.5

No.	Building Members	Tolerances
1.	Variation in cross sectional dimensions of columns and beams and thickness of slabs	and walls (-) 5 mm and (+) 10 mm.

4.1.1.6 Footings:

No.	Building Members	Tolerances
1.	Variation in dimension in plan	(-) 5 mm and (+) 50 mm.
2.	Misplacement or eccentricity in the direction of misplacement	0.02 times the width of the footing in the direction of the deviation but not more than 50 mm
3.	Reduction in thickness	(+/-) 0.05 times the specified thickness

4.1.1.7 Variation in steps

No.	Building Members	Tolerances
1.	In a flight of stairs riser	(+/-) 3 mm
2.	In a flight of stairs tread	(+/-) 5 mm
3.	In consecutive steps riser	(+/-) 1.5 mm
4.	In consecutive steps tread	(+/-) 3 mm

4.1.2 Tolerances in other Concrete structures

4.1.2.1 All structures

No.	Building Members	Tolerances
1.	Variation of the constructed linear outline from established position in plan	(+/-) 10 mm in 5 M (+/-) 15 mm in 10 M or more
2.	Variation of dimensions to individual structure features from established positions in plan	(+/-) 25 mm in 20 M or more (+/-) 50 mm in buried construction
3.	Variation from plumb, specified batter or curved surfaces of all structures	(+/-) 10 mm in 2.50 M (+/-) 15 mm in 5 M (+/-) 25 mm in 10 M or more (+/-) Twice the above amounts in buried construction
4.	Variation from level or grade indicated on drawings in slabs and beams soffits, horizontal grooves and visible arises	(+/-) 5 mm in 2.50 M (+/-) 10 mm in 7.5 M or more (+/-) Twice the above amounts in buried construction
5.	Variation in cross sectional dimensions of columns, beams, buttresses, piers and similar members	(-) 5 mm and (+) 10 mm
6.	Variation in the thickness of slabs, walls, arch sections and similar members	(-) 5 mm and (+) 10 mm

4.1.2.2 Footings for columns, piers, walls, buttresses and similar members

No.	Building Members	Tolerances
1.	Variation in dimension in plan	(-) 10 mm and (+) 50 mm.
2.	Misplacement or eccentricity in the direction of misplacement	0.02 times the width of the footing in the direction of the deviation but not more than 50 m
3.	Reduction in thickness	(+/-) 0.05 times the specified thickness

4.1.2.3 Tolerances in other types of structures shall generally conform to those given in clause 2.4 of recommended Practice for Concrete Formwork (ACI 347).

5.0 TYPE OF FORMWORK

5.1 Formwork may be of timber, plywood, metal, plastic or concrete. For special finishes the formwork may be lined with plywood, steel sheets, oil tempered hard board, etc. sliding forms and slip forms may be used with the approval of Engineer-in-Charge

6.0 FORMWORK REQUIREMENTS

6.1 Forms shall conform to the shapes, lines, grades and dimensions including camber of the concrete as called for on the drawings. Ample studs, waler, braces, ties, straps, shores, etc. shall be used to hold the forms in proper position without any distortion whatsoever until the concrete has set sufficiently to permit removal of forms. Form shall be strong enough to permit the use of immersion vibrators; in special case form vibrators may also be used. The shuttering shall be close boarded. All forms should not have any warps or other surface defects in contact with concrete; seasoned, free from sap, shakes, loose knots, worm holes for timber forms and shall be free from adhering grout, plaster, paint, projecting nails, splits or other defects. Joints shall be sufficiently tight to prevent loss of water and fine material from concrete.

6.2 Metal Forms shall be used for exposed concrete surface where called for. Sawn and wrought timber or metal may be used for unexposed surfaces. Inside faces of forms for concrete surface, which are to be rubbed finished shall be planed to remove irregularities or unevenness in case of timber form in the face. Formwork with lining will be permitted.

6.3 All new and used forms shall be maintained in a good condition with respect to shape, strength, rigidity, water tightness, smoothness and cleanliness of surfaces. Forms with unsatisfactory in any respect shall not be used and if rejected by the Engineer-in-charge shall be removed from the site.

6.4 Shores supporting successive stories shall be placed directly over those below or be so designed and placed that the load will be transmitted directly on them. Trussed supports shall be provided for shores that can be secured on adequate foundation.

6.5 Form work during any stage of construction showing signs of distortion or disturbed to such a degree that the intended concrete work will not conform to the exact contours indicated on the drawings shall be re-positioned and strengthened. Poured concrete affected by faulty formwork shall be removed entirely and the formwork shall be corrected prior to placing new concrete.

6.6 Excessive construction camber to compensate for shrinkage settlement etc. that may impair the structural strength of the members will not be permitted.

Forms for substructure concrete may be omitted in the opinion of the Engineer-in-charge the open excavation is firm enough to act as the form. Such excavation shall be slightly larger than that required by drawings to compensate for irregularities in excavation and to ensure the design requirement.

6.7 Forms shall be designed and constructed that they can be stripped in order required and their removal do not damage the concrete. Face form work shall provide true vertical and horizontal joints conforming to the architectural features of the structure as to location of joints and be as directed by the Engineer-in-charge.

6.8 Where exposed smooth or rubbed concrete finishes are required, the forms shall be constructed with special care so that the desired concrete surfaces could be obtained which require a minimum finish.

7.0 BRACINGS, STRUTS AND PROPS

7.1 Shuttering shall be braced, strutted, propped and so supported that it shall not deform under weight and pressure of the concrete and also due to the movement of men and other materials. Bamboos shall not be used as props or cross bracings.

7.2 The shuttering for beams and slabs shall be so erected that the shuttering on the sides of the beams and under the soffit of slab can be removed without disturbing the beam bottoms.

7.3 Re-propping of the beams shall not be done except when the props have to be reinstalled to take care of construction loads anticipated being excess of the design load. Vertical props shall be supported on wedges or other measures shall be taken whereby the props can be gently lowered vertically while striking the shuttering.

7.4 If the shuttering for a column is erected for the full height of the column, one side shall be left open and built upon sections as placing of concrete proceeds or windows may be left for pouring concrete from sides to limit the drop of concrete to one meter or as directed by the engineer-in-charge.

8.0 FORM OIL

8.1 Use of the form oil shall not be permitted on the surface that requires painting. If the contractor desires to use form oil on the inside of form work of the other concrete surfaces, a non staining mineral oil or other approved oil ‘CEMOL-35’ of M/s Hindustan Petroleum Co. Ltd. or equivalent may be used provided it is applied before placing of reinforcing steel and embedded parts.

8.2 All excess oil on the form surfaces and any oil on metal or other parts to be embedded in the concrete shall be carefully removed. Before treatment with oil forms shall be thoroughly cleared of dried splatter of concrete from placement of previous lift.

9.0 CHAMFERS AND FILLETS

9.1 All corners and angles in the finished structure shall be formed with mouldings to form chamfers or fillets on the finished concrete. The standard dimensions of chamfers and fillets unless otherwise specified shall be 20 mm x 20 mm. Care shall be exercised to ensure accurate moulds. The diagonal face of the moulds shall be planed or surface to the same texture as the forms to which it is attached.

9.2 Vertical construction joints on faces which will be exposed at the completion of the work shall be chamfered as above except where not permitted by Engineer-in-charge for structural or hydraulic reasons.

10.0 WALL TIES

10.1 Wall ties passing through the walls shall not be allowed. Also through bolts shall not be permitted. For fixing of formwork alternate arrangements such as coil nuts shall be adopted at the contractor’s cost.

11.0 REUSE OF FORMS

11.1 Before reuse all forms shall be thoroughly scraped, cleaned, nails removed, holes that may leak suitably plugged and joints examined and when necessary repaired and the inside retreated to prevent adhesion to the satisfaction of Engineer-in-charge. Warped timber or metal shall be resized. Contractor shall equip himself with enough shuttering to complete the job in the stipulated time.

12.0 REMOVAL OF FORMS

12.1 Contractor shall record in the drawings or a special register the date upon which the concrete is placed in each part of the work and the date on which the shuttering is removed there from.

12.2 In no circumstances shall form struck until the concrete reaches a strength of at least twice the stress due to self weight and any construction/erection loading to which the concrete may be subjected at the time of striking of formwork. The strength referred to shall be that of concrete using the same cement and aggregates and admixture, if any, with the same proportions and cured under conditions of temperature and moisture similar to those existing on the work.

12.3 In normal circumstances where the ambient temperature does not fall below 15^{o}C and where Ordinary Portland Cement is used and adequate curing is done the stripping time is to be followed as specified in IS: 456-2000 (clause 11.3).

12.4 Striking shall be done slowly with utmost care to avoid damage to arise and projections and without shock or vibration by gentling easing the wedges. If after removing the formwork it is founds that timber has been embedded in the concrete, it shall be removed and made good as specified earlier.

12.5 Reinforced temporary openings shall be provided as directed by the Engineer-in-Charge to facilitate removal of formwork which otherwise may be inaccessible.

12.6 Tie rods, clamps, form bolts, etc. which must be entirely removed from walls or similar structure shall be loosened not sooner than 16 hours not later than 24 hours (in case the conditions in 12.3 are satisfied) after the concrete has been deposited. Ties except those required to hold the forms in place may be removed at the same time. Ties withdrawn from walls and grade beams shall be pulled towards the inside face. Cutting ties back from the faces of forms and grade beams will not be permitted. Work damaged due to premature or careless removal of forms, any undulation in exposed concrete surface due to sag / settlement or movement of supports found after removal of shuttering shall be reconstructed or rectified to the satisfaction of the Engineer-in-charge by the General Contractor at his own risk and cost. Abrupt changes in surface of concrete, mortar fins at formwork joints shall be made even by chipping, grinding and finishing with cement mortar, curing, etc. as directed by Engineer-in-charge at his own cost.

13.0 MODE OF MEASUREMENT

13.1 The net area of exposed surfaces of concrete members as shown in the drawings coming in contact with form work shall be measured under item of form work in square meter.

13.2 The dimensions of the formwork shall be measured correct to a centimeter.

13.3 No deductions shall be made from the shuttering for openings/obstructions up to an area of 0.10 m2 and nothing extra shall be paid of forming such opening.

13.4 For the purpose of measurements for formwork IS: 1200 (Part V) shall be referred.

14.0 SPECIFICATION FOR STAGING WORK

14.1 General Contractor shall note that only steel tubular staging (acrow type or equivalent) shall be used for all RCC beams, slabs, etc. at all floor levels and the same shall be designed by him and the detailed drawings and the design calculations shall be submitted for the approval of Engineer-in-charge at least two weeks in advance of the scheduled date of its erection at site.

14.2 Depending upon the height of the staging, suitable vertical and horizontal cross bracings shall be provided. The General Contractor shall note that no concreting of floor beams, stairs and slabs including roof slab will be permitted unless the staging work is inspected and approval in writing for its soundness by the Engineer-in-charge is given prior to the commencement of concreting.

H RUBBER / P.V.C. WATER STOPS

1.0 GENERAL

1.1 The corrugated Rubber/PVC water stops with centre bulb of specified width, shall be of approved manufacture and shall satisfy all the normal tests such as tensile strength, elongation etc.

2.0 SAMPLE

2.1 A sample of Rubber/PVC water stops shall be got approved from the Engineer-in-charge before procurement of bulk quantity.

3.0 PLACING IN POSITION

3.1 The water stops shall be provided in available maximum length and as far as possible, jointing shall be avoided. All the joints when unavoidable, shall be field jointed for water tightness as per manufacturers specifications and recommendation.

3.2 The water-stops shall be positioned with suitable temporary supports so as to render adequate rigidity to the water stops while concreting. The exposed surfaces of water stops revealed after first concreting shall be cleaned thoroughly of all the droppings, mortar splashing, timber scantlings sticking etc. before the next pour of concrete is taken up in hand. Any damage caused to water stops shall be made good by the contractor at his own cost as per manufacturer's specification and recommendation.

3.3 All corners pieces and laps should be factory made and no modification will be permitted at site.

4.0 MODE OF MEASUREMENT

4.1 The mode of measurements shall be in running meter, of water stop actually laid without any allowance for laps, wastage etc., measured correct to one centimetre.

4.2 Rate shall include supply, transport, fixing, welding, supporting arrangements, cleaning etc. all as described above.

I STEEL REINFORCEMENT

1.0 GENERAL

1.1 Steel reinforcement bars, if supplied or arranged by the General Contractor, shall be either plain round mild steel bars grade – I or medium tensile steel bars as per IS: 432 or hot rolled mild steel and medium tensile deformed as per IS: 1139 or Thermo-mechanically treated (TMT) bars - high yield strength deformed bars as per IS: 1786 as shown and specified on the drawings and shall be manufactured by M/s SAIL or TISCO and shall be rolled from their own plants and from virgin material. Materials manufactured by their authorized conversion agents and re-rollers shall not be accepted.

Documentary evidence of purchasing steel produced from these manufacturers and their manufacturing test certificate shall be submitted. The third party test shall be carried out as directed in line with the relevant Indian standards and cost of which shall be included in the item rate and no separate payment shall be made on account of this.

1.2 Wire mesh or fabric shall be in accordance with IS: 1566.

1.3 Substitution of reinforcement will not be permitted except upon written approval from Engineer-In-Charge.

2.0 SCOPE

2.1 This specification covers the general requirements for quality, storage, bending and fixing of reinforcement.

3.0 APPLICABLE CODES AND SPECIFICATIONS

3.1 The relevant IS specification, standards and codes given below are made a part of this specification. All standards, specifications, code of practices refer to herein shall be the latest edition including all applicable amendments, revisions and additional publications.

1.	IS: 432 (Part I)	Mild Steel and Medium Tensile Steel bars and Hard drawn Steel Wires for concrete reinforcement
2.	IS: 432 (Part II)	Mild Steel and Medium Tensile Steel bars and Hard drawn steel wires for concrete reinforcement
3.	IS: 1139	Specification for Hot Rolled Mild steel, Medium steel and HYSD bars for concrete reinforcement
4.	IS: 1200 (Part VIII)	Method of Measurement of Building and Civil Engineering work (Steel and Iron works)
5.	IS: 1566	Hard drawn Steel Wire fabric for concrete reinforcement
6.	IS: 1599	Method for Bend Test
7.	IS: 1608	Method of Tensile Testing of Steel Products
8.	IS: 1786	High Strength Deformed Steel and Wires for concrete reinforcement
9.	IS: 2502	Code of Practice for Bending and Fixing of Bars for concrete reinforcement

4.0 STORAGE

4.1 The reinforcement shall not be kept in direct contact with the ground but stacked on top of an arrangement of timber slippers or the like. The reinforcement shall be coated with cement wash before stacking to prevent scale and rust. Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deterioration.

5.0 QUALITY

5.1 All steel shall be of grade-I quality unless specifically permitted by the Engineer-In-Charge. No re-rolled material will be accepted. General Contractor shall submit the manufacturer's test certificate for steel.

5.2 Random test on steel supplied by the General Contractor may be performed by Engineer-in-Charge as per relevant IS. All cost incurred to such tests shall be at the contractor's expenses. Steel not conforming to the specifications shall be rejected.

5.3 All reinforcement shall be clean, free from grease, oil, paint, dirt, loose mill scale, loose rust, dust, bituminous material or any other substance that will destroy or reduce the bond. All rods shall be thoroughly cleaned before being fabricated.

5.4 Pitted and defective rods shall not be used. All bars shall be rigidly held in position before concreting. No welding of rods to obtain continuity shall be allowed unless approved by the Engineer-in-charge. If welding is approved the work shall be carried out as per IS: 2751, according to best modern practices and as directed by the Engineer-in-charge.

5.5 In all cases of important connections, test shall be made to prove that the joints are of the full strength of the bar welded. Special precaution as specified by the Engineer-in-charge shall be taken in the welding of cold work reinforcing bars and bars other tan mild steel.

6.0 LAPS

6.1. Laps and splices for reinforcement shall be as shown on the drawings. Splices and adjacent bars shall be staggered and the location of all splices except those specified on the drawings shall be approved by the Engineer-in-charge. The bars shall not be lapped unless the length required exceeds the maximum available length required of bars at site.

7.0 BENDING

7.1 All bars shall be accurately bent (cold) according to the size and shape shown on the detail working drawing / bar bending schedule. They shall be gradually bent by machine or approved means.

7.2 Reinforcing bars shall not be straightened and re-bend in the manner that will injure the material. Bars containing cracks and splits shall be rejected. They shall be bent cold except bars above 25 mm in diameter which may be bent hot, if specifically approved by Engineer-in-charge.

7.3 Bars which depend for their strength on cold working shall not be bent hot. Bars bent hot shall not be heated beyond cherry-red color (not exceeding 645^{o} C) and after bending shall be allowed to cool slowly without quenching.

7.4 Bars incorrectly bent shall be used only if the means used for straightening and re-bending be such as shall not in the opinion of the Engineer-in-charge injure the material.

7.5 No reinforcement bars shall be bent when in position in the work without approval, whether or not it is partially embedded in hardened concrete. Bars having kinks or bends other than those required by the design shall not be used.

8.0 FIXING

8.1 The reinforcement shall accurately be fixed by any approved means and maintained in the correct position as shown in the drawing by use of blocks, spacers and chairs as per IS: 2502 to prevent displacement during placing and compaction of concrete.

8.2 Bars intended to be in contact at crossing point shall be securely bound together at all such points with 1.6 mm diameter annealed soft iron wire.

8.3 The vertical distance required between successive layers of bars in beams or similar members shall be maintained by provision of mild steel spacer bars at such intervals that the main bar do not perpetually sag between adjacent spacer bars.

9.0 COVER TO REINFORCEMENT

9.1 Unless indicated otherwise on the drawing, clear concrete cover for reinforcement (exclusive of plaster or decorative finish) shall be as per the provisions of IS: 456.

10.0 INSPECTION

10.1 Erected and secured reinforcement shall be inspected and approved by the Engineer-in-charge prior to placement of concrete.

11.0 MODE OF MEASUREMENT

11.1 The actual quantity of reinforcement bars embedded in concrete as specified in the drawing and as approved by the Engineer-in-charge irrespective of the level or height at which the reinforcement bars are placed shall be measured for payment.

11.2 The reinforcement bars shall be measured in length nearest to a centimeter for different diameters and their weight shall be calculated based on the standard weights as per Indian Standard.

11.3 Wastage, unauthorized overlap and annealed steel binding wires shall not be measured for payment.

11.4 Pins, chairs and spacers wherever required shall be provided As directed by the Engineer-in-charge and measured separately and paid for.

11.5 The rate for reinforcement item shall include the cost of labour and materials required for all operations described above including transportation, cleaning, straightening, cutting, bending, placing in position and binding of reinforcement bars and wastage, etc.

J STRUCTURAL STEEL

1.0. SCOPE

1.1. This specification covers requirements for the supply wherever, fabrication and delivery of structural steel and miscellaneous steel items for the work.

1.2. This specification also covers redesign wherever necessary, design of all connections and published members, preparation of all shop fabrication drawings, inspection and painting of structures by the fabricators.

2.0. APPLICABLE CODES AND SPECIFICATIONS

2.1 Unless otherwise specified herein, the design, materials and workmanship shall conform to the latest edition of the one or as many as applicable of the following standards or their approved equivalents.

2.2. All standards, specifications and code of practices, referred to herein shall be the latest edition including all applicable amendments, revisions and additional publications.

2.3. List of Indian Standards :

IS. 226	:	Structural steel (standard quality)
IS. 808	:	Rolled steel beams, channel and angles sections.
IS. 1099	:	Structural steel (ordinary quality)
ASTM 06	:	General requirements for delivery of rolled steel plates, sheet piling and bars for structural use.
IS. 1367	:	Technical supply conditions for threaded fasteners.
IS. 3757	:	High tensile friction grip fasteners for structural engineering purposes.
IS. 814	:	Specifications for covered electrodes for metal arc welding for mild steel.
IS. 3613	:	Acceptance tests for wire flux combination for submerged-arc welding.
AWS. A-5.1	:	Specification for mild steel covered arc welding electrodes.
AWS.A-5-17	:	Specification for hard mild steel electrodes and submerged arc welding.
IS. 1052	:	Specification for rolling and cutting tolerances for hot rolled steel products.
IS. 2074	:	Ready mixed paint, red oxide zinc chrome, priming.
IS. 102	:	Ready mixed paint, brushing, red lead, non-setting, priming.
IS. 300	:	Code of practice for use of structural steel in general building construction.
IS. 875	:	Code of practice for structural safety of building : Loading standards.
IS. 1893	:	Recommendations for earthquake resistant design of structures.
IS. 816	:	Code of practice for use of metal arc welding for general construction.
IS. 4353	:	Recommendations for submerged arc welding of mild steel and low alloy steel.
IS. 823	:	Code of procedure for manual metal arc welding of mild steel.
IS. 817	:	Codes of practice for training and welding of metal arc welders.
IS. 1182	:	Recommended practice for radiographic examination of fusion-welded butt joints in steel plates
IS. 5334	:	Codes of practice for magnetic particle flaw detection of

welds

ASTM E. 94	:	Recommended practice for radiographic testing.
ASTME. 109	:	Dry powder magnetic particle inspection.
ASTME. 130	:	Wet magnetic particle inspection.
ASTME. 165	:	Liquid penetrant inspection.
IS. 1477	:	Code of practice for painting of ferrous metals in building all allied finishes.
IS. 1161	:	Steel Tubes for structural purposes
IS:1363	:	Hexagon Head Bolts, Screws and Nuts of product (Part I to III)
IS. 1852	:	Rolling and Cutting Tolerances for Hot Rolled Steel Products
IS. 3502	:	Steel Chequered Plate
IS. 3757	:	High Strength Structural Bolts
IS. 1200	:	Method of Measurement

3.0. STEEL MATERIALS

3.1. Structural steel shall be procured by the contractor conforming to relevant IS codes and manufactured by M/s SAIL or TISCO and shall be rolled from their own plants and from virgin material. Materials manufactured by their authorized conversion agents and re-rollers shall not be accepted. Documentary evidence of purchasing steel produced from these manufacturers and their manufacturing test certificate shall be submitted. The third party test shall be carried out as directed in line with the relevant Indian standards and cost of which shall be included in the item rate and no separate payment shall be made on account of this.

3.2. General Contractor shall take proper care of the steel delivered to site/fabrication yard and protect the same from weathering and damage. Any such materials rendered unserviceable or damaged while in the contractor's custody shall be replaced by contractor at his own cost as directed by the Engineer-in-Charge.

3.3. General Contractor's stock material may be used provided the mill test reports identified with the materials, satisfactorily demonstrate specified grade and quality. Also all such materials supplied by contractor shall be in a sound condition of recent manufacture, in full length, free from defects, loose mill scale, slag intrusions, laminations, pitting, flaky rust etc. and be of full weight of thickness specified.

3.4. Unidentified steel material may be used only with prior permission from Engineer-in-charge, in writing, for short sections of minor importance or for small unimportant welds and connections where in the opinion of the Engineer-in-charge the quality of such material would not adversely affect the strength and / or durability of the structure. Engineer-in-charge may also permit use of such material for other work if adequate and random samples taken out and tested to demonstrate conformity with specification & requirement for work in view.

3.5. General Contractor shall submit the fabrication drawing for the Engineer-in-charge's approval before fabrication commences and make any modification therein as directed by the Engineer-in-charge. Approval by the Engineer-in-charge of any of the drawings shall not relieve the Contractor from the responsibility for correctness of engineering & design of connections, workmanship, fit of parts, details, material, errors or omissions of any and all work shown thereon. The Engineer-in-charge's approval shall constitute approval of the

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

3.6. Approved design drawings will be furnished to the contractor and all drawings so furnished shall form a part of this specification. Contractor shall consult these in detail for all the information contained therein; which pertains to and is required for his work.

3.7. The Engineer-in-Charge reserve the right to make changes, revisions to drawings even after release for preparation of shop drawings, which are very likely to be made to reflect additional data/details received and more updated requirements.

3.8. Revisions in drawings and any new drawings made to include additional work by the Engineer-in-charge shall be considered a part of this specification and contract and the contractor shall have no extra claims on this account.

3.9. Unless otherwise specified, the drawings and specifications are intended to include every thing obviously requisite and necessary for the proper and entire completion of the work and job shall be carried out accordingly for the completeness as required.

3.10. Design drawings prepared by the Engineer-in-Charge will show all the dimensions and if necessary clearance of structure, landings where necessary, size of each member, definite location of openings at various levels and all other information necessary to enable the General Contractor in prepare drawings for fabrication and erection.

3.11. It shall be clearly understood that the Engineer-in-charge's drawings are design drawing and are not intended to show detailed connection, thickness of members, cuts, notches, bends and such other details.

3.12. In the case of variation in drawings and specifications the decision of the Engineer-in-Charge shall be final.

3.13. Should General Contractor in the execution of his work, find discrepancies in the information furnished by the Engineer-in-charge he shall refer such discrepancies to the Engineer-in-Charge before proceeding with the work.

4.0. FABRICATION

4.1 All workmanship and finish shall be of the best quality and shall conform to the best-approved method of fabrication.

4.2. All materials shall be finished straight and shall be machined true and square where so specified. All holes and edges shall be free of burrs.

4.3. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished.

4.4. Standard fabrication clearance as detailed in American Institute of steel construction manuals shall generally be followed unless otherwise directed approved.

4.5. Material at the shops shall be kept clean and protected from weather.

4.6. Shop connections shall be effected by welding as specified on the Engineer-in-Charge's design drawings.

4.7. Rolled materials before being worked shall be straightened unless otherwise required/specified.

4.8. If straightening or flattening is necessary it shall be done by methods that will not injure the material. Long plates shall be straightened by passing through a mangle or leveling rolls and structural shapes by the use of mechanical or hydraulic bar straightening machines.

4.9. Heating or forging shall not be resorted to without the prior approval of the Engineer-in-charge in writing.

4.10. Cutting may be by shearing, cropping, sawing or machine flame cutting. All reentrant corners shall be shaped notch-free to a radius of at least 12 mm. Sheared or cropped edges shall be dressed to a neat workmanlike finish and shall be free from distortion and burrs.

4.11. The korf on machine flame cut edges shall be removed. Where machine flame cutting is permitted for high tensile steel, special care shall be taken to leave sufficient metal and all flame hardened material shall be removed by machining/edge planning.

4.12. Hand flame cutting shall be undertaken only if so permitted by Engineer-in-charge and only be carried out by an expert in such work. Hand flame cut edges shall be ground smooth and straight.

4.13. Edge planning of sheared, chopped or gas cut edges is not intended unless the sheared, chopped or gas cut edges are such as to warrant it or specifically called for.

5.0. WELDING

5.1. Welding procedure shall be submitted to Engineer-in-charge for approval. Welding shall be entrusted to only qualified and experienced welders who shall be periodically tested and graded as per IS 817, IS: 7310 (Part 1) and IS: 7318 (Part 1). All weld shall be inspected welder's supervisor and punched on welded element for record.

5.2. Electrodes for structural welding works shall comply with the requirements of IS: 226 and / or BS: 634 or AWS: A-5.1 and shall be of approved make.

5.3. The electrodes shall be suitable for use in the position and type of work as laid down in the above specifications and as recommended by the manufacturer.

5.4. Electrodes of classification AWS E 60 XX and C 70 XX shall be used for welding steel conforming to I.S. 226 and I.S. 2062 and of classification AWS E 70 XX for steel conforming to I.S. 961. Electrodes other than low-hydrogen electrodes shall not be permitted for thickness of 32 mm and above.

5.5. Joints in materials above 20 mm thick and all the important connections shall be made with low Hydrogen electrodes of AWS E 7016 or E 7010 classification.

5.6. The filler wire and flux combination for submerged arc welding shall conform to the requirements for the desired application as laid down in I.S. 3613. The weld metal deposited by the submerged arc process shall have mechanical properties not less than that specified for American Welding Society's classification 5.17 E 60 for steel to I.S. 226 and I.S. 2042 and AWS classification 5.17 E 70 for steel to IS: 961.

5.7. Electrode Flux covering shall be sound and unbroken. Broken or damaged coating shall cause the electrodes to be discarded. Covered electrodes for manual-arc welding shall be

properly stored to an oven prior to use in a manner recommended by the manufacturer and only an hour's quota shall be issued to each welder from the oven.

5.8. Electrodes larger than 5mm diameter shall not be used for root-runs in butt welds.

5.9. Welding plants and accessories shall have capacity adequate for the welding procedure laid down and shall satisfy appropriate standards and be of approved make and quality. Contractor shall maintain all welding plants in good working conditions. All the electrical plants in connection with the welding operation shall be properly and adequately earthen and adequate means of measuring the current shall be provided.

5.10. All welds shall be made only by welders and welding operators who have been properly trained and previously qualified by tests to perform the type of work required as prescribed in the relevant applicable standards.

5.11. All welds shall be free from defects like blowholes, slag inclusions, lack of penetration, under cutting, cracks etc. All welds shall be cleaned of slag or flux and show uniform sections, smoothness of weld metal, featheredges without overlap and freedom from porosity.

5.12. Fusion faces and surfaces adjacent to the joint for a distance of at least 50 mm on either side shall be absolutely free from grease, paint, loose scales, moisture or any other substance which might interfere with welding or adversely affect the quality of the weld.

5.13. Joint surfaces shall be smooth, uniform and free from fins, tears, laminations etc.

5.14. Preparation of fusion faces shall be done in accordance with the approved fabrication drawings by shearing, chipping, achining or machine flame cutting except that shearing shall not be used for thickness over 8 mm.

5.15. In the fabrication of cover plated beams and built up members all shop splices in each component part shall be made before such component part is welded to other parts of the member. Wherever weld reinforcement interiors with proper fit-up between components to be assembled for welding, these welds shall be ground flush prior to assembly.

5.16. The members to be joined by fillet welding shall be brought and held as close together as possible and in no event shall be separated by more than 3 mm. If the separation is 1.5 mm or greater the fillet weld size shall be increased by the amount of separation. This shall only apply if the surfaces are completely sealed by welds. In all other cases the fit-up shall be close enough to exclude water after painting.

5.17. The separation between faying surfaces of lap joints and butt joints with backing plate shall not exceed 1.5 mm. A butting part to be butt-welded shall be carefully aligned and the correct root gap maintained throughout the welding operation.

5.18. Misalignments greater than 25 percent of the thickness of the thinner plate or 3 mm whichever is smaller shall be corrected and in making the correction the parts shall not be drawn into a shape sharper than 2 degrees (1 in 27.5).

5.19. Pre-qualified procedures recommended for appropriate welding standards and known to provide satisfactory welds shall be followed. For non-standard procedures, qualification testes are prescribed in IS: 823 shall be made to verify the adequacy of the procedures. A welding procedure shall be prepared by the General Contractor and submitted to the Engineer-in-charge for approval before the welding starts. This shall include all the details of welding procedures with reference to the provisions of IS: 823 and IS: 4353. Approval of

the welding procedure by the Engineer-in-charge shall not relieve the contractor from his responsibility for correct & sound fabrication without distortion to the finished structure.

5.20. Submerged arc automatic or semi automatic welding shall generally be employed. Only where it is not practicable to use submerged arc welding manual arc welding may be resorted.

5.21. Voltage and current (and polarity if direct current is used) shall be set according to the recommendations of the manufacturer of the electrode being used and suitability to thickness of material, joint form etc.

5.22. The work shall be positioned for flat welding wherever practicable and overhead weld shall be avoided.

5.23. No welding shall be done when the surface of the member is wet nor during periods of high wind unless the welding operator and the work are properly protected.

5.24. In joints connected by fillet welds the minimum sizes of single run fillet welding or first runs and minimum full sizes of fillet welds shall conform to the requirement of IS: 816 and IS: 823.

5.25. All complete penetration butt welds made by manual arc welding except when produced with the aid of backing material or welded in flat position from both sides in square-edge material not over 8 mm thick with root opening not less than one-half the thickness of the thinner part joined shall have the root of the initial layer gouged and on the back side before welding is started from that side and shall be so welded as to secure sound metal and complete fusion throughout the entire core section.

5.26. Butt welds shall be terminated at the ends of joint in a manner that will ensure their soundness. Where abutting parts are 20 mm or more in thickness run-on and run-off plates with similar edge preparation and having a width not less than the thickness of the thicker part joined shall be used. These extension pieces shall be approved upon completion of the weld and the ends of the weld made smooth and flush with the abutting parts. Where the abutting parts are thinner than 20 mm the extension pieces may be omitted but the ends of the butt welds shall then be chipped or gouged out to sound metal and side welded to fill up the ends to the required reinforcement.

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

5.28. No welding shall be done on base metal at a temperature below 5°C. Base metal shall be preheated as required to the temperature given in the table below prior to tack welding or welding. When base metal not otherwise required to be preheated is at a temperature below zero degree centigrade it shall be preheated to at least 20oC prior to tack welding or welding. Preheating shall bring the surface of the base metal within 75 mm of the point of welding to the specified preheat temperature and this temperatures shall be maintained as minimum inter pass temperature while welding is in progress.

5.29.

Thickness of thickest part at point of welding	Min. Preheat & Inter pass Temp.			
	Other than low Hydrogen welding electrodes		Low Hydrogen welding electrodes	
	I.S : 226	IS : 961	IS: 226	IS: 961

	I.S : 2062		IS: 2062	
Upto 20mm	None	Welding with this process not allowed	None	10 DC
20mm to 40mm	65 DC		10 DC	65 DC
40mm to 63mm	110 DC		95 DC	110 DC
Over 63mm	150 DC		110 DC	150 DC

5.30. Minimum preheat for IS. 226 steel in thickness up to 80 mm shall be 10 degree centigrade.

5.31. Electrodes other than low-hydrogen electrodes shall not be permitted for thickness of 75 mm and above.

5.32. Before commencing fabrication of a member or structure in which welding is likely to result in distortion and or locked up stresses a complete programme of fabrication, assembly and welding shall be made and submitted to the Engineer-in-charge for approval. Such a programme shall include, besides other appropriate details, full particulars in regard to the following:

5.33.1 Proposed preheating in components such as flanges and presetting of joints to offset expected distortion.

5.33.2 Make up of sub-assemblies proposed to be welded before incorporation in final assembly.

5.33.3 Proposed joint forms, classification of wire and flux or covered electrodes, welding process including fitting and welding sequence with directions in which freedom of movement is to be allowed.

5.33.4 Proposed number, spacing and type of strong backs and details of jigs and fixtures for maintaining proper fit-up and alignment during welding.

5.33.5 Any other special features like assembling similar members back to back or stress relief.

5.34 If so desired by the Engineer-in-Charge mock-up welding shall be carried out at General Contractor's cost to establish the efficiency of the proposed programme, with any modification suggested by the Engineer-in-charge in limiting distortion or/ and residual stress to acceptable levels.

5.35. All welds shall be inspected for flaws by any of the methods described under the clause of 'Inspection' given below in this specification. The choice of the method adopted shall be determined by Engineer-in-charge.

5.36. General Contractor shall quote separately for carrying out such tests as called for in the schedule of quantities. Contractor shall be paid only for tests, which establish soundness of welds. In case the tests wherever defective work such tests will be at the contractor's cost and contractor shall correct such defects at his own cost and prove the soundness of rectified work.

5.37. The correction of defective welds shall be carried out as directed by the Engineer-in-charge without damaging the parent metal. When a crack in weld is removed, magnetic particle inspection or any other equally positive means as prescribed by the Engineer-in-charge shall be used to inspect that the whole of the crack and material up to 25 mm beyond each end of the crack has been removed. Cost of such test & operation incidental to correction shall be on contractor's account.

6.0 TOLERANCES

6.1. The dimensional and weight tolerances for rolled shapes shall be in accordance with IS. 1852 and / or ASTM A6.

6.2 No rolled or fabricated member shall deviate from straightness by more than 1/1000th of the length or 10 mm whichever is smaller.

6.3 The length of members with both ends finished for contact shall have a tolerance of (±) 1 mm.

6.4 Members without ends finished for contact bearing shall have a tolerance of (±) 1.5 mm for members up to 10 metres long and a tolerance of (±) 3 mm for members over 10 metres in length.

6.5 Lateral deviation between center line of web plates and center line of flange plate at contact surface in the case of built up sections shall not exceed 6 mm.

6.6 The combined warpage and filet of flanges in welded built up sections shall not exceed 1/200th of the flange width or 3 mm whichever is smaller.

6.7 The deviation from flatness of welded plate girder web in the length between stiffeners or a length equal to the depth of the girder shall not exceed 1/150th of each length.

6.8 Deviations from the specified depth of welded girders measured at the center line of the web shall not exceed (±) 3 mm up to a depth of 1000 mm, (±) 5 mm for depths above 1000 mm up to 2000 mm and (+) 0 mm and (-) 5 mm for depths over 2000 mm.

7.0 END MILLING

7.1. Column ends bearing on each other or resting on based plates and compression joints designed for bearing shall be milled true and square to ensure proper bearing and alignment.

7.2. Base plates shall also have their surfaces milled true and square.

8.0 INSPECTION

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

8.2. No materials shall be painted or dispatched to site without inspection and approval by the Engineer-in-charges unless such inspection is waived in writing by the Engineer-in-charge.

8.3. Shop inspection by the Engineer-in-charge or his authorized representative on submission of test certificates and acceptance thereof by the Engineer-in-charge shall not relieve contractor from the responsibility of furnishing material conforming to the requirements of these specifications nor shall it invalidate any claim which the Engineer-in-Charge may make because of defective or unsatisfactory material and of workmanship.

8.4. General Contractor shall provide all the testing and inspection services and facilities for shop work except where otherwise specified. General Contractor's inspection work shall be under the control of a competent and approved independent testing agency whose primary responsibility is inspection reporting to Engineer-in-Charge.

8.5. For fabrication work carried out in the field the same standard of supervision and quality control shall be maintained as in shop fabricated work. The inspection and testing shall be conducted in a manner satisfactory to the Engineer-in-charge.

8.6. The inspection and tests on structural steel members shall be as set forth below:

8.7 If mill test reports are not available to any steel material the same shall be rejected and removed from the site.

8.8. The under mentioned tests shall generally required for the work and will not be paid extra.

8.8.1. Magnetic Particle Test:
Where root and intermediate passes of weld is examined by magnetic particle testing such testing shall be carried out throughout. It's entire length shall be in accordance with ASTM specification E-109. In the case of completed welds such tests shall be carried out in accordance with ASTM specification E-109 0r E-130 as decided by the Engineer-in-charge. If heat treatment is performed the completed weld shall be examined after the heat treatment. All defects shall be replaced and retested. Magnetic particle tests shall be carried out using alternating current. Direct current may be used with the permission of the Engineer-in-charge.

8.8.2. Liquid Penetrant Inspection:
In the case of welds examined by liquid penetrant inspection such tests shall be carried out in accordance with ASTM E-164 or I.S. 3650. All defects shown shall be repaired and rechecked.

8.8.3. Radiographic Inspection:
All full strength butt welds shall be fully tested with radiograph in accordance with the recommended practice for radiographic testing as per ASTM E-94 and Part U.W. 51 ASME Code Section VIII.

8.8.4 Dimension, Workmanship & Cleanliness:
The structural steel members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment and surface finish, painting where specified are in accordance with the requirements shown on contractor's approved shop drawings and Engineer-in-charge's drawings.

8.9 Inspection or Test failure

8.9.1. In the event of any failure of structural steel members to meet an inspection or test requirement, General Contractor shall notify to Engineer-in-charge or his authorized representative. Contractor must obtain permission from Engineer-in-charge before repair is undertaken.

8.9.2. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by Engineer-in-charge.

8.9.3. Engineer-in-charge has a right to specify additional inspection or testing, as he deems necessary and the additional cost of such testing will be borne by the General Contractor.

8.9.4. General Contractor shall maintain records of all inspection and testing which shall be made available to Engineer-in-charge or his authorized representative.

9.0 DRILLING HOLES FOR OTHER WORKS

9.1. Holes in members required for installing equipment or steel furnished by other manufacturers or other contractors shall be drilled in contractor's shop as part of this contract. The information for which will be supplied by Engineer-in-charge before fabrication of the steel.

10.0. HANDLING AND STORAGE

10.1. No dragging of steel shall be permitted. All steel shall be stored 300 mm above ground on suitable packing to avoid damage in the order required for erection and with erection marks visible. All storage areas shall be prepared and maintained by General Contractor.

10.2. Steel shall not be stored in the vicinity of area where the excavation or grading will be done and if stored temporarily, this shall be removed by General Contractor well before such excavation and /or grading commencing in a safe distance to avoid burial under debris.

10.3. Scratched or abraded steel shall be given a coat of the primer specified on drawings for protection after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust/corrosion by suitable coating and also from getting damaged.

10.4. After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20 mm high and to such optimum depth as to be clearly visible.

10.5. Structural steel frames shall be erected to plumb and true. All steel columns and beams/trusses shall be checked for plumb and level individually before and after connections are made. Temporary bracings may be introduced wherever necessary to take care of all loads to which the structure may be subjected including erection equipment and the operation thereof. Such bracings shall be left in place as long as may be required for safety and stability.

11.0. INSPECTION AT SITE

11.1. Engineer-in-charge or their authorized representatives shall have free access to all parts of the job during erection and all erection shall be subject to their approval. In case of faulty erection, all such dismantling and re-erection required will be at General Contractor's cost. No paint shall be applied to field welds until these have been approved by Engineer-in-charge.

12.0. PAINTING

12.1. All fabricated steel material except those galvanized shall receive protective paint coating as specified on design drawings.

12.2. Paint shall be stirred frequently to keep the pigment in suspension. All paint delivered to the fabrication shop shall be ready mixed in original sealed containers as packed by the paint manufacturers and no thinners shall be permitted. No painting shall be done in frosty / foggy weather or when the humidity is high enough to cause condensation of the surface to be painted. Paint shall not be applied when the temperature of the surface to be painted is 5 degree centigrade or lower.

12.3 The surface of steel work to be painted shall be thoroughly cleaned of all mill scale, rust, grease, dirt and other foreign matter by hand tool cleaning, power tool cleaning, flame cleaning or sand/ shot blasting as indicated on drawings. In power brushing sufficient care shall be taken not to burnish mill scale to a slick finish to which paint may not adhere properly.

12.4. The paint treatment as specified on drawings shall be applied either by brushing or spraying on the thoroughly cleaned and dry surface. Airless spraying shall be done if so specified.

12.5. Surfaces inaccessible after assembly shall receive and additional coat of the specified paint prior to assembly.

12.6. Surfaces to be welded after erection shall receive one coat of shop paint. Such paint shall be removed, before field welding if any, for a distance of at least 50mm on either side of the joint.

12.7 Except for encased steelwork, all steel shall be sand blasted to SA 2.5 and protected with 1 coat of primer and 3 coats of approved epoxy paints as follows:

Prime coat	One shop coat of approved zinc chromate primer, 50 microns Dry Film Thickness (DFT) or approved equivalent. One similar coat, but of different colour shall be applied at site.
Under coat	One undercoat, 50 microns DFT, of approved brand or equivalent.
Middle coat	One middle coat of 50 microns DFT, of approved brand or equivalent.
Finish coat	One finish coat of approved epoxy coat to 50 microns DTF, or equivalent.

12.8 For galvanized steelwork if required to paint, thorough washing with an approved etching solution shall be applied to prior to proceed with the above application.

12.9 All connections, contact surfaces, site weldings shall be prepared and painted to the same standard as the adjacent steel.

13.0 BOLTING

13.1 The nominal length of the bolt shall be the distance from the underside of the head to the other end of the shank and nominal diameter shall be diameter of shank above the screwed thread. The bolts shall be of such length as to project at least one clear thread beyond the nuts when fixed in position.

13.2 When nuts or bolts heads bear on tapered surfaces washers with corresponding taper shall be provided to give satisfactory bearing.

13.3 Bolts shall be provided with a washer of sufficient thickness so as to avoid any threaded portion failing within the thickness of the parts bolted together.

14.0. MODE OF MEASUREMENTS

14.1. For the purpose of payment the weight of the actual completed structures shall be calculated from the approved drawings for different items of work.

14.2. The allowances will be permitted for galvanizing, welding or for cutting margins. One Tonne for the purpose of payment shall mean One Metric Tonne i.e., 1000 Kg.

14.3. The weight of member made out of standard rolled section such as beam, channels, angles, etc. shall be based on the standard IS: 800. The weight of member shall be considered without deducting for holes, notches, bevels cuts etc. Where a component consists of a cut joist or channels, the full weight of the rolled section shall be considered only if more than half the depth of the original section is used. Otherwise, only half the section unit weight shall be considered for calculation of the weight of plates for skew cuts and notches of 900 square centimetre or larger.

14.4. The weight of any built-up member shall be separated into weight of each component.

K WATER PROOFING TREATMENT

To Be read in conjunction with the Technical specification under Architectural works.

L FLOOR HARDENER

1.0 GENERAL

1.1 To withstand heavy wear and tear, concrete flooring with metallic concrete hardening compound such as Ironite / hardonate shall be laid as wearing layer as detailed below.

2.0 METALLIC CONCRETE HARDENING COMPOUND

2.1 The metallic compound shall be Quartz of approved quality or other equivalent consisting of uniformly graded iron particles, free from non-ferrous metal particles, oil, grease and soluble alkaline compound.

3.0 CEMENT CONCRETE UNDER LAYER

3.1 Cement concrete flooring of specified thickness and mix shall be laid as specified and generally conforming to specifications laid down for cement concrete flooring. The top surface shall be roughened with brushes while the concrete is still green and the form shall be kept projecting up 12 mm. over the concrete surfaces, to receive the metallic hardening compound topping.

4.0 METALLIC CONCRETE HARDENER TOPPING

4.1 This shall consist of 12mm. thick layer of mix 1:2 (1 part of cement mixed with hardener: 2 parts of stone aggregate of 6 mm. nominal size by volume). The metallic concrete

hardener compound being mixed with cement in the ratio of 1:4 (1 metallic concrete hardener: 4 cement used by weight) or as specified by the manufacturer. Concrete hardener shall be dry mixed thoroughly with cement on a clean dry pucca platform. This dry mixture shall then mixed with stone aggregate 6mm. nominal size or as otherwise specified in the ratio of 1:2 (1 cement mixed with hardener: 2 stone aggregate) by volume, and well turned over. Just enough water shall then be added to this dry mix as required for floor concrete, water cement ratio not exceeding 0.4.

4.2 The mixture so obtained shall be laid in 12mm. thickness, on cement concrete floor within 1 to 4 hours of its laying. The topping shall be laid true to provide a uniform and even surface. It shall be firmly pressed into the bottom concrete so as to have good bond with it. The concrete shall be compacted well mechanically. Manual compaction will not be permitted. After the initial set has started, the surface shall be finished smooth and true to slope with steel power floats.

5.0 CURING, PRECAUTIONS, MEASUREMENTS ETC

5.1 Specifications for curing, precautions, quantity measurements etc. shall be same as specified for cement concrete flooring.

5.2 No water curing shall be permitted to industrial floor slab with hardeners.

M UNDER GROUND DRAINAGE WORK

1.0 MATERIALS

The pipes shall be RCC spun pipes NP2/ NP3 class as specified, conforming to IS 458-1988 and shall be approved by the Engineer-in-Charge for soundness before incorporation in the work.

2.0 LAYING RCC SPUN PIPES

2.1 The work consist of providing, laying, jointing and testing RCC spun pipe for rain water collection network of required diameter as mentioned in the schedule to discharge the rain water collected from roof to the rain water collection tank as shown in the drawing.

2.2 After the cement concrete cradle has been laid properly, if specified or as directed by the Engineer-in-Charge, the pipes shall be lowered gradually into the trenches over the concrete cradle or bed. Necessary working space/gap for collars shall be made at every joint. Laying of pipe shall proceed upgrade of a slope. The collars shall be slipped-on before the next pipe is laid.

2.3 The pipe drain shall rest on the bed at every point through its length. To ensure this the space between the undersides of the pipe on the invert of the cradle shall be carefully grouted solid with cement slurry consisting of one part of cement to one part of clean washed sand in such a manner that no void is left. It shall be ensured that the load of the pipes and the super imposed load of the earth filing are evenly distributed on the cradle or bed.

2.4 General Contractor shall take precautions to see that no dirt; earth or other foreign matter is allowed on the surface of the cradle or bed of the pipe resting there-on, all to the full satisfaction of the Engineer-in-Charge. After the alignment and grading of the pipes is checked by the Engineer-in-Charge, the grouting shall be done with specified stiff mix of cement mortar.

2.5 The cradle of concrete shall be allowed to set a least for three days before any pipe is placed on it and the contractor shall take due care in setting the pipe in the cradle so that no damage is occur to the cradle. If any damage to the cradle occurs, it shall be rectified to the satisfaction of Engineer-in-Charge and in any particular case where damage to the cradle is beyond repair in the opinion of the Engineer-in-Charge, the contractor shall cut out the damaged section of the cradle and re do the same at his own expenses to the complete satisfaction of the Engineer-in-Charge.

2.6 No backfilling shall be laid or placed till the alignment of the pipe drain and its levels and gradient have been carefully checked and found correct/approved by the Engineer-in-Charge.

3.0 JOINTS

3.1 The joints for the pipes shall be made by loose collars and the connecting space shall be as minimum as possible. The collars shall be specifically roughened inside to provide a better grip.

3.2 The two adjacent pipes will be so designed and manufactured that when butted together concentrically, a dowel is left between the two ends. In this dowel, cement mortar of (1:1) proportion or mix as specified in the schedule be filled and then between the ends a paste of cement mortar of the same proportions will be placed. The space remaining between the pipe ends and the collar being then caulked with cement mortar of (1:1) or other specified proportion so that an even space appears all round the external diameter of the pipes. All the joints shall be finished off smooth at an angle of 45º with the longitudinal axis of the pipe on either side of the collars.

3.3 The interior of the pipe drains shall be cleaned off all dirt, cement mortar and superfluous materials and joints shall be cured for at least 7 days.

BACK FILLING / FILLING TRENCHES:

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 20 cm. watered, rammed and consolidated taking care that no damage is caused to the pipe

below. In case of excavation of trenches in rock, the filling upto a depth of 30 cm. above the crown of pipe or barrel shall be done with fine material such as earth, murrum or pulverized decomposed rock according to the availability at site. The remaining filling shall be done with rock filling or boulders of size not exceeding 15cm. mixed with fine material as available to fill up the voids, watered, rammed and consolidated in layers not exceeding 30cm.

4.0 TESTING OF RCC SPUN PIPES

4.1 After sufficient interval has been allowed for the joints to set, the pipe drains will be tested under a water head of at least 1.2 m. and in no case under a head greater than 1.8 m. of water above the top of the pipes. In addition, the pipe drains shall be examined for leaks of land/sub-soil water making its way through the joints. The General Contractor shall make the pipe drains water tight against the entrance of land/sub-soil water from outside and also against the leakages of water from the inside of the pipe drains at the test heads specified above to the full satisfaction of the Engineer-in-Charge.

4.2 All defective or leaking pipes or joints shall be cut out and replaced and made good by the General Contractor at his own cost. In case of the joints that may be defective and cannot be made good, shall be entirely embedded/surrounded externally with cement concrete of 1:2:4 proportion to render the joint (s) water tight and this shall be allowed to set before encasing or back filling is done. A strong colour shall be added to the water used for testing of the pipes, in order to detect any leakage easily. The cost of testing of the pipe drain shall be borne by the General Contractor and is deemed to be included in the rates quoted by the contractor.

N FENCING WORK

1.0 GENERAL

The work shall generally be carried out as per these specifications, relevant drawings and as directed by the Engineer-in-Charge.

2.0 MS POSTS AND STRUTS

All the MS posts/struts shall be free from rust, scale, cracks, twists and other defects and shall be fabricated to the required shape and size out of the specified sections. The posts and struts shall be conforming to relevant specifications stipulated here-in-before under relevant sections. All the posts and struts shall be of sizes and lengths as specified in the tender schedule and drawing. The posts and struts shall have split ends for proper fixing and shall be embedded in the cement concrete as specified in the drawings / schedule. The exposed surfaces of the posts and struts shall be painted with two coats of synthetic enamel paint of approved make and shade over a coat of approved primer as specified in Architectural drawings/schedule of finishes.

3.0 RCC POSTS AND STRUTS

3.1 All the posts and struts shall be of standard size as specified in schedule. These shall be constructed on suitable foundation in cement concrete as shown in drawings and as per relevant specifications stipulated here-in-before. The reinforcement shall be provided as shown in the drawings, as directed by Engineer-in-Charge and specified here-in-before under relevant sections. The posts and struts shall be free from honeycombing, cracks and other defects.

3.2 If pre-cast posts are used, after casting, the posts/struts shall be left at the same place and cured for a minimum period of 7 days. After 7 days curing the same shall be shifted to a leveled ground and stacked for further curing for 14 days. After 21 days of curing only, the posts/struts shall be transported to work site without any damage, for fixing in position.

4.0 SPACING OF THE POSTS AND STRUTS

The spacing of posts shall be 3 m centre to centre unless otherwise specified or as directed by the Engineer-in Charge, to suit the dimensions of the area to be fenced.

Every 10th posts, last but one end posts, corner posts, and posts where the level of fencing changes in steps and end post when the fencing changes its direction shall be strutted on both sides, or as directed by the Engineer-in-Charge. End posts where barbed wire fencing is discontinued shall be strutted on one side only.

5.0 FIXING OF MS/RCC POSTS AND STRUTS

5.1 Pits of size 450 x 450 x 450 mm deep or of sizes mentioned in the drawings, shall first be excavated centrally in the direction of proposed fencing work, true to line and level to receive the posts. In case of struts, the pits shall be so excavated, as to receive minimum 150mm concrete cover at any point of the struts to suit its inclination or as shown in the drawing.

5.2 The pits shall be filled with a layer of 150 mm thick cement concrete of specified mix. The posts and struts shall then be placed in the pits, the posts projecting to the specified height above ground level, true to line, plumb and position, by providing adequate supports temporarily, and cement concrete of specified mix shall then be filled-in so that the posts are embedded in cement concrete blocks of specified sizes. The concrete in foundation shall be watered for at least 7 days to ensure proper curing.

6.0 BARBED WIRE

6.1 The barbed wire shall be of MS or GI as specified and it shall generally conform to IS 278-1978.

6.2 The base metal of the line and point wire shall be of good commercial quality mild steel. The line and point wire shall be circular in section, free from scales and other defects and shall be uniformly galvanized if specified.

6.3 The line wire shall be in continuous lengths and shall generally be free from signs of welds. It shall be able to withstand Wrapping and unwrapping 8 turns round its diameter.

6.4 The barbed wire shall consist of two splices per reel. The barbed wire shall be formed by twisting two lines wires one containing the barbs.

6.5 The barbed wire and its weight shall be as given in the table below:

Type	Nominal diameter of wire		Nominal distance between two barbs (in mm)	Mass of complete barbed wire (in gm./m.)
	Line wire (in mm.)	Point wire (in mm.)		
1.	2.50 (12G)	2.50 (12G)	75	146 (136-155)
2.	2.50	2.50	150	114 (108-120)
3.	2.50	2.00 (14G)	75	117 (108-125)
4.	2.50	2.00	150	96 (89-103)
5.	2.24 (13G)	2.00	75	102 (97-106)
6.	2.24	2.00	150	82 (78- 85)

6.6 The barbs shall carry four points and shall be formed by twisting two point wires, each two turns, tightly round one line wire, making altogether 4 (four) complete turns. The barbs shall be so finished that the four points are set and locked at right angles to each other.

6.7 The barbs shall have a length of not less than 13 mm. and not more than 18 mm. The points shall be sharp and well pointed. Barbed spacing shall be as given in the above table. Wherever required for every 50 reels or part thereof, samples of the barbed wire and the individual line wires shall be put to tensile test and in case of failure to conform to tensile properties given below, two additional tests of each kind shall be made on the samples cut from other reels.

7.0 TENSILE PROPERTIES

Size of line wire Nominal dia (in mm)	Breaking load of line wire		Min. breaking load of complete barbed wire (in Kg.)
	Min. (in Kg.)	Max. (in Kg.)	
2.50 (12G)	216	302	444
2.24 (13G)	128	179	263

7.1 On the results of these additional tests, the whole or portion of the barbed wire shall be accepted or discarded as the case may be.

8.0 FIXING OF BARBED WIRE

8.1 The barbed wire shall be stretched and fixed in number of rows and two diagonals as specified. The bottom row shall be 140 mm. above ground and the rest at 125 mm or at given spacing as per drawing. The diagonals shall be stretched between adjacent posts from top wire of one post to the bottom wire of the 2nd post. The diagonal wires will be interwoven with horizontal wires by fixing the odd rows of wires, then the diagonal cross wires and lastly the even rows of wires. The jointing of the barbed wire in between the posts shall not be permitted.

8.2 Necessary holes should be tapped in the post and the barbed wire shall be fixed in position by means of 'U' clamps or bolts and nuts as specified in drawings. In case of fixing with 'U' clamps, the legs of the 'U' clamps passing through the 10 mm dia. hole in the RCC post to hold barbed wire shall be turned up and down to get an over-lap of 25 mm. on the face of RCC post. Turn buckles and straining bolts shall be used at the end posts if specified.

9.0 MODE OF MEASUREMENT OF BARBED WIRE FENCING

9.1 The work shall be measured in running metre length of fencing correct to a centimeter for the finished work, from centre to centre of the posts.

9.2 The rate shall include the cost of labour and materials involved in all the operations described above including the cost of barbed wire, turn buckle, straining bolts, bolts and the nuts/U clamps including excavation and foundation concrete or as specified in item description for the work.

10.0 CHAIN LINK

10.1 The chain link shall be of approved manufacture and of correct size, gauge etc. It shall be of MS. or GI. as specified of approved manufacture and of required size, gauge etc.

10.2 The base materials of the wire shall be of good commercial quality mild steel. The wire shall be circular in section, free from rust, scale, cuts, welds and other defects and shall be uniformly galvanized if specified.

11.0 FIXING OF THE CHAIN LINK FENCING TO MS. OR RCC POST

11.1 The chain link of specified height of fencing shall be fixed first to the end post with necessary GI approved type U clamps threaded at both the ends and GI nut, bolts, washers etc. and with 6 mm. dia. full height MS/GI anchor bar.

11.2 After fixing the chain link at the end post, it shall be stretched tightly and fixed to next post one after the other by the above mentioned clamps and bars etc. leaving 50 mm clearance from the ground and 20mm clearance in the case of concrete coping at bottom to avoid rusting.

11.3 The point at the change in level of the fencing top/bottom, necessary links shall be adjusted suitably as per the manufacturers specification or as directed by the Engineer-in-Charge.

11.4 The entire chain link fence shall be painted with two coats of synthetic enamel paint of approved make and shade over a coat of approved primer or as specified in the item/drawing.

12.0 MEASUREMENT OF CHAIN LINK FENCING

12.1 The work shall be measured in running metre length of fencing correct to a centimetre for the finished work from centre to centre of the posts.

12.2 The rate shall include the cost of labour and material involved in all the operation described above including the cost of chain links, turn buckle, straining bolts and bolts and the nuts/U clamps, 6 mm dia. MS/GI anchor bar etc. including excavation and foundation concrete or as specified in item description for the work.

O. ROAD AND PAVEMENTS

1.0 SCOPE OF WORK

The work contemplated under these specifications refers to Earth work in Excavation, Forming Embankments, Proof rolling, Soling, W.B.M., Bituminous Macadam, Bituminous concrete, Mecadam grouting, Wearing Course/Sealing Coat etc. for road and pavement works.

2.0 EARTH WORK EXCAVATION FOR ROAD

The specifications for “Excavation, Fill and Back fill” specified here-in-before shall hold good as far as they are applicable.

2.1 The work under this item will include excavation in all types of soil, murrum, etc. and in loose boulders not longer than one metre in any direction and not more than 200mm in any one of the other two directions. The excavated material shall be disposed off as directed by the Engineer-in-Charge.

2.2 Payment will be made for theoretical section. No claim for extra cutting in any direction is permissible unless otherwise agreed upon by Engineer-in-Charge. The contractor shall also clean of all vegetation before starting the work of excavation for the entire width and length of the road and no extra shall be paid for this.

2.3 Black agricultural soil wherever met with, shall also be removed to the required depth as directed by the Engineer. The excavation for roads shall be carried out to the gradients and cambers and sub-grade levels as indicated in plans or as decided by the Engineer-in-

Charge. The excavated areas should be kept free of water at no extra cost, while work is in progress.

3.0 FORMING EMBANKMENT

3.1 The work shall include preliminaries of clearing site, setting out and preparing the ground and there after forming embankment for the roads, paths etc. with approved material available from excavations under this contract (excavation paid separately under respective items) or elsewhere, spreading in layers, watering and compacting to the required density and lines, curves, grades, camber and cross section and dimensions shown in the plan or as directed by the Engineer-in-Charge.

3.2 When the embankment is to be laid on hill sides or slopes, the existing slopes are to be ploughed deeply. If the cross slopes are steeper than 1 in 3, steps with reverse slope shall be cut into the slopes to give proper hold and seating to the bank as directed by the Engineer-in-Charge. The top 15 cm. of soil shall be scarified and watered if directed and compacted to the same density as specified for the embankment before any material is laid for the embankment work.

3.3 Only the approved excavated earth shall be placed in the embankments in successive horizontal layers not exceeding 150mm, extending to the full width of the embankment including the slopes at the level of the particular layer and 300mm more on both sides to allow compaction of the full specified section. The extra loose stuff at the edges shall be trimmed later, after completion of the bank work without extra cost leaving the correct section fully compacted. On resuming work after one interval, if the previous compacted surface has dried up or hardened, it shall be moistened and scarified before any fresh material is placed on it.

3.4 Keeping the width of the bank initially less and widening it later by dumping loose earth on the slopes shall not be permitted as the additional width and slopes will remain loose and un compacted. Similar procedure to extend the embankment by dumping the material longitudinally shall also not be allowed. Each layer of the embankment shall be watered, leveled and compacted as specified here-in-after, before the succeeding layers are placed. The surface of the embankment shall at all times during construction, be maintained in such a manner so as to prevent ponding. Water to be used shall be free from all harmful elements and approved by the Engineer-in-Charge.

3.5 If the material for embankment contains moisture less than the optimum moisture, water shall be added in the 100 mm layers of the embankment to bring moisture uniformly up to requirement. If the excavated material contain more than required moisture, it shall be allowed to dry until the moisture is reduced to required extent. If due to the wetness, the moisture content of the soil cannot be reduced to the appropriate amount by exposure, embankment work shall be suspended till suitable conditions prevail at no extra claim/compensation.

3.6 When loose layer is leveled manually or mechanically and moistened or dried to a uniform moisture content suitable for maximum compaction, it shall be compacted by 8 to 10 tonne power roller or sheep foot rollers or heavy hauling or dozing equipment to give the specified 90% of the proctor density. If on testing, the density is found to be less than 90% of the proctor density, the General Contractor shall do additional compaction necessary to get the specified density after adding water if required. Test shall be made to determine the maximum density of the material to be used by the proctor method before starting the work. Density test shall be carried out for the embankment work during the progress of the work. One set of three core samples for every 1000 sqm area of each layer of

embankment work shall be taken and tested. The average density shall not be less than 90% of the proctor density, obtained in the laboratory.

3.7 Arrangement for obtaining the samples and transporting the same to laboratory, shall be made by the General Contractor at his own cost.

3.8 Embankment not accessible to rollers, such as those adjoining bridges, culverts and other works shall be carried out independently of the main embankments and shall have the layers placed in 150 mm. to 200 mm. height and each layer shall be moistened and thoroughly compacted with mechanical or manual tamper.
Before placing the next layer, the surface of the under layer shall be moistened and scarified so as to provide a satisfactory bond with the next layer.

3.9 The embankment shall be finished and dressed smooth and even, in conformity with the alignment levels and cross sections and dimensions shown on the drawing.

On curves, section shall be provided with super elevation and increased width, as shown on the plans as directed by the Engineer-in-Charge. The last layer shall be finished off with a suitable camber etc. all as per drawing and as directed to receive the soling.

3.10 Joining of old and new embankments shall be done by stepping in an overall slope of about 1 to 5.

3.11 General Contractor shall be responsible for maintaining the embankment work in satisfactory conditions at his own cost till finally accepted including making good any damage.

3.11 Measurement and rate of embankment

The contract rate shall be per cubic metre of the finished embankment. Measurements shall normally be taken by taking cross sections at suitable intervals. The measurements of the section shall be limited to the dimensions shown on the drawing or those ordered by the Engineer-in-Charge in writing. The sectional area shall be worked out correct up to two places of decimal of square metre and the quantity worked out to two places of decimal of cubic metre on lines similar to those specified for earth work here-in-before.

4.0 SUB GRADE

4.1 Preparation of Sub-Grade:

The surface of the formation for a width of sub-base, which shall be as per drawing shall first be cut to a depth equal to the combine depth of sub-base and surface courses below the proposed finished level (due allowance being made for consolidation). It shall then be cleaned of all foreign substances.

Any ruts or soft yielding patches that appears due to improper drainage conditions, traffic hauling or from any other cause, shall be corrected and the sub-grade dressed off parallel to finished profile to the required gradient and camber.

4.2 Proof rolling and Consolidation:

The sub-grade shall be adequately watered and consolidated with a power road roller of 8 to10 tonnes. The roller shall run over the sub-grade till the soil is evenly and densely

consolidated and behaves as elastic mass (the roller shall pass a minimum of but not limiting to 5 runs on the sub-grade).

All undulations in the surface that develop due to rolling shall be made good with fresh material or quarry spoils as the case may be and the sub-grade is rerolled.

4.3 Surface Regularity: The finished surface shall be uniform and conform to the lines, grades and typical cross sections shown in the drawings. When tested with the template and straight edge, the variation shall be within the tolerances specified in the Table below:

PERMISSIBLE TOLERANCES OF SURFACE REGULARITY

Longitudinal profile	Cross profile
Maximum permissible undulation when measured with a 3 metre straight edge template.	Maximum permissible variation from specified profile when measured with a camber-
24 mm	15 mm

4.4 Where the surface irregularity of the sub-grade falls outside the specified tolerances, the contractor shall be liable to rectify these with fresh material or quarry spoils as the case may be, and the sub grade re-rolled to the satisfaction of the Engineer-in-charge.

4.5 Measurement and rate of sub-grade:

The excavation will be measured in cubic metres, correct to two places of decimal. The length and width shall be measured correct to a cm. The measurement for proof rolling shall be worked out in square metre, correct to two places of decimal. The rate shall include the cost of materials and labour required for all the operations mentioned above, unless specified otherwise.

5.0 RUBBLE SOLING

5.1 Material for soling shall be trap stone of approved variety. It shall be hard, durable and free from defects and shall be got approved by the Engineer-in-Charge before incorporation in the work. Spotted rubble stone shall not be used for the work.

5.2 On the sub-grade prepared as specified hereinbefore, soling shall be laid in regular lines. The stone shall be set as closely as possible and packed well. The stones shall be laid so as to have their bases or the largest areas resting on the sub-grade.

5.3 Soling shall be laid in one layer of 15 cm thickness (or as specified) and no stone shall be less in depth than the specified thickness of Soling.

5.4 After packing the stone properly in position, the interstices between them shall be carefully wedged with quarry spalls or stone chips. These shall be hammered well to obtain a hard and compact surface. Spreading stone chips of loose spalls or stone chips is prohibited.

5.5 The entire surface shall then be examined for any protrusions and the same shall be knocked off by a hammer.

5.6 Soling shall be laid to proper gradient and camber which shall all be checked frequently to ensure accuracy.

5.7 Rolling shall then be carried out by a 8 to 10 ton power roller and soling consolidated properly. Water shall be lightly sprinkled during rolling if ordered by the Engineer-in-Charge.

5.8 The surface thus prepared shall first be passed by the Engineer-in-Charge after which 40 to 50 mm thick layer of hard murrum or stone screenings shall be spread over the soling and rolled again such that the hard murrum or stone screening get into the interstices. It shall, however, be ensured that a thin layer of murrum or screenings shall remain on the finished surface of soling.

6.0 BITUMINOUS MACADAM & BITUMINOUS CONCRETE SURFACING FOR ROAD (GENERAL)

6.1 Scope of work

6.1.1 The work covered under these specifications provides for bituminous treatment for roads consisting of providing specified thickness of bituminous macadam, bituminous concrete and seal coat as in item in the schedule of quantities.

6.1.2 General Contractor shall make at his own cost, all the arrangements for controlling the traffic during the execution of the work. All arrangements such as proper barricading of road, diversion of road if necessary, red and green flags during the day, red lights at nights shall be made by General Contractor at his own cost to control and safeguard the traffic.

6.2 Bituminous macadam over water bound macadam

6.2.1 Preparation of Existing Water Bound Macadam Surface:
The existing water bound macadam surface shall be brushed, cleaned properly with wire brushes and coir brooms, so as to free from all loose materials, murrum, earth, silt and caked mud etc.

The surface shall then be dusted clean with gunny bags etc. If during the process of cleaning the sub grade (water bound macadam), soft spots and pockets, hollows etc. are found, such, spots/pockets will be filled with approved pre-coated bituminous chips, consolidated and finished to proper level, rolled with power roller if necessary.

The pot holes shall be excavated properly in a rectangular or rhomboidal shape with vertical edges. The bottom and sides shall be cleaned as stated above. The sides and bottom shall then be thoroughly painted with heated 60/70 (or of specified grade) penetration bitumen. The pot holes shall thereafter be filled with premixed bituminous chips so that after thorough tamping and rolling, the surface is flush with surrounding road surface all as directed by the Engineer-in-Charge. It shall be the responsibility of the General Contractor to ensure that the sub-grade is even and is finished to camber and slope as shown on the drawings or as directed by the Engineer-in-Charge.

6.2.2 The surface of the sub-grade shall be checked for its trueness by means of the scratch template set to the exact profile of the base course. The template shall be drawn along the forms at right angles to the road.

6.2.3 Unevenness of the surfaces as indicated by the scratch points shall not exceed 10mm in 30 m. The area of depression shall then be painted or sprayed with 60/70 (or of specified grade) penetration bitumen at the rate of 0.75 kg per sqm and the leveling course applied by hand or machine to grade and camber and rolled. If the depressions are deeper than

50mm, the leveling course shall be applied in two or more layers and rolled as directed by the Engineer-in-Charge.

6.2.4 The prepared surface shall be closed to traffic and maintained fully clean and no asphalting work shall be started unless this prepared surface is approved by the Engineer-in-Charge. The rate quoted by the tenderer against the item of bituminous macadam shall be inclusive of preparation of surfaces, to receive the bituminous macadam as detailed above and no extra payment is admissible on account of the same.

6.2.5 Materials

Representative samples of materials proposed to be used shall be submitted to the Engineer-in-Charge and got approved. No material shall be used unless it is approved by the Engineer-in-Charge.

6.3 Hot mixed hot laid bituminous macadam

6.3.1 Coarse Aggregate:

It shall consist of crushed hard trap stone metal, free from coatings of clay, silt and any objectionable material. Metal brought by General Contractor for different items of work shall strictly conform to I.R.C. specifications in all respects.

The aggregate shall be obtained by crushing approved stones of specified type in mechanical crusher and shall be hard, close grained, sound trap stone metal, free from decay and weathering and obtained from approved quarries.

Metal shall be collected in stacks on level ground and neatly stacked at site of mixing.

The metal shall be free from all earth, rubbish, vegetation and other foreign matter and graded before stacking and closely packed in stacks.

Tests considered necessary shall be carried out in an approved laboratory when the Engineer-in-Charge considers the quality to be doubtful or there is a dispute about the quality. The cost of testing shall be borne by the contractor.

6.3.2 Aggregate grading:

The requirements of base course shall be as under:

B.S. Sieve Designation	Equivalent I.S. Sieves	Passing percentage
32 mm. (about 1.25")	40 mm. (1.5")	100
20 mm. (about 3/4")	20 mm.	50 – 100
12 mm. (about 1/2")	12.5 mm.	30 - 60
6 mm. (about 1/4")	6.3 mm.	18 - 30
No. 10	1.7 mm.	10 - 20
No. 200	75 micron	0 – 5

Note: The aggregate/chips shall be entirely dry at the time of mixing.

6.3.3 Bitumen:

Bitumen to be used shall conform to I.S. 73-1992 for paving bitumen, with 60/70 (or of specified grade) penetration and shall be from approved manufacturers.

General Contractor on demand by the Engineer, obtain and furnish a laboratory test certificate to the effect that the material conforming to the requirement of the specified

grade, to the satisfaction of the Engineer-in-Charge. Bitumen (60/70 penetration or as specified) specified content by weight of the total mix, shall be used in the mixture.

6.3.4 Tack Coat:
Bitumen of the same grade as that used for premix shall be heated to a temperature of 163° C to 177° C (325° F to 350° F) in a bitumen boiler and the hot bitumen shall be applied evenly to the thoroughly cleaned and prepared road surface (as specified here-in-before) @ 7.5 kg. per 10 sq.m. or as specified leaving no part of the surface unpainted. Application shall be done by a mechanical pressure sprayer or if permitted, by perforated pouring cans. The tack coat shall be applied just before the macadam is laid. Application of tack coat shall be only slightly in advance of laying premixed chips.

6.3.5 Premixing Chips:
The bitumen shall be heated to 163° C to 177° C (325° F to 350° F) in boiler. The aggregate of the approved grading or as decided by the preliminary tests shall be dried and heated in an aggregate drier to a temperature of 149° C to 177° C (300° F to 350° F) and fed into a twin shaft peddle type mixer at a temperature not less than 149° C (about 300° F).

The bitumen, the approved aggregate and the filler shall be measured separately and accurately to the proportions in which they are to be mixed and mixed intimately till all the particles are completely coated with bitumen. The bitumen content in the mix shall not be less than 3.5 % by weight of total mix. Asphalt/bituminous mixing plant proposed to be used by the General Contractor for the preparation of Asphalt/bituminous mixing shall conform to all of the requirements of the job, which shall produce uniform mixtures of the required quality, and got approved by the Engineer-in-Charge before mixing.

6.3.6 The temperature of the premix bituminous macadam when leaving the mixer shall not be less than 130° C (about 280° F) and it shall not be less than 121° C (about 250° F) at the time of laying.

6.3.7 Bituminous macadam shall be transported to site of work in suitable tipping vehicle properly insulated and covered with canvas or other suitable materials to protect the mixture from weather conditions and to retain the heat. The road surface shall be suitably marked to ensure correct and uniform application. Width of macadam to be laid shall be slightly more (not exceeding 50 mm. on each side) than the required carriage way as per drawing. Excess on either side shall be neatly cut after full compaction to get final width of carriage way as per drawing. The premixed bituminous macadam shall be laid by a mechanical self powered spreader and compactor and finished to correct line, level, & final consolidation done by means of power roller not less than 10 tonne. Any irregularities shall be corrected during rolling.

6.3.8 Compaction
The base bituminous macadam course shall be compacted thoroughly and evenly with 10 to 12 tonne power roller immediately after it is laid. Compacted thickness shall be as specified in schedule of quantity.

6.3.9 The surface shall be checked for correct grade during and after rolling. Any irregularities shall be corrected by adding pre-coated chips or removing the surplus. The disturbed surface shall be well compacted again. If necessary, the roller wheel shall be coated with oil to prevent the coated chip from sticking to the wheels. Rolling shall be continued till no wheel marks are left on the surface.
The speed of the roller shall be sufficiently slow to prevent any pushing under the wheels.

6.4 Specifications for Asphaltic Concrete Road Surfacing

6.4.1 Nature and scope of work: Specifications under the "Asphaltic Macadam" shall apply to the "Asphaltic Concrete" also as far as cleaning existing road surfaces, mixing, weighing, transporting, laying and rolling are concerned.

The dust, dirt, debris, etc. collected from the cleaning operations shall be disposed of to an approved site and leveled to the satisfaction of the Engineer-in-Charge. The road surface should be cleaned and screened properly before laying asphaltic concrete. It may be noted that the rate to be quoted by the tenderer against the item of Asphaltic concreting shall be inclusive of preparation of surfaces, to receive the Asphaltic concrete as detailed above and no extra payment is admissible on account of the same.

6.4.2 Hot mix hot laid asphaltic concrete: Bituminous concrete shall consist of mixture of mineral aggregate, and filler, graded to fill the voids, mixed with a bituminous binder to obtain maximum stability and durability spread and compacted on a prepared base of sub-grade on conformity with the lines, grades and cross sections shown in the drawings. The aggregate shall be pre-heated to the temperature specified for the bitumen and the mixture shall be prepared and laid hot.

6.4.3 Materials:

i) Bitumen — The bitumen shall be of 60/70 penetration or such other grade as specified by the Engineer-in-Charge and shall conform to IS:73 latest edition.

ii) Filler — The filler added shall be dry and clean lime stone powder or hydrated lime having CaO content of not less than 60%.

iii) Sand — The sand shall be clean, natural, river sand, duneer pits and or quarry sand roduced in a crushing plant, as specified.

iv) Coarse — The coarse aggregate shall consist of clean trap aggregate stone of approved quality free from dust, angular but not flacky.

The grading, composition and characteristic of the asphaltic concrete mixture shall be approximately as given below:

6.4.4 Grading of Aggregate

IS Sieve No.	Percentage passing
20 mm	100
15 mm	80 - 100
10 mm	70 - 90
4.75 mm	50 - 70
2.36 mm	35 - 50
1.18 mm	26 - 38
600 micron	18 - 29
300 micron	13 - 23
150 micron	8 - 16
75 micron	4 - 10

6.4.5 Asphaltic concrete shall consists of Bitumen 7.75% plus or minus 0.25% by weight of total mix, with voids to a maximum of 2% to 4% by volume and specific gravity not less than 2.3; all properties conforming to respective IS codes, latest edition. The tenderer shall indicate the exact grading, bitumen content voids, specific gravity, Marshall Stability, etc. which they propose to adopt for the work offered by them.

6.4.6 The General Contractor shall also be responsible to see that the surface to receive Asphaltic concrete is properly consolidated so as to give uniform and adequate support to the asphalt carpet for the period of its usual life.
A thin layer of sand or stone dust should be spread over the compacted base and rolled before the asphaltic concrete carpet is laid where the base is water bound macadam, otherwise base should be swept clean.

6.4.7 Mixing:
The aggregate shall be dried and heated to the temperature specified for application of bitumen (350° F to 370° F) screened into the necessary sizes for producing the desired grading, free from dust and deposited in bathing bins. The coarse aggregates shall then be measured or weighed into the mixer at the specified temperature and in the correct proportions and thoroughly mixed dry. Approximately 2/3 the quantity of bitumen shall then be weighed into the mixer at the correct temperature. After addition the bituminous binder the mixing shall be continued till a homogeneous mix is produced. The required quantity of sand at correct temperature shall be weighed into the mixture and the remaining quantity of bitumen added.
Mixing shall be continued to produce homogeneous mix in which all the particles are uniformly coated. Finally the correct quantity of filler shall be added in a dry condition and thoroughly incorporated in the mix. As hot mix bituminous concrete must be spread, shaped and compacted while hot, it shall not be stored but used on the work immediately following the mixing operations.

6.4.8 Formwork:
Necessary formwork of a design approved by the Engineer-in-Charge shall be used to retain the asphaltic concrete in position at the sides to required lines, levels and gradients during the entire progress of work.

6.4.9 Spreading:
The asphaltic mix will be laid by a mechanical compactor and finisher, the final consolidation being by means of a power roller. Before wearing coarse mixture is laid a tack coat of 0.75 Kg of bitumen per m2 shall be applied.

6.4.10 Testing:
The General Contractor shall have a well equipped testing laboratory with a competent approved laboratory staff. Daily tests shall be made by them on the asphalt mixes produced to ensure compliance with this specification and a copy of the test results shall be submitted to the Engineer-in-Charge for record. Tests shall include water absorption, stability, filler content, grading of aggregates, bitumen content, specific gravity, void content etc. The General Contractor shall give all facilities at all times to the Engineer-in-Charge or his representative to inspect the work of testing done by them.

6.4.11 Testing of surface

The completed surface when ready for acceptance shall be thoroughly compacted, smooth, true to line, grade, camber and free from irregularities. When tested by means of a straight edge of 3.0 m long laid on the finished surface parallel with the centre line of the road, the surface shall vary in no place more than 6.0 mm from the working edge.

6.4.12 Maintenance:
It will be binding on the General Contractor to maintain the road free of cost for a period of 1 year from the date of completion of the work. The defects in the asphalt paving which the contractor may be called upon to rectify are of the following types:

I. Deformation of asphalt resulting in waves or ruts.
II. Cracking of the asphalt resulting in admission of the sub-grade and the deterioration of the asphalt adjoining the cracks provided that if such cracking results from defective foundations and General Contractor shall at their own cost carry out the necessary remedial work.
III. Unrevalling the asphalt resulting in the formation of pot holes.
IV. Polishing of the asphalt under traffic resulting in a surface which the vehicles are liable to skid.
V. Defects in area of asphalt under guarantee where they shall exceed the limits specified below be remedied immediately by the contractor.

The limiting values of defects shall be the following:

I. Deformation, 25 mm in 3.0 metres.
II. Cracks, exceeding 1.5 m length or 3.0 mm in width.
III. Unravelled patches exceeding 194 sq. cms. in area and or 13 mm in depth.
IV. Polishing to the extent greater than that of a sample to as a representative border line case by the General Contractor and the Engineer-in-Charge cut from the road, divided into two approximately equal portions and retained for reference by the Engineer-in-Charge and contractor.

6.4.13 Permitting traffic:
Traffic may be allowed on the road after a lapse of 24 to 48 hours after laying.

7.0 HOT MIXED HOT LAID BITUMINOUS CONCRETE WEARING COURSE (SEAL COAT)

7.1 Bituminous concrete shall consist of mixture of mineral aggregate, sand and filler, graded to fill the voids, mixed with bitumen binder to obtain the maximum stability and durability. It shall be spread and compacted on a prepared bituminous macadam base in conformity with lines, grades and cross section shown in the drawings. The aggregate shall be preheated to the temperature specified for the bitumen and the mixture shall be prepared and laid hot.

7.2 Coarse Aggregate:
The coarse aggregate brought by General Contractor shall be met with I.R.C. requirement, hard black trap, crushed in mechanical crushers and shall be clean, strong, tough, dense, close grained, angular but not flaky, and free from soft, decayed, weathered portion, coating of dust, dirt or other objectionable matter. Maximum size of the aggregate shall be suitable for the thickness of the seal coat (12mm./15mm. or as specified).

The aggregate grading composition and characteristics of surface (wearing course mix) shall conform to standard code of practice. The mix shall satisfy the following requirements:

Bitumen:	7.25 (+/-) 0.25% by weight of total mix.
Voids of air in total mix:	2% by weight of mix and 4% by volume.
Specific gravity	Not less than 2.3.
Marshall stability:	453.6 kg (1000 lb.) minimum
Flow :	1020.
Water absorption:	0.50%

7.3 Fine Aggregate:
The fine aggregate shall be clean, natural, river bank or pit sand or quarry sand produced in a crushing plant and satisfying the requirement of the grading of aggregate for the bituminous concrete as stated above or as determined by the preliminary tests.

7.4 Filler:
The filler shall be dry and clean lime stone powder hydrated lime having calcium oxide content of not less than 60% both passing B.S. sieve No.8. or equivalent IS sieve; It shall be free from lumps and loosely bonded aggregation. When tested by laboratory sieves, 100% shall pass through B.S. sieve No.14, 80% shall pass through B.S. sieve No.8. Fillers shall be added to the aggregate to give the above grading determined by preliminary tests.

7.5 Bitumen:
Bitumen shall be of 60/70 penetration or such other grade specified by the Engineer-in-Charge and shall conform to I.S. 73 – latest edition.

7.6 The tenderers shall indicate the exact grading, bitumen content, voids, specific gravity etc. which they propose to adopt for type to treatment offered by them.

7.7 Preparation of Base:
Dirt, dust and other foreign materials if accumulated shall be cleared off leaving the surface entirely clean. The prepared surface shall be closed to traffic and so maintained fully clean till the seal coat is applied.

7.8 Mixing and Laying Wearing Course:
Grade 60/70 (or of specified grade) bitumen shall be heated to a temperature of 163 C to 177 C (325 F to 350 F) in a boiler. The aggregate of the suitable approved grading or as decided by preliminary tests, shall be dried and heated in an aggregate drier to a temperature of 149 C to 177 C (300 F to 350 F) and fed into a twin shaft peddle type mixer at a temperature not less than 149 C (300 F).

The bitumen, the aggregate and the filler shall be measured separately and accurately to the proportions in which they are to be mixed and mixed intimately till all the particles are completely coated with bitumen. The quantities of aggregate, bitumen and the filler shall be such as to obtain the percentage of each as specified above or decided after tests.

Continues batching and mixing plant shall be used. Asphalt/bituminous mixing plant proposed to be used by the contractor for the preparation of asphalt/bituminous mixes, shall conform to all of the requirements of the job, which shall produce uniform mixtures of the required quality.

7.9 The temperature of bituminous concrete when leaving the mixer shall not be less than 138 C (280 F) and it shall not be less than 121 C (250 F) at the time of laying.

7.10 The bituminous concrete shall be transported to the site of work in suitable tipping vehicles properly insulated and covered with canvas or other suitable materials to protect the mixture from weather conditions and to retain the heat.

7.11 The mixture shall be spread with mechanical self powered spreader. The bituminous concrete shall be laid to the specified line, curve, grade and camber. Any irregularities shall be corrected immediately before rolling is started. Before laying the mixture, the faces of the joints shall be painted with a uniform coating of hot bitumen. The bituminous

concrete shall be laid to such loose depth as to give a compacted layer of specified thickness as per item in the schedule of quantities.

7.12 Compaction :

The bituminous concrete layers shall then be allowed to cool sufficiently such that it does not spread under wheel load of 10/12 tonne power roller. The compaction shall be done by the roller till no wheel mark are left on the surface and no further compaction is possible. The road shall be opened to traffic on cooling of the concrete to the atmospheric temperature or after a lapse of 24 to 40 hr. after laying.

8.0 GENERAL REQUIREMENTS FOR BITUMEN MACADAM, CONCRETE & SEAL COAT

8.1 Testing:

General Contractor shall engage a well equipped testing laboratory with a competent laboratory staff. Daily tests (not less than two specimen per day) shall be made by them on the bituminous mixture produced to ensure compliance with these specification and copy of the test results duly signed by the competent authority shall be submitted to Engineer-in-Charge for record. Tests shall include water absorption, stability, filler content etc.

8.2 The contractor shall give all facilities at all times to the Engineer-in-Charge or his representative to inspect the work or testing done by him.

8.3 Testing Surface

The completed surface when ready for acceptance shall be thoroughly compacted, smooth, true to line, grade, camber and free from irregularities when tested by means of a straight edge of 3 m long, laid on the finished surface parallel with the centre line of the road, the surface shall in no place vary more than 6mm from the working edge.

8.4 Mode of measurement:

8.4.1 Measurement for bituminous macadam including filling in pot holes and depressions shall be paid by weight measured in metric tonne used on the job (or as specified in the schedule of quantities), completed satisfactorily, measured up to second place of decimal including preparing surface, applying tack coat, mixing, transportation and compacting by roller etc. complete as specified.

8.4.2 Measurement for bituminous concrete and seal coat shall also be paid by weight as measured at site of work, irrespective of the thickness laid, in Metric tonne used on the job (or as specified in the schedule of quantities), compacted satisfactorily, measured up to second place of decimal including all the relevant items of work specified, complete.

THIS PAGE LEFT BLANK INTENTIONALLY

TECHNICAL SPECIFICATION FOR

WATER SUPPLY

AND

SANITARY SYSTEM

1.00 SCOPE

This specification covers the general requirements for sanitary and water supply installation work with all fittings and fixtures including ancillary works such as connections, manholes, inspection chambers etc.

The scope of work covers supply and installation of the sanitary, water supply and drainage items of works in accordance with drawings and specification.

2.00 GENERAL REQUIREMENTS

2.01 The Contractor shall furnish all skilled and unskilled labour, plant, equipment, scaffolding all materials etc. required for complete executions of the work in accordance with the drawings and as described herein and / or as directed by the Engineer.

2.02 All pipe lines, locations of fittings and fixtures etc. shall be as per the GFC drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry and levels shall be strictly ensured. All items shall be fully secured against movement in both directions and must be so located as to allow easy maintenance.

2.03 All pipe lines and fittings shall be leak proof. All connections shall be such as to prevent any splashing or emission of foul odour or gases.

2.04 The installation shall also be in conformity with the bye laws and requirements of the local authority in so far as these become applicable to the installation. This specification shall take precedence over the said regulations and standards, wherever this specification calls for a higher standard of materials and/or workmanship than those required by any of the above regulations and standards. The regulations shall govern and prevail if the drawings and specifications indicate details which violate the regulations,

2.05 Contractor shall set out the drainage, soil, waste and water pipes lines and other fittings and fixtures in accordance with the GFC drawings and instructions of the Engineer. The Contractor shall be responsible for the correctness of the above and any inaccuracies are to be rectified by him at his own expense. The Contractor will be responsible for taking levels of the site before setting out and putting them on record without extra charge.

2.06 All works should conform to the description given for each item and in specification in addition to the bye-laws / requirements of the Municipal Corporation / Local Authorities within whose jurisdiction the work is required to be done.

2.07 The drawings, specifications and schedule of quantities forming part of the contract are self explanatory and are complementary to one another. They together represent scope of works / installation to be carried out. The Contractor shall provide the any other work or installation required if it is required to complete the work as a whole even if the same is not indicated in the GFC drawings, technical specifications or the schedule of quantities.

2.08 Works shall comply with local regulations and unit rates shall include all costs:

a. All sanitary installations, water supply and drainage work shall conform to the Local Municipal Bye-Laws and/or rules and regulations of Local Bodies and the work shall be inspected and passed by the various authorities having jurisdiction.

b. The work shall be carried out through a licensed plumber.

c. The rates quoted shall be for complete items as fixed in position and cover all cost of materials, labour, tools, supervision, cutting of holes, chases, etc. and also for providing fixing arrangements viz. clamps brackets, wooden blocks etc. The rate shall also include restoration to original condition of all damages to walls, floors, etc. during the process of fixing of sanitary installations, water supply and drainage to the entire satisfaction of the Engineer. All debris of plumbers' excavation, demolition etc. shall be removed without any extra charge. The plumbing work or the other building work if affected by the PHE work shall be left thoroughly cleaned to the satisfaction of the Engineer.

d. All brackets shall be painted with one coat of approved primer and two coats of enamel of approved colour. All painting work shall be carried out to the entire satisfaction of the Engineer. Additional coats of paint shall be applied to get uniform and matching finish without any extra cost if directed.

e. All pipes shall be embedded in an approved manner in chases made in walls or floors in the interior of the building if required by the Engineer. The Contractor shall make necessary holes in the walls, etc. as required and restore them to the original condition.

f. All water supply and sanitary fixtures, pipes and pipe fittings, traps, etc., which are to be embedded into the concrete or masonry work or other building work shall be placed in position and embedded or concealed at the time of casting concrete or erecting the brickwork. The locations of such fittings, alignment of pipe lines and traps etc., shall be marked suitably in case chasing or cutting of concrete, masonry, or other structural or construction work is unavoidable and the cutting, chasing or disturbing of the construction work shall proceed only after approval of the Engineer.

g. All cutting, chasing and fixing work shall be completed before commencement of any plastering, tiling or finishing work.

h. Unless otherwise specified, galvanized iron pipes and pipe fittings shall be of medium quality conforming to IS: 1239 and shall be tested if required by the Engineer.

i. The Contractor shall be responsible for the adequacy and efficiency of the entire plumbing system and if, in his opinion, he finds any serious objection to the system shown on the drawings, he shall intimate his objection or his suggestions to ensure adequacy and efficiency of the said system and notify the Engineer before proceeding with the work.

j. The works, during its progress and till final acceptance by the Engineer and handover, including raw materials delivered at site to be incorporated for use in the work by the Contractor, shall be under the care of and responsibility of the Contractor and at his risk. The Contractor at his expense shall immediately replace any loss or damage to such materials or work prior to final acceptance of the work by the Engineer.

2.09 The Contractor shall strictly follow, at all stages of work, the stipulations contained in the Indian Standard Safety Code and the provisions of the safety rules as specified in the General Conditions of the Contract for ensuring safety of men and materials.

2.10 Any approval, instructions, permission, checking, review, etc. whatsoever by the Engineer shall not relieve the Contractor of his responsibility and obligation regarding adequacy, correctness, completeness, safety, strength, workmanship etc.

3.00 CODES AND PRACTICES

3.01 All standards, specifications, acts, and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.

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

Latest editions shall always be consulted.

IS : 458 Precast concrete pipes (with and without reinforcement).
IS : 771 Glazed fire clay sanitary appliances.
IS : 772 General requirements for cast iron sanitary appliances.
IS : 775 Cast iron brackets and supports for wash basins and sinks.
IS : 778 Copper alloy gate, globe and check valves for water works purposes.
IS : 781 Cast copper alloy screw down bib taps and stop valves for water services
IS : 783 Code of practice for laying of concrete pipes.
IS : 1172 Code of basic requirements for water supply drainage and sanitation.
IS : 1200 Methods of measurement of building and civil Engineering works.
IS : 1230 Cast iron rainwater pipes and fittings.
IS : 1538 Cast iron fittings for pressure pipe for water gas and sewage.
IS : 1703 Copper alloy float valves for water supply fittings.
IS : 1726 Cast iron manhole covers and frames intended for use in drainage works.
IS : 1742 Code of practice for building drainage.
IS : 2064 Code of Practice for selection, installation and maintenance of sanitary appliances.
IS : 2065 Code of practice for water supply in building.
IS : 2470 Code of practice for installation for septic tank.
IS : 2527 Code of practice for fixing rain water gutters and down pipes for roof drainage.
IS : 2548 Plastic seats and covers for water-closet
IS : 4111 Code of practice for ancillary structures in sewerage system
IS : 4127 Code of practice for laying of glazed stoneware pipes.
IS : 4984 Specification for high density polyethylene pipes for potable water supplies, sewage and industrial effluents
IS : 4985 Specification for uPVC pipes for conveying potable Water supply. This pipe can also be used for internal Concealed waste pipe for sizes 63mm dia and down Sizes
IS : 5219 Cast copper alloy traps (Part - I)
IS : 5329 Code of practice for sanitary pipe work above ground for buildings.
IS : 5961 Specification for cast iron gratings for drainage purposes.
IS : 13592 PVC SWR GRADE Type B pipes for soil, Waste and vent pipes
IS : 13592 PVC SWR GRADE Type B pipes for soil, Waste and vent pipes
ASTM D-1784 : Rigid poly vinyl chloride (PVC) compounds
ASTM D-1785 : Poly vinyl chloride (PVC) plastic pipes, Sch 40& Sch 80
ASTM D-2466 : Socket type Poly vinyl chloride (PVC) plastic pipe fittings, Sch 40
ASTM D-2467 : Socket type Poly vinyl chloride (PVC) plastic pipe fittings, Sch 80
ASTM D-2564 : Solvent cements for plastic pipes & fittings.
ASTM D-2846: Chlorinated poly (vinyl chloride) CPVC plastic hot & cold water distribution systems.
ASTM D-F493:Solvent cements for Chlorinated poly (vinyl chloride) CPVC plastic pipe & fittings.

ASTM D-F441 Chlorinated poly (vinyl chloride) CPVC plastic pipe Sch 40& Sch 80
ASTM D-F438 Socket – Type Chlorinated polyvinyl chloride plastic pipe fittings. Schedule 40
ASTM D-F439 Socket – Type Chlorinated polyvinyl chloride plastic pipe fittings. Schedule 80.

4.00 MATERIALS

4.01 Materials shall be of the best-approved quality available in the market and unless otherwise specified they shall conform to the respective Indian Standard Specification.

Contractor shall submit samples of all materials and get them approved before placing order and the approved samples shall be deposited with the Engineer.

The nearest size in FPS units shall be provided with prior approval of the Engineer in case of non-availability of materials in metric sizes. No additional payment or any deduction will be made for such substitution.

The materials shall be tested in any approved Testing Laboratory and the Contractor shall produce the test certificate in original to the Engineer and entire charges for original as well as repeated tests shall be borne by the Contractor if directed. The Contractor shall arrange to test portions of the work at his own cost in order to prove their soundness and efficiency if directed by the Engineer. The Contractor shall pull down and redo the work at his own cost if any portion of works is found to be defective or unsound in the opinion of the Engineer even if tests have been conducted. Defective materials shall be immediately removed from the site.

It shall be obligatory for the Contractor to furnish certificate, if demanded by Engineer, from manufacturer or the material supplier that the work has been carried out by using their material and installed/fixed as per their recommendations.

4.02 Cement

Cement shall comply in every respect with the requirements of the latest publication of IS: 8112-1989. Ordinary Portland cement Grade 43 shall be used unless otherwise specified.

Cement shall be stored in weatherproof shed with raised wooden plank flooring to prevent deterioration by dampness or intrusion by foreign matter.

4.03 Sand

Sand shall be clean, free from salt, clay, loam, shells, vegetable matter and fit for use in the opinion of Engineer and shall conform to IS : 383 and IS : 2116. If directed, the sand shall be washed.

4.04 Coarse aggregate

Coarse aggregate shall conform to IS: 383.

It shall be angular, tough, and sharp and well graded stone metal from approved source. It shall be clean and free from any foreign material. The aggregate shall be washed If directed.

4.05 Bricks

Bricks shall conform to IS: 1077.

Bricks shall be with a minimum compressive strength of 40 Kg/Sq.cm.

Bricks shall be of chamber burnt best quality locally available and shall be well burnt, but not over burnt and shall be free from cracks, chips, flaws and stones. It shall not absorb water more than 20% of its own weight when dry.

4.06 **Cement mortar**

It shall be of proportion specified in the particular item in the Schedule of Quantities. Sand shall be measured in suitable measuring boxes and correct quantity of cement shall be added. The materials are to be mixed dry on a clean platform. Clean water is then added and mixed thoroughly. It shall be prepared in such quantity as can be readily used up. Mortar, which has partially set, shall under no circumstances be re-tempered by mixing with additional material or water.

5.00 DRAINAGE (Internal & External)

5.01 **Trenches for Drains**

Alignment and gradients: The pipes are to be laid to alignment gradients shown on the drawings but subject to such modifications, as shall be ordered by the Engineer from time to time to meet the requirements of the works. No deviations from the lines, depths of cutting or gradients of pipeline shown in the plans and sections shall be permitted except by the expressed direction in writing of the Engineer.

The minimum gradients of soil and drainage pipeline shall be as follows if not otherwise specified:

100 mm nominal dia	...	1 in 35
150 mm nominal dia	...	1 in 65
230 mm nominal dia	...	1 in 120
300 mm nominal dia	...	1 in 200

Water Supply Pipeline

Under no circumstances, shall drainage and soil pipes be allowed to come close to water supply pipelines.

5.02 **Excavation**

The trenches for the pipes shall be excavated to lines and levels as directed. The bed of the trench shall be truly and evenly dressed throughout from one change of grade to the next.

The gradient is to be set out by means of boning rods. The trench shall be refilled by means of cement concrete of proportion 1: 4: 8 at the contractor's own expense and should the required depth exceed at any point.

The bed of the trench, if in soft or made up earth, shall be well watered and rammed and the depression thus formed shall be made up with sand or other suitable materials as directed by the Engineer without any extra cost.

If rock is met with, it shall be removed to 15 cm. below the level of the pipe and the trench refilled with concrete or sand or other suitable material as directed by the Engineer without any extra cost.

The rates shall include keeping trenches dry either by bailing out or pumping water, timbering and shoring of sides of excavation if required and as directed by the Engineer.

The trench width shall be nominal diameter of the pipe plus 38 cm. (15") but it shall not be less than 53 cm. (21").

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to become such as to endanger the stability of the excavation. Spoil may be carried away and used for filling the trench behind the work.

5.03 **Protection of Existing Services**

All pipes, water mains, cables etc. met with in the course of excavation shall be carefully protected and supported.

5.04 **Refilling:**

Refilling in trenches for pipes shall be commenced as soon as the joints are tested and approved. The refilling on the top and around the pipes shall be done with great care and in such a manner as to obtain the greatest amount of compactness and solidity possible. For this purpose the selected excavated earth shall be laid in regular layers of 15 cm. watered and each layer rammed. Utmost care shall be taken in doing this, so that no damage shall be caused to the pipeline and other permanent works.

All surplus earth shall be disposed off as directed by the Engineer.

5.05 **Concreting**

All pipes at shallow road crossings and made up ground shall be laid on a bed of 150mm thick 1:4:8 concrete (one part of cement, four parts of sand and eight parts of 40 mm and down gauge stone metal) and properly consolidated. The pipes shall be encased with 1:3:6 cement concrete using 25 mm and down gauge stone metal. Concrete shall be laid to the full width of the trench and also in haunches as per the standard drawings.

5.06 **Laying**

The pipe shall carefully be laid to the levels and gradients shown on the drawings with “socket up” the gradient.

Each separated pipe shall be individually set for line, level, plumb etc. Where lengths of sewer or drain pipes are laid in trench, properly painted sight-rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed.

5.07 **Jointing**

Jointing of laid pipes shall be so carried out immediately as to avoid any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and manholes shall be gastight when above ground and watertight when underground. Method of jointing shall be as per instruction of the pipe and fittings manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer, methods as detailed hereunder shall be used.

5.08 Spun yarn soaked in thick cement slurry shall be passed round the joint and inserted into it by means of a caulking tool. More skins of yarn shall be added and caulked tightly so as to fill more than 1/4th of the total depth of the socket. The remainder of the socket in the joint shall be carefully filled with a stiff cement mortar of 1:1 (One part of cement and one part of sand) proportion by hand. When the joint is completely filled with tightly caulked mortar, a fillet shall be formed round the joint with a trowel, forming an angle of 45^{o} with the barrel of the pipe. The newly laid joints shall be protected until set from sun and rain and shall be covered with damp sack or other suitable materials.

5.09 **Curing**

The joints shall be cured at least for seven days.

5.10 **Testing**

All lengths and joints shall be fully tested for water tightness by means of water pressure maintained for not less than 30 minutes. Testing shall be carried out from manhole to manhole. All pipes shall be subjected to a test pressure at least 2.0M head of water at the highest point of the section under test. Any joint found leaking or sweating shall be remade and section re-tested at Contractor's own cost.

5.11 **Support and Protection to Pipelines**

All drainage and sewer pipes shall be laid with socket leading uphill. Preferably the pipes shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instructions as approved by the Engineer shall be followed in the matter of support and jointing.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

5.12 **Entry into Structures**

For entry of the pipelines into any building or structures suitable conduits under the structures or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When openings or chases are required to be made in the structure for entry of pipe-lines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be made good.

5.13 **Ducts**

Where soil, waste and ventilating pipes, rain ware pipes are accommodated in ducts, access to cleaning eyes shall be provided. Connection to drain shall be through a gully with sealed cover to guard against increase of sewer gas, vermin or back flow.

5.14 **Traps and Ventilating Pipes**

Pipes for carrying off the waste from water closets and waste water and overflow from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50 mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap.

Ventilating pipes shall be carried up vertically from the drain to a height of at least 800 mm above the outer covering of the roof of the building or as shown on drawings. All vertical ventilation, anti-siphon and similar pipe shall be covered on top with a cowl.

B. HUME PIPE FOR DRAINAGE

5.15 Pipes

Shall be reinforced and conform to relevant I. S. Specification. They shall be new and perfectly sound, free from cracks, cylindrical, straight and of specified nominal diameter. Each pipe shall have one collar.

5.16 Jointing

Socket and spigot pipes shall be joined by lead joints. The spigot shall be centered in the socket of the next pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yard has been caulked tightly, a jointing ring shall be placed round the barrel and tightened against the face of the socket to prevent airlock.

Molten lead shall then be poured in to fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3 mm behind the socket face.

In special cases if flanged joints are accepted by the Engineer, the joints shall be made leak proof by inserting approved type of rubber or other gasket no less than 1.5 mm thick. The bolts shall be secured in stages to avoid uneven strain. Damaged gasket shall be replaced.

6.00 Manholes and Inspection Chambers

6.01 The maximum distance between manholes shall be 30 metres unless specially permitted otherwise. In addition, at every change of alignment/gradient or diameter there shall be a manhole for inspection chamber. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 metres unless desired otherwise. Manhole shall be constructed so as to be watertight under test. The benching at the sides shall be carried out in such a manner as to provide no lodgement for any splashing in case of accidental flashing of the chamber. The chamber or drain at the bottom of chamber shall be plastered with 1:3 cement, sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connection to existing sewer lines shall be through a manhole.

Manholes shall be provided with standard covers, usually FRP or as desired by the Engineer. The covers shall be close fitting so as to prevent gases come out.

6.02 Size of manholes

The size specified in the Schedule of Quantities shall be internal size of the manhole.

The work shall be done strictly as per standard drawing and following specifications.

6.03 **Bed concrete**

Shall be in 1: 4: 8 cement concrete 150 mm thick for inspection chambers, 230 mm for depths up to 2.1 meters and 300 mm for greater depths in case of manhole.

6.04 **Brickwork**

Shall be with locally available best quality chamber burnt bricks in 1: 4 cement mortar or as specified.

6.05 **Plaster**

Inside of the walls shall be plastered with 12 mm. thick cement plaster 1: 3 and finished with a floating coat of neat cement.

In wet grounds, 20 mm thick plaster of the above specification shall be done on the exterior surface of the walls also and this plaster shall be waterproofed with the addition of approved waterproofing compound as per manufacturer's specification.

6.06 **Pointing**

In dry ground, pointing shall be done in 1: 2 cement mortar to the outside surface.

6.07 **Benching**

Channels and benching shall be done in cement concrete 1: 2: 4 rendered smooth with neat cement.

The following size of channels for the bench shall be adopted.

Size of drain		Depth at the centre		Depth at sides at walls	
in cm.	**in inches**	**in cm.**	**in inches**	**in cm.**	**in inches**
10	4	15	6	25	10
15	6	20	8	30	12
23	9	28	11	38	15
30	12	35	14	45	18
38	15	43	17	53	21
45	18	50	20	61	24

6.08 **Foot rests**

Polypropylene foot rests / steps shall be embedded in masonry, whenever the depth of the manhole / chamber is more than 1.2 metres as shown in the drawing. They shall be fixed 30 cm. apart and projecting 11 cm. from the wall.

6.09 **Manhole Covers**

Manhole covers shall be of tough homogeneous FRP of heavy/medium/light type as specified. The sizes specified are the clear internal dimensions. Cover placed on the frame shall be air tight.

7.00 **SANITARY INSTALLATION & FIXTURES:**

7.01 All fixtures and fittings shall be of approved quality and type manufactured by well-known manufacturers. All items brought to the site must bear identification mark of the type and manufacturer. Procurements shall be made well in advance and got inspected and approved immediately by the Engineer. All fixtures shall be adequately protected covering and plugging till handed over.

All fittings, gratings, fasteners, unless specified otherwise, shall be chromium plated.

All fixtures shall be fixed in a neat workman like manner true to line and as recommended by the manufacturer or shown on the drawings. Care shall be taken to fix all fixtures, brackets and accessories by proper wooden cleats, raw plugs, bolt and nuts as each fixture will warrant with the correct site of screws, nuts or bolts.

Care shall be taken in fixing all approved chromium plated fixtures and accessories so as not to leave any tool marks or damages. All such fixtures shall be tightened with fixed spanners. Use of pipe wrenches with toothed jaws shall not be allowed.

All fixtures shall be thoroughly tested after connecting up the drainage and water supply system. All fixtures shall be thoroughly finished and any leakage in piping, valves and waste fittings corrected to the entire satisfaction of the Engineer.

Upon completion of the work, remove all labels, stickers, plasters etc. from the fixtures and clean all fixtures with soap and water so as to present a neat and clean toilet.

7.02 **Water closet**

i) Indian type W. C. pans

The W. C. pan shall be of white vitreous china, of specified size and pattern. Pan shall be of approved quality and shall bear the mark of the firm manufacturing it.

ii) **Orissa type pans**

Shall be from an approved manufacturer and trapped as specified above.

Fixing

Pan shall be fixed securely with a cushioning bed in an approved manner taking care that the cushion is uniform and even, without having any hollows between pan and the concrete. The joint between the pan and the trap shall be made with cement mortar 1: 1 and shall be leakproof.

Each closet shall be provided with the following accessories and the rate shall be all-inclusive

a. Necessary length of 10 cm. H. C. I. pipe or lead pipe connecting the pan and plug bend. (The plug bend/tee connection to vertical stack shall be paid under appropriate item).

b. Wherever anti-syphonage pipe connections are required necessary length of lead pipe 62.5 mm. dia. shall be provided.

c. Necessary length of porcelain or lead or C.I. connecting pipe 10 cm. dia. (plug bend/tee connection to vertical stack shall be paid under appropriate item.)

Painting

All fittings and fixtures shall be painted with two coats of enamel paint over a coat of primer.

iii) **European Type W.C.**

The Closet shall be of white Vitreous China readily flushed, of "cascade model wall mounted European type with close coupled flushing cistern" and shall be of best quality manufactured by an approved firm, and fixed to the floor by approved means. It shall have 100 mm dia. porcelain 'P' or 'S' trap with effective seal.

Each closet shall be provided with the following accessories and the rate shall be all inclusive

a. **Seat**

Matching colour plastic seat of approved quality and seat cover with rubber buffers fixed to the pan with C.P. brass bar hinge.

7.03 **Cistern/ Flush valve**

Flush valve having 32/ 40mm dia inlet or dual purpose flushing tank with 3 or 6liters/ flush capacity of white vitreous china cistern of best quality manufactured by an approved firm with C.P. flush handle and C.P. overflow pipe of length as per Municipal requirement or as per Engineer's drawing with mosquito-proof bronze cap etc. complete unit including enameled or C.P. flush pipe and bend.

Necessary length of lead water inlet pipe and 12 mm dia. C.P. brass stopcock.

Necessary length of lead or C.I. connecting pipes 10 cm dia. (Plug bends / tee connection to vertical stack shall be paid under appropriate item).

Wherever anti-syphonage pipe connections are required, necessary length of lead pipe 6.25 cm. dia. shall be provided.

Painting

All fittings and fixtures shall be painted with two coats of enamel paint over a coat of primer.

7.04 **Urinals**

i) **Lipped Urinals**

Shall be magnum urinal with automatic sensor or flat back or angle urinal of specified dimensions and shall be of white Vitreous china from an approved manufacturer.

They shall be screwed to the wall with coach screws of chromium plated brass on dowel shaped wooden plugs built into the walls or fixed as per manufacturer's specification. Each basin should have an outlet with C. P brass hinged grating connected to 40 mm diameter waste pipe through a C.P. bottle trap. When a range of urinals are provided only a straight length of 40 mm diameter

Waste pipe and white glazed half round channel with tread platform finished with white glazed tiles complete as per Engineer's drawings shall be provided. All joints shall be in plumber’s wiped solder joint with necessary C.P. brass sockets and thimble etc.

ii) **Stall wall type urinals**

Shall be white vitreous china of approved design and manufacturer.

They shall be fixed to the wall as per manufacturer's specification. Each urinal should have an outlet with C.P. brass hinged grating connected to 40 mm diameter waste pipe through a C.P. brass bottle trap. All joints shall be in plumber's wiped solder joint with necessary C.P. brass sockets and thimble etc.

7.05 **Flushing Cistern**

These shall be automatic/ manually operated flushing cisterns of vitreous china or as specified in the Schedule of Quantities complete with valve less siphon fittings. Cistern shall be supported on brackets of standard pattern and fixed to wooden dowel plugs embedded in the wall with C.P. brass screws.

7.06 **Angle valve**

The cistern shall be fed with 15 mm. (1/2") C. P. brass inlet tube angle valve of approved make with necessary length of lead inlet pipe complete with C. P. brass unions unless otherwise specified in the Schedule of Quantities.

The main and distribution pipefittings and clamps shall be of C. P. brass unless otherwise specified in the Schedule of Quantities. Distribution pipes shall feed the urinals with C. P. brass spreaders of approved make.

Painting

All brackets etc. shall be painted with two coats of enamel paint over a coat of primer.

7.07 **Lavatory Basin**

Wash basin

They shall be of white vitreous china of best quality manufactured by an approved firm and size as specified in the schedule of quantities. They shall be supported on a pair of CI brackets of approved design.

Fittings

Each lavatory basin shall be provided with a single cold water C.P. brass pillar tap of approved design and make, C. P. brass waste, C. P. brass chain and rubber plug, C. P. brass bottle trap of approved quality and design, with C. P. brass stop cock and water inlet pipe of standard length complete.

Waste pipe

Waste pipe beyond bottle trap shall be measured and paid separately under appropriate item.

Painting

All brackets, pipes etc. shall be painted with two coats of enamel paint over a coat of primer.

7.08 **Sinks**

They shall be of stainless steel sink with drain board of best quality and sizes as per the schedule of quantities. They shall be supported on necessary brackets.

Fittings

Each sink shall be provided with 40 mm. (1.5") C. P. brass waste of approved pattern with C. P. brass chain and 40 mm. rubber plug and 40 mm. dia. C. P. brass trap and union which shall be connected to 40 mm. diameter waste pipe.

Waste pipe beyond the trap shall be measured separately and paid under appropriate item.

Where specified, sinks shall be provided with puff pipe with a brass-perforated screw cap.

Painting

All fittings, brackets and pipes shall be painted with two coats of enamel paint over a coat of primer.

7.09 **Drain board**

Drain board of type and size as specified in the Schedule of Quantities shall be provided. These shall be fixed on strong brackets of approved design and where necessary provided with hinges. Brackets shall be painted with two coats of enamel paint over a coat of primer.

8.00 **TOILET REQUISITES**

8.01 **Mirrors**

Mirrors shall be of the best quality, specified size, approved design and make. It shall be mounted on asbestos sheet backing and shall be fixed in position by means of four C. P. brass screws and cup washers over rubber washers on wooden plugs firmly embedded in the wall. Alternative method for fixing could be by using brass clamps with C. P. brass screws. A suitable T. W. cover of approved design shall be fixed all round as directed.

8.02 **Glass shelf**

The shelf shall be of glass of approved quality and thickness with edges rounded off. The size of the shelf shall be as specified and shall rest on C. P. brass brackets which shall be fixed with C. P. brass screws to wooden plugs, firmly embedded in the wall. The shelf shall have C. P. brass guard rail all round.

8.03 **Towel rail**

Towel rail shall be of C. P. brass with two C. P. brass brackets. The size of the rail shall be as specified. The bracket shall be fixed by means of C. P. brass screws to wooden cleats firmly embedded in the wall. Where specified, anodized aluminum towel rails may be used of approved quality and design.

8.04 **Toilet paper holder**

Toilet paper holder shall be of Jaquar or equal approved make exposed type to be fixed over wall dado.

8.05 **Floor sump/ Traps**

The floor sump/ trap shall be have fabricated in PVC self-cleaning and deep water seal type with a 50 mm water seal. It shall have an outlet ranging from 75mm to 110 mm dia. With grating at top. These shall be fixed in concrete to the required level and position.

8.06 **Shower**

These shall be of CP finish swivel type as specified.

8.07 **Towel Ring, Soap Tray, Cloth Stand etc.**

These shall be of CP/ anodized aluminium as described in the schedule and as per the displayed sample. These shall be fixed by means of CP brass screws to wooden cleats, firmly embedded in the wall.

8.08 **Liquid Soap Dispenser**

It shall be round and easily revolving with removable threaded nozzle. The body, bracket for wall mounting and screws shall be chromium plated.

9.00 **WATER HEATERS**

These shall be of Venus / Racold make. The type and capacity will be as per schedule of quantities. They shall be mounted on the wall with necessary bolts of approved make. They shall have 8 mm PVC inlet pipe, 12 mm lead pipe outlet, and 15 mm non-return valve.

10.00 **Waste and Vent Pipes and Fittings**

10.01 **Laying**

The pipes shall be laid as described in the Schedule of Quantities and as shown on the Engineer's drawings.

uPVC Soil, Waste Vent and rain water pipe system:

PVC pipe of SWR grade TYPE B pipes conforming to IS 13592 shall be used for soil, waste, vent and rainwater pipe system. The fittings shall conform to relate IS and Joints will be pasted or ring seal type.

10.02 **Fixing**

The pipes and fittings shall be fixed to walls by using proper holder-bat clamps, if directed. The pipes shall be fixed perfectly vertical or in approved alignment. The spigot end shall abut the shoulder of the socket and shall leave no annular space in between. All soil and waste water pipes shall be carried up above the roof parapet wall and shall have Vent cowl.

Connection between main pipe and the branch pipes shall be made by using appropriate branches and bends invariably with access doors for cleaning.

10.03 **Testing**

All PVC soil, waste, vent and rain water pipes and fittings including joints shall be tested by smoke test as recommended by ISI and left in working order after completion. The acceptance criteria shall be as laid down therein.

10.04 **Nahani or floor traps**

The traps shall be of self-cleaning design deep seal type with a minimum seal of 5 cm. (2"). If directed, 25 mm. puff pipe shall be provided. The other specifications for these shall be the same as those for C. I. soil, waste and vent pipes and fittings. The nahani trap shall be back inlet type.

10.05 **Painting**

All exposed C. I. pipes and fittings shall be painted to match the colour of the surroundings with two coats of flat/enamel paint over a coat of approved primer. If directed, additional coats shall be given at no extra cost.

10.06 **WATER SUPPLY**

A. INTERNAL WATER SUPPLY

11.00 CPVC Pipes as per ASTM D 2846 – SDR 11 only with fittings as per ASTM F 438 for pipes up to 50 mm.

For pipes above 65 mm and above pipes shall be ASTM F 441 Schedule 80 and fittings as per ASTM F 439.

The CPVC SDR 13.5 and SDR 11 pipes shall be used for cold and hot water supply respectively.

11.01 ASTM PVC pipes and fittings:

Pipes conforming to ASTM D 1785 poly vinyl chloride (PVC) plastic pipes sch'80 and fitting conforming to ASTM D 2467 sch'80

Brass female threaded fitting should be used for connecting C.P. Bathroom fittings like Angle stopcock, health faucet bibcock, etc.,

Laying and fixing:

CUTTING:

In order to make a proper and neat joint, measure that the pipe and fitting length accurately and make a small mark. Ensure that the pipe and fittings are size compatible. You can easily cut with a wheel Type plastic pipe cutter or hacksaw blade. Cutting tubing as squarely as possible provides optimal bonding area with in a joint.

DEBURRING / BEVELING:

Burss and filings can prevent proper contact between tube and fitting during assembly and should be removed from the outside and inside of the pipe. A pocketknife or files are suitable for this purpose. A slight bevel on the end of the tubing will ease entry of the tubing into the fitting socket.

FITTING PREPARATION:

Using a clean, dry rag, wipe dirt and moisture from the fitting sockets and tubing end. The tubing should make contact with the socket wall 1/3 to 2/3 of the way into the fitting socket.

SOLVENT CEMENT APPLICATION:

Use only CPVC cement or an all – purpose cement conforming to ASTM – 493 or joint failure may result. When making a joint, apply a heavy, even coat of cement to the pipe end. Use the same applicator without additional cement to apply a thin coat inside the fitting socket. Too much cement can cause clogged waterways.

ASSEMBLY:

Immediately insert the tubing into the fitting socket, rotate the tube ¼ to ½ turn while inserting. This motion ensures and distribution of cement within the joint. Properly align the fittings. Hold the assembly for approximately 10 seconds, allowing the joint to set-up.

SET AND CURE TIMES:

Solvent cement set and cure times are a function of pipe size, temperature and relative humidity. Curing time is shorter for drier environments smaller sizes and higher temperatures. It requires 10 to 20 minutes for perfect joint.

12.00 **Testing**

Before any pipes are concealed or covered in false ceiling, they shall be tested to a hydrostatic pressure of 10 Kg/cm or 1.5 times maximum working pressure whichever is higher. Pressure shall be maintained for at least two hours without appreciable drop in pressure. In addition to the sectional testing of water supply pipes, the contractor shall test the entire installation to the entire, satisfaction of the Engineer.

All CPVC SDR 13.5 & SDR 11 pipes or any other pipes and fittings shall be tested in an approved manner while unloading at the site. All leaky materials, joints must be made leak proof by tightening or redoing at contractor's expenses.

13.00 **BUTTERFLY AND BALL VALVES:**

13.01 **Ball valves: -** The valve shall be brass body with specified size and shall be of approved quality.

The valves shall work easily and smoothly under all conditions and shall be watertight when closed under the working pressure as stipulated in the relevant I. S. codes.

The diameter of the water way, when the valve is fully opened shall not be less than the diameter of the pipe.

13.02 **Butterfly Valves**

Valves above 50 mm dia. shall be butter fly valves.
Butterfly valves shall conform to the following specification:

Body : High duty cast iron to IS 210 FG 220 and BS 1452 Gr 220

Seating : Molded in situ resilient lining of black nitrile rubber.

Disk : Nylon coated S.G iron to IS 1865/SG 400/12 and BS 2729 Gr.470/12.

Shaft: The shafts are made of stainless steel AISI 431. Only flanged and valves to be used with flanges drilled to BS 10 Table F. Valves shall be capable of being locked in open position. Hand wheel shall be with flow control lever unit for smooth opening and closing of the valve. Key rods with MS coated extended spindles to be provided whenever the valves are not Approachable from the ground surface.

14.00 APPURTENANCES

The other appurtenances of the pipe line are mentioned below:

14.01 **Air valves:-** These are placed at every summit in the pipe line to permit the escape of air when the main is filled, and afterwards air if any is carried into the main (they are also placed on long stretches of nearly level main).

14.02 **Scour valves: -** These are placed at the bottom of all depressions for emptying the main or letting out sediment.

14.03 **Reflux valves :-** These are fixed on the ascending parts of the main which open in the direction of flow, but automatically close if a burst occurs and the water flows back. They diminish the damage done by the escape of water at a burst.

17.00 SEWAGE DISPOSAL

Sullage and sewage produced from this complex shall be conveyed through a common inspection chambers at appropriate locations. After this, the collected sewage will be treated by providing suitable sewage treatment plant within the premises. Then the treated effluent will be stored and re-used for flushing and gardening purposes.

18.00 TESTING AND ACCEPTANCE

18.01 Inspection before Installation

All pipes, fittings and fixtures shall be inspected before delivery at the site to see whether they conform to accepted standards. The pipes shall again be inspected on site before laying by sounding to disclose cracks. All defective items shall be clearly marked and forthwith removed from the site.

18.02 Testing of Pipelines for Drainage and Sanitation

Comprehensive test of all pipe lines shall be made by simulating conditions of use. The method of actual tests shall be decided by the Engineer. All test data shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the tests are given below:

(a) **Smoke Tests**

All soil pipes, waste pipes and vent pipes and all other pipes when above ground shall be approved gastight by a smoke test connected under a pressure of 25 mm of water and maintained for 15 minutes after all trap seals have been filled with water. The smoke is produced

by burning oily waste or tar paper or similar material in the combustion chamber of a smoke machine. Chemical smokes are not satisfactory.

(b) **Water Test for pipes other than Cast Iron**

Glazed ware pipes shall be subjected to a test pressure of at least 1.5 m head of water at the highest point of the section under test. The tolerance figure of two litres per centimeter of diameter per kilometer be allowed during a period of 10 (ten) minutes. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, filling the system with water. A knuckle bend shall be temporarily jointed in at the top and a sufficient length of the vertical pipe jointed to it so to provide the required test head or the top may be plugged with connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitable for observation.

Subsidence of test water may be due to one or more of the following causes:

(i) Absorption by pipes and joints

(ii) Sweating of pipes or joints

(iii) Leakage at joints or from defective pipes

(iv) Trapped air

Allowance shall be made for (i) by adding water until absorption has ceased and after which the proper tests should commence. Any leakage and the defective part of the work shall be cut out and made good.

(c) **For Straightness**

(I) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball will roll down the invert of the pipe and emerge at the lower end; and

(ii) By means of mirror at one end of the line and lamp at the other. If the pipeline is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipeline is not straight.

18.03 **Testing of Water Mains after Laying**

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main, by providing 25 mm inlet with a stop-cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5 kg/cm² or double the maximum working pressure, whichever is greater. The pressure shall be applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter, by a power-driven test pump provided that the pump is not left unattended. In either case, due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall be preferably have been recalibrated before the test. The pump having been stopped the test pressure shall maintain itself without measurable loss for at least five minutes. The end of the main shall be closed by fitting a

watertight expanding plug and plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

18.04 **Testing of Service Pipes and Fittings**

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer.

18.05 **Fixtures Etc.**

All fixtures and fittings shall be connected by water tight joints. No dripping shall be accepted.

18.06 **Manuals**

3 copies of manuals shall be submitted duly indexed with complete technical data sheet of each piece of equipment installed. The manuals shall be well bound and shall contain the following:

i. Table of Contents.
ii. Design data / standards.
iii. 'As built' drawings.
iv. Manufacturer's catalogues, installation and maintenance brochure.
v. Spare parts list.

19.00 **MODE OF MEASUREMENT**

1. Unless otherwise stated, all pipes shall be measured net, length as laid or fixed and measured linear over all fittings, such as bends, junctions, etc. and given in running metres. The length shall be taken along the center line of the pipes and fittings.

2. Length of fittings viz., taps, valves, traps, etc. which are paid under appropriate items shall not be re-measured under linear measurements as enumerated above.

3. Soil, waste and vent pipes shall be measured along the center line of the stack including the connecting bends/tees to W. C. Pan, Nahani trap, etc. and shall be paid as enumerated above.

4. W. C. pans, Lavatory basins, Sinks, Drain boards, Urinals, Mirrors, Glass shelf, Toilet paper holder shall be measured by number and shall include all accessories as enumerated in detailed specifications under each item.

5. Unless otherwise specified, all types of taps, valves, etc. shall be measured by number and paid separately.

6. Manholes, Inspection Chambers, Gulley traps, etc. shall be constructed according to detailed specifications, and measured by number and paid separately. The depth of manhole shall mean the vertical distance from the top of the manhole cover to the outgoing invert of the main drain channel.

7. Water meter shall include 'Y' strainer and other appurtenances required by the Local bodies and shall include Brick Masonry Chamber etc. as per detailed specification and item shall be measured by number and paid for accordingly.

ANNEXURE TO BILL OF QUANTITIES FOR THE WORKS RELATED TO WATER SUPPLY AND SANITARY ENGINEERING

BIDDERS WILL NOTE THE FOLLOWING BEFORE OFFERING THEIR RATES.

GENERAL NOTES TO CONTRACTOR:

1. All glazed Sanitarywares, Chromium plated bathroom fittings, Pipes and pipe fittings, Valves, pumps etc., shall be as specified in the bill of quantity.

2. Transportation of materials, lead, lift, for fixing in position, fixing materials like brackets / rag bolts, screw nails, wooden plugs or any other like materials for proper as well satisfactory completion, labour charges to fix in position, making holes or cutting in masonry or concrete surfaces, restoring the damaged portions using materials like river sand, cement, stone chips, steel rods, shuttering materials, curing the works, carting away the broken materials from respective site of operations, conveying by head load or any other means, to ground floor, stack neatly at appropriate places - such items of work should be included in the rates offered by Contractors, in addition to basic prices of all materials with taxes, duties & levies.

3. The Contractors should make his own arrangement to bring testing equipments, any other materials for temporary fixing/ removing, conducting tests required at their cost and should include for these in their rates against each item of work.

4. Incase of non-availability of material with specification mentioned in schedule of quantities, the Contractor shall obtain approval from Architects to use material with alternative specification. This is subject to satisfaction of Architect & client.

5. The Contractor will take care to procure samples of materials as stated in schedule of quantities. After obtaining approval from Architects & clients Contractor to arrange for required materials as per approved samples. Approved sample of materials are to be retained at site by the Contractor and can be taken off after completion of works or with approval of Architects and clients.

6. All the materials to be used on works should bear I.S.I. mark. Wherever Non I.S.I. marked products are brought in, such materials should be the best in Market & prior approval of Architect's/ Consultant's should have been obtained. It is the responsibility of the Contractors to follow the product specification.

7. Only drilling machines shall be used for making the holes in the walls and no jumper and hammer will be allowed. Wall chasing shall be done with chasing machine.

8. Quoted rate shall be inclusive of cost of hi-tech supports with anchor fasteners and all consumables like hacksaw blade, solvent cement, twine/ Teflon tape, etc.

9. Quoted rate shall be inclusive of cement concrete all around the IWC/EWC and pipe works wherever required.

10. Commercial Terms & Conditions for this part of work will be identical to what is stated for General Builders Work Contract.

11. Quantities of work involved for above project on water supply and sanitary engineering is enclosed herewith. These quantities are arrived based on consultants drawing in consultation with Project Architect & client.

12. Quantities mentioned may differ from actual. Hence it is not a lump sum contract and vendors will be paid on completed quantity of work certified measurement of work by the authorities' in-charge at site. Vendors should read and follow the technical specification followed in tender documents.

13. It is the responsibility of the vendor awarded with the work to take on the successful commissioning of the system. For this purpose changes or alterations on the work front are to be brought to the notice of the consultants/ architects/ clients for their approval. The vendor is not permitted to find any reasons for failure on performance of the system and authorities are also flexible to effect changes as well these to be within the value of the contract awarded.

14. It is necessary that shop drawing is prepared by the vendor. Approval will be provided only if the shop drawings mention ascends and descends of pipe work without damaging the structural concrete members supporting the construction. The vendors should also note that making holes wherever needed, cutting earth, refilling the trench with excavated earth are item included in their rates. Additional claim in the invoice of the vendors will not be paid under any circumstances.

15. The vendors after receiving the work order should submit catalogue, technical details, Proforma on all the materials to be used on the work. The authorities will scrutinize, inform the vendor for procurement. On completion, the vendor will submit to authorities "as built" drawings showing actual work carried out with measurements. Absence of this will attract the client to withhold payment due to the vendor.

    In addition to said above, the following points shall also be taken into account while quoting the price of each item.

Co – ordination:

- Work shall be carried out in conformity with the specifications, accompanying drawings and with the requirements of the general architectural and structural plans after approval by the Architects / Project Manager of the Employer. The Contractor shall be responsible for taking actual measurements at site and varying the work in details if required to meet the site conditions. Such deviations shall, however, be subject to the approval of the Architects / Project Manager.

- The Contractor shall also co-operate with the Employer's Project Manager / other Contractors, compare and co-ordinate plans, specifications and time schedules and so arrange his work that there will be no interference. The Contractor shall forward to the Employer copies of all correspondence and drawings so exchanged. Failure to check plans and conditions will render the Contractor responsible for bearing the costs of any subsequent change found necessary.

Bye-Laws:

- The Contractor shall comply with all bye-laws and regulations of local and other statutory authorities having jurisdiction over the works and shall be responsible for the payment of all fees and other charges and giving and receiving of all necessary notices and keeping the Employer informed of the said compliance with the bye-laws, payment made, notice issued and received.

- The Contractor shall indemnify the Employer, Architect and Project Manager against all claims in respect of patent rights, designs, trade marks or names or other protected rights in respect of any plant, machine, work or material used for or in connection with the works or temporary works and from and against all claims, demands, proceedings, damages, cost, charges and expenses whatsoever in respect thereof or in relation thereto. The Contractor shall defend all actions arising from such claims and shall himself pay all royalties, licenses fees, damages, costs and charges of all and every sort that may be legally incurred in respect thereof.

Drawings and Literature:

- Before proceeding with the work, the Contractor shall submit for approval, general layout and assembly drawing and such additional assembly and sub – assembly detail drawings as are necessary to demonstrate fully that all parts of the system to be furnished conform to the specifications.

- Within 10 days of the acceptance of the tender, the Contractor shall furnish required prints of layout, assembly and erection drawings for approval. If any modification is proposed by the architects / Project Manager, required further prints of the modified drawings shall be submitted. No modifications shall be made in a drawing after it has been approved by the Architects / Project Manager, without their prior consent. All drawings necessary for assembly, erection, maintenance, repair and operation of the equipment shall be furnished. Different parts shall be suitably numbered for identification and ordering of spare parts.

- Approval by the Architect / Project Manager of the drawings shall not relieve the Contractor of any part of his obligations to meet all the requirements of the contract or of the correctness of his drawings. The Contractor shall be responsible for and pay for all alterations of the works due to discrepancies or omission in the drawings or other particulars supplied by him, whether such drawings have been approved by the Architect / Project Manager or not

- Copies of a comprehensive manual for use by the Project Manager before and during erection and subsequent operation and maintenance of the plant shall also be furnished after approval of the contract drawings.

- The Contractor shall furnish and install in the machine room, a neatly typed set of operating instructions securely framed and glazed. The Contractor shall also provide one set of tools free of cost required for routine and special maintenance work.

Shop Drawings:

- Prior to the execution of the work, the Contractor shall check all drawings, specifications and Bill of quantities and shall within fifteen days report any error, discrepancies and / or omission

discovered therein, to the Consultant and obtain appropriate orders on the same. Any adjustment made by the Contractor without prior approval of the Architect / Project Manager shall be at his own risk.

- The drawings attached to these specifications are design drawings and are general in nature and cannot be regarded as working drawings. The Contractor shall prepare his own detailed working drawings and shall get them approved by the Consultant before execution.

- Cost of all shop drawings, fabrication drawings and details to be furnished by the Contractor shall be deemed to be included in his tendered rates for the work. Approval of shop drawings shall not be construed as authorizing additional works or authorized in writing by the Architect / Project Manager.

- Space allotted for major equipment shall be taken into consideration before ordering the equipment. The Contractor should ensure that the equipment shall fit into the space provided with required clearances all round as per relevant I.S.S. and I.E. Rules

- Prior to submission of all drawings to ensure that they comply with the intent of the specifications and that they fit in with the overall building layout. Drawings found to be inaccurate or otherwise erroneous will be returned to the Contractor.

- Contractor shall submit copies each of all drawings for the approval of the Consultant. Additional copies of drawings, if required, shall be supplied by the Contractor without additional cost.

- The approval of the drawings by the Consultant shall not be construed as a complete dimensional check but will indicate only that the general method of construction and detailing is satisfactory. The Contractor shall be responsible for the dimensions and design of adequate connections, support, details and satisfactory construction of the work.

- All shop drawings shall be submitted within 15 calendar days of the award of contract, except the control drawings, which shall be submitted within 30 days.

Negligence:

- If the Contractor shall neglect to execute the work with due diligence or shall contravene the provisions of the Contract, the Employer may give notice in writing to the Contractor calling upon him to make good the neglect or contravention complained of. If the Contractor fails to comply with such notice within a reasonable period, the Employer shall have the option and get it completed at a reasonable price. The Employer shall then be entitled to retain and apply any balance sum, which may otherwise be then due on the contract, by him to the Contractor towards the payment of the cost of execution of such work as aforesaid. If the cost of execution shall exceed the balance due to the Contractor, the Employer shall be at liberty to dispose off any of the Contractor's material or construction plant that may be at site and apply the proceeds for payment of the difference of such cost or recover the balance by due process of law.

Statutory Inspections:

- The Contractor shall be fully responsible for meeting all the statutory obligations & local inspectorates wherever applicable to the works carried out by them. The Contractor should prepare all working drawings and obtain approval of competent authorities and also have the equipment and installation inspected and got approved. All official fees will be paid by the clients directly against demand in writing from the appropriate authority and all other expenses for submission and approval of the various and relevant statutory/bodies shall be embodied in the tender prices.

Tools and Spare parts:

- All tools, tackle, scaffolding and staging required for erection and assembly of the equipment and installation covered by the Contractor shall be obtained by the Contractor himself. All other materials such as foundation bolts, nuts etc. required for the installation of the plant shall also be supplied and included in the contract.

Testing:

- The Contractor shall carry out tests on different equipment as specified in various sections in the presence of representative of clients, architects and consulting Engineer in order to enable them to determine whether the plant, equipment and installation in general comply with the specifications.

- Routine and type tests for the various items of equipment shall be performed at the Contractor's works and test certificate furnished. If required by the Project Manager, the Contractor shall permit the Employer's authorized representative to be present during any of the tests. The Contractor shall bear all the expenses thereof.

- All equipment shall be tested after carrying out necessary adjustments and balancing to establish equipment rating and all other design conditions. At least four sets of readings shall be taken for each item tested and submitted in the form shown in annexure or any other Acceptance Test forms supplied by the consultants. Instruments required for testing shall be furnished by the Contractor along with initial requirements of all consumables.

RESPONSIBILITIES OF SPECIALIZED CONTRACTORS

Contractors shall include in their contracts, provision for costs in connection with the following:

- The Provision, erection, maintenance, and removal of all their temporary office and storage accommodation.
- Full responsibility for loss or damage to their plant, tools, equipment and other property on the site.
- Water for construction purpose will be made available by the main Contractor at one point within the site premises; further distribution will have to be taken care of by the Contractor. No claim for non-supply / inadequate supply shall be entertained.

- Power for construction purpose will have to be taken care of by the FIRE PROTECTION Contractor.
- No Contractor workers shall be entitled to stay inside the site premises.
- Contractors to make their own office on space allotted by the Project Managers.

Handing Over & Taking Over:

The plant shall be handed over after satisfactory testing along with sets of documentation each consisting of:

- Detailed equipment data in the proforma approved by the Architects / Project Manager / Employer.
- Manufacturer's maintenance and operating instructions.
- Set of As – built drawings, showing plant layouts, piping, and cable route etc. both in soft format and tracing film.
- Approved Test readings.
- Certificates of approval from statutory or Local Authorities for the operation and maintenance of the installation and equipment, wherever such approval or certification is required.
- List of recommended spares.
- Certificate from the Contractors that they have cleared the site of all debris and litter caused by them during the construction.

The equipments when erected at site shall be deemed to have been taken over by the Employer, after the Contractor gets it certified in writing from the Employer/ Project Manager/ Architects that the plant has fulfilled the contract conditions.

APPROVALS / TNGST & CST

- **All statutory approvals from various authorities shall be obtained by the Contractor. Any Statutory fees to be paid to the authorities will be borne by the Employer upon intimation from respective departments.**
  Note: Scope includes preparation, submission of Application Forms and other associated works with necessary documents and General Arrangement Diagrams to relevant Statutory Bodies(CMWSSB, etc) for obtaining approval for drawing and availing Safety Certificate, approval for Energisiation, availing service connections required as per single line diagram. Quoted Rates shall be inclusive of all Liaisoning / Incidental charges with the respective departments wherever applicable and No additional charges will be given.

TECHNICAL M

SPECIFICATION

FOR

ELECTRICAL WORKS

Scope

This Specification covers general principles to be follow for the selection of electrical equipment and accessories and their installation, testing and commissioning. The term selection of electrical equipment means the electrical equipment and accessories as well as materials. This also covers installation procedure of electrical equipment as well as materials.

The selection of electrical equipment and their installation work as well as during testing and commissioning, safety of equipment and operating personnel, ease of operation and maintenance shall have to be give the prime considerations.

The electrical installation shall be complete in all respects and any item not included in the specifications but essential for proper installation and functioning of the electrical system shall be deemed to be included in the scope of the specification whether specifically mentioned in the Technical and General specifications or not.

All electrical equipment, installation materials and accessories shall be selected from the standardized types and ratings and shall be oriented towards maximizing inter change ability and minimizing maintenance.

In the interest of standardization, the Purchaser reserves the right of selecting particular types and makes of installation materials and accessories and the supplier shall provide materials and accessories of the particular makes if so required.

- **Standards**

The equipment and accessories covered by this specification shall be designed, manufactured and tested in accordance with Indian Standards and codes of practice published by the Indian Standards Institution wherever available, in order that specific aspects under Indian Conditions are take care of.

In case where Indian Standards are not available, then equipment and accessories shall conform to the latest publications and codes of practice by any other recognized National Standards Institutions.

All electrical equipments and installations shall conform to the latest publication of Indian Standards maintenance as listed below:

S.No.	ISI Codes	Description
(1)	(2)	(3)
01.	IS:3072-1975	Code of Practice for Installation and Maintenance of Switch gear.
02.	IS:732-1989	Code of Practice for electrical wiring Installations (Systems Voltage not exceeding 650V)
03.	IS:2274-1963	Code of Practice for Electrical wiring Installation (System Voltage exceeding 650V)
04.	IS:3043-1987	Code of Practice for Earthing
05.	IS:374	Electric ceiling type fans and regulators
06.	IS:375	Aluminum Busbar

07.	IS:694:2010	Wires
08.	IS:1293	6Amps & 16Amps Switches & Sockets
09.	IS:1951	PVC Pipes
10.	IS:2551	Specifications for Danger Plates
11.	IS:4064/1978	Air Break switches
12.	IS:5077	Light Fittings
13.	IS:5216/1982	Safety in Electrical work general
14.	IS:7752/1975 PART I	Guide for PF Improvement (L.V.)
15.	IS:8623	LV Swith Gear
16.	IS:13947 PART II	Air Circuit Breaker / Fuse Switch Units / Module case Circuit Breaker.
17.	IS:13947 PART IV	Contractor / Over load Relays

All electrical equipment and installation shall also conform to the latest Indian Electricity Rules as regard Safety, earthling and other essential provisions specified therein for installation and operation of electrical plants.

Design

Site Conditions

All equipment shall be designed for operation in tropical climate for 35 Deg. C ambient as a 24 hours average with a short time of maximum of 45 Deg. C and relative humidity of 100%. Maximum temperature and maximum humidity however are not likely to occur simultaneously. The de rating of all equipment shall be done for if specifically mentioned in the Technical Specification. The equipment to be installed outdoor subject to direct incidence of sunrays shall be designed for operation at a maximum ambient temperature of 50 Deg.C and shall be weatherproof design.

Reliability and Safety

Continuity of Power supply is the first consideration and the installation shall be such as to provide facilities to simplify inspection, testing, maintenance, cleaning and general repairs at Site.

Special care shall be taking to make the enclosed equipment proof against entry of creeping reptile, which may create electrical short circuits inside the live equipment.

All ventilating and forced-draft opening shall have suitable screen protection. When screens are, provide on top of the equipment, means shall be provide to protect them from falling objects.

Voltage Drop in Cables

The total allowable voltage drop in the power circuits from the load centers to any motor or other consumers shall not exceed 5%. The distribution of this voltage drop in different parts of the System shall depend on the layout of the installation. General the voltage drop in main feeders from the load centers to the PCCs or PDBs shall not exceed 2% and in the sub-feeders from the PCC or PDB to individual equipments or other consumers shall not exceed 3%.

MCB Distribution Board

All the MCB Distribution Boards shall be fabricated out of 16 G thick sheet steel and Shall be of the totally enclosed dust proof type suitable for wall mounting

The Board shall have welded back and sides and gasketted fully hinged front door. Detachable gland plates shall be providing at the top and bottom with suitable gaskets for cable entry. All DBs will have double door only.

The enclosure shall undergo suitable pretreatment followed powder coated.

The MCB Distribution Boards shall have the following:

Incoming MCB of required rating is in an independent compartment with door interlock. The incoming terminals shall be fully shrouded.

Three phase segregated compartments, each housing MCB's connected to one phase of the power supply system. Each of the sections shall have a DP ELMCB on the incoming and SP MCB's for Lighting/Computer/power on outgoing.

In each section, a separate neutral bus and independent earth bus shall be provided.

The MCB's shall be of current limiting type.

All cable entries shall be from the bottom or top.

The busbar shall be of Copper having continuous current ratings equal to that of the incoming switch. The busbars shall be designed to withstand a fault level of not less than 31 MVA for one second.

The MCB's shall have a lockable switching lever.

The minimum electrical endurance shall be 20,000 operations.

The housing of the MCB shall be mounted self-extinguishing thermo set plastic Material.

The short circuit current shall be brought to zero within 4 to 5 milli seconds from the time they are established.

All MCBs shall have a minimum short circuit capacity of 10 KA RMS.

Un drilled gland plates shall be provided both at the top and bottom.

The degree of protection shall confirm to IP 50.

LT Cables - Lying of Cables

Method of Laying Cables

All cables lay indoor and outdoor but exposed shall be enclose in MS conduits.

Extra length of cables shall be providing wherever possible for any future contingency to the extent of 10% of the length of any section.

The cables laid fully buried in ground or partly in trench and partly in ground shall be armoured type. Cables are laid fully in rack/tray/hook or laid in GI pipes/Hume pipes, shall be also armoured type.

The installation work shall be carried out in a neat worker like manner by skilled, experienced and competent workers particularly with experience in jointing termination of aluminum / copper conductor cables.

Cables runs shall be uniformly spaced properly supported and protected in an approved manner. All bends in runs shall be well-defined and made with due consideration to avoid sharp bending and linking of the cable. The minimum bending radius of cables shall not be less than twelve times the overall diameter.

Cable installation shall be property co-coordinated at site with the routing of other services, utilities and the cable routings with a view to avoid interference with any part of the building, structure, equipment, utilities and services.

Entry of cables directly burried in ground or from underground trenches, to the buildings shall be through PVC pipe sleeves. Necessary precautions shall be taking to make entry point watertight by properly sealing the pipe sleeves with epoxy resin (rubberized compound).

All cables shall be providing with identification tags indicating the cable numbers in accordance with the cable/circuit schedule. Tags shall be fixing at both the ends of cable at joints and at 20 m. spacing for straight runs. When a cable passes through a wall, tags shall be of durable fiber of aluminum sheet with the numbers punched on them, and securely attached to the cables with non-corrosive wire. For single core cables, wire shall be non-ferrous material.

All cables shall be test for proper insulation prior to laying. The cable drums shall be transport on wheels to the place of work. The cables shall be laid out in proper direction as indicated on the drum using cable drunk stands. In case of higher size cables, the laid out cables shall run over rollers placed at close intervals and finally transferred carefully on to the trenches and racks. Care shall be taking so that links and twists or any mechanical damage does not occur in cables. Only approved cable pulling grips or other devices shall be use.

Adequate length of cables shall be pull inside the switchboards, control panels, terminal boxes etc. to permit neat termination of each core/conductor. Control cables cores entering switchboard or control panels shall be neatly bunch and strapped with PVC perforated tapes and suitable supported to keep it in position at the terminal block. All spare cores shall be neatly dressed and suitably taped at both ends.

Power cable terminations shall be carried out in such a manner to avoid strain on the terminals by providing suitable clamp near the terminals.

All power cable terminations shall be by means of crimping type cable lugs. Control cables shall be terminated by crimping or directly clamped in the terminal blocks by screws

No jointing shall normally be made at any intermediate point in through runs of cables unless the length of the run is more than the length of the standard drum supplied by cable manufacturers. In such cases when jointing is unavoidable, the same shall be made by means of standard cable jointing boxes/kits.

All cables entry openings in the equipment shall be sealed and made proof against entry of creeping reptiles.

II. Laying of Cables on Racks / Trays / Brackets / Hooks

All power cables in trenches and on structures shall be laid on racks and shall be clamped by means of single or multiple galvanized MS saddles. The saddles shall be placed at an interval of 1000 mm. in both horizontal and vertical straight runs, at each bend and turnings from horizontal to vertical direction and vice versa. All 1100 V grade power cables shall be laid touching each other.

Multi-core control cables shall be laid touching each other on trays and wherever required may be taken in two layers.

Ladder type cable racks shall be selected from two sizes viz. 300 mm. and 600 mm. Ladder type trays shall be galvanized after fabrication.

Vertical spacing between cable racks/trays shall be 250 mm.

Power cables of different voltage grades shall be laid in separate racks / brackets / hooks. Control cables as well as signal and communication cables shall be laid in a separate trays. However, in cases where smaller size power cables (below 16 sq.mm) of fewer numbers cables provided suitable vertical barriers are installed between them. As far as possible AC and DC Power cables shall be laid in separate trays.

Order of laying of various cables in racks/trays brackets/hooks shall be such that control cables are located at the bottom-most tier and 1100 V grade cables at top tier. In case of duplicate feeders of same consumer, these shall be laid in two separate racks/brackets.

Where there is possibility of mechanical damage, cable rack / trays shall be adequate protected by sheet steel covers.

For future installation of cables, provision shall be made to keep 20% space as spare on each tray/rack/bracket.

Cable Terminations and Jointing

Termination and jointing of aluminium conductor power cables shall be by means of compression method using compression type of aluminium lugs. Copper conductor control cables shall be terminated directly into screwed type terminals provided in the equipment. Wherever control cables are to be terminated by means of terminal lugs, the same shall be tinned copper compression type.

Wiring

III. Internal Wiring (Open Fashion) for Small Power / Light Point

All wiring shall be carried out only with PVC conduits.

All light, fan sockets and any other equipment must be earthed.

Wiring shall be carried out with 650 V grade PVC FRLS insulated single core multi stranded copper conductor wires as per IS : 694.

The method of wiring shall be as recommended in IS : 732 and its several parts.

The physical and electrical continuity of the conduit system shall be maintained throughout.

No wire shall be left exposed at any location, metallic flexible pipe shall be used to cover the same.

Colour coding of wire shall be carried out as detailed below:

PHASES	RED
	YELLOW
	BLUE

NEUTRAL BLACK
EARTH GREEN

The minimum diameter of the conduits shall be 25mm. only.

The following sizes of PVC insulated FRLS multi stranded copper conductor wires shall generally be followed throughout:

a. From the final switch to individual outlets — 1.5 sq.mm

b. From Distribution Boards to First Switch Board and subsequent switchboards — 2.5 sq.mm

c. All 16Amps socket — 4.0 Sq.mm.

d. All 20Amps Socket — 4.0 Sq.mm

e. Earth wire throughout for Lighting (Green) — 1.5 Sq.mm.

f. Earth wire throughout for Power (Green) — 4.0 Sq.mm.

f. Adequate protection for other larger size feeders have been provided.

Bunching of Wires

Wires carrying current shall be so bunched that the outgoing and return wires are drawn into the same conduit. Wires originating from two different phases shall not run in the same conduit.

Strands of wires shall not be cut for connecting terminals. The terminals shall have sufficient cross sectional area to take all strands and shall be soldered. At all bolted terminals, brass flat washer of large area and approved steel shall be used. Brass bolts and nuts shall be used for all connections.

Only certified wiremen and cable jointers shall be employed to do jointing work. All wires and cables shall bear the manufacturer's label and shall be brought to site in original packing. For all internal wiring, PVC Insulated wires of 650Volts grade shall be carried out in loop system and no joints shall be allowed in the length of the conductors. If the use of joints/connections are unavoidable due to any reason prior permission, in writing shall be obtained from the Engineer. No wire shall be drawn into any conduit, until all work of any nature, that may cause injury to wire is completed. Care shall be taken in pulling the wires into the conduits. The conduits shall be thoroughly cleaned of moisture, dust, dirt or any obstruction by forcing compressed air through the conduits. The minimum size of PVC FRLS Insulated copper conductor wires for all sub-circuit wiring for light points shall be 1.5 Sq.mm.

All inspection boxes shall have a minimum depth of 65 mm. and shall be of circular nature (Dia 50 mm.) They shall have a cover securely fixed through screws and shall be fixed flush with the wall.

Mains and Sub-Mains Wiring

Mains and sub-mains cable or wires called for shall be of rated capacity and Approved make. Every main and sub-main wires shall be drawn into an Independent adequate size conduit. An independent earth wire of the proper Rating shall be provided for every single phase sub-main. For every 3 phase sub-Main, 2 Nos. earth wires of proper rating shall be provided along with the sub-Main. Where mains and sub-mains cables are connected to switch gear, sufficient extra length of cable shall be provided to facilitate easy continuous and Maintenance.

Load Balancing

Balancing of circuits in three phases installation shall be planned before the commencement of wiring and shall be adhered to.

Conduits must be placed inside conduit sleeves at all expansion joint crossings.

Conduit sleeves shall be provided at all beams to take point wiring conduit, so as to avoid the bend.

Circuit Wiring

Circuit wiring shall mean the length of wiring from the Distribution Board upto the tapping point for nearest first point of that circuit - viz upto the nearest first switch board measured along the run of wiring. Such wiring shall not be measured on linear basis. The cost of Circuit mains shall be included in the point wiring rate itself.

Sub-main wiring shall mean the length of wiring from one main / distribution
switchgear to another main/distribution switchgear measured along the run of wiring. Such wiring shall be measured on linear basis.

Lights, 6A sockets, Ceiling fans and Exhaust fans may be wired on a common circuit. Such circuit shall have 10 points of light, ceiling and exhaust fan and socket outlets or a load of 800 watts, whichever is less. A switch board might have more than two circuits but should be of same phases.

The smallest copper conductor to be used for lighting circuits shall be 2.5 Sq.mm. and for power circuits 4 Sq.mm. Wiring shall be done in the "looping system" and neutral conductor can be looped from the ceiling fan and exhaust fan or socket outlet. Neutral conductor and earth continuity wire shall be brought to each switchboard situated in rooms and halls. These shall be terminated inside the switchboards with adequate size to accommodate one number 6Amps socket outlet and control switch in future.

Conduit Wiring

In this system of wiring, no bare or twist joints shall be made. In through run of cables, if the length of final circuits / sub main is more than the length of the standard coil, joints shall be made by means of approved mechanical connector in suitable and approved junction boxes.

The chases in the wall shall be neatly made and ample dimensions to permit the conduit to the fixed in the manner desired. In case of buildings under constructions, conduits shall be buried in the wall before plastering. These shall be grouted and covered with cement and mortar, neatly finished at the plate of the un plastered brick work and scratched for providing key to the plaster and cured. Under no circumstances finished plastered surfaces shall be allowed to be chased for

the conduit work. Before taking up chasing of the wall, the routes shall be marked and got approved by the Engineer. The horizontal chases shall be avoided as far as possible. In case of exposed brick/rubble masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work.

All conduits after erection shall be tested for electrical continuity.

Fixing of standard bends or elbows shall be avoided as far as practical and all curves maintained by bending the conduit itself with a long radius which will permit easy drawing conductors. All thread joints of conduit shall be treated with some approved "preservation compound" to secure against rust.

Pipe runs between outlet and outlet or between outlet and equipment shall not contain more than two 90 Deg bends (180 Deg total) including those bends located immediately at the outlet or fittings. Straight run of cables in pipes shall be limited by provision of approved type of pull boxes once every 15 mts.

Insulated type end bushings shall be used where conductors enter or leave pipes.

To facilitate pulling of cables in pipes, powdered soft, stone, plastic soap or other dry inert lubricant may be used but grease or other material harmful to the cable sheathes shall not be used.

Ends of MS Pipe shall be cut square and the threads cut in the field shall have the same effective length and the same dimensions and taper as specified for factory cut threads. Ends of pipe shall be reamed to remove burrs and sharp edge after threads are cut.

All joints shall be made tight with a minimum of 5 boxes, panels, cabinet etc. by means of one lock-nut outside and one inside and shall be provided with bushing of approved insulating materials unless the pipe is directly screwed into a thread hub in the box.

In damp locations the entire pipe system, including all boxes and fittings used, shall be made water-tight and the pipe shall be so mounted on spacers so as to leave minimum of about 6mm. gap between the MS pipe and the surface over which it passes.

A minimum separation of 700mm. shall be maintained between hot pipe lines and electrical pipelines. Also where required, electrical pipe shall be properly shielded from direct heat.

The termination of MS Pipe in rotating machines subject to vibration as well as connections to equipment required to be disconnected at periodic intervals shall be made by means of flexible pipes. Flexible metallic pipes shall also be use for termination of connection to limit switches, level switches, pressure switches etc. The equipment where the direct termination of rigid pipe is inconvenient, the termination can be done by means of flexible pipe. The use of flexible pipe in outdoor location shall be avoided as far as practicable.

Flexible pipes shall be of liquid tight galvanized heavy duty interlocked type generally conform to IS : 3480-1966 with PVC Jacket extruded over the pipe. The adapter for coupling rigid MS Pipe to flexible conduit and termination to equipment shall be of either cast aluminium or galvanized sheet steel.

Suitable junction/inspection boxes according to requirements shall be provide to permit periodical inspection and to facilitate replacement of wires. However, such boxes shall be located and arranged so that they are not in-irregular postures. These locations shall also be specifically

shown in the conduit layout of the shop drawings and approval shall be obtained before installation.

However, such installation and the number of such boxes shall be minimizing. The boxes shall be mounting flush with the wall or ceiling. Minimum 65mm. depth junction boxes shall be used in roof slabs and depth of boxes in other places shall be as per IS : 2667-1977. All outlets such as switches wall, sockets etc. shall be flush mounting type.

Conduit Capacity

Maximum number of PVC FRLS insulated cable conforming to IS:694 that can be drawn in one conduct shall be as follows:-

Nominal cross section area of conductor in Sq.mm.	Size of conduit									
	25mm		32mm		38mm		51mm		64mm	
	S	B	S	B	S	B	S	B	S	B
1.50	10	8	18	12	-	-	-	-	-	-
2.50	8	6	12	10	-	-	-	-	-	-
4	6	5	10	8	-	-	-	-	-	-
6	5	4	8	7	-	-	-	-	-	-
10	4	3	6	5	8	6	10	7	12	8
16	2	2	3	3	6	5	8	6	9	7
25	-	-	3	2	5	3	6	5	8	6
35	-	-	-	-	3	2	5	3	6	5
50	-	-	-	-	-	-	4	3	5	4
70	-	-	-	-	-	-	-	-	-	-

The columns headed S applies to run of conduit which have distance not exceeding 4.25mm between draw in boxes and which do not deflect from the Straight by an angle or more than 15 degrees. The columns headed `B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.

Switches and Accessories

All switches shall be placed in the live conductor of the circuit and no single pole of fuse shall be inserted in the earthed neutral conductor of the circuit.

Single pole switches (other than for multiple control) carrying not more than 16Amps may be of the piano key type / moulded plat type and the switch shall be `ON' when the knob is down.

The switch box shall be made of metal on all sides, except on the front. In the cases of cast iron boxes wall thickness shall be at least 3mm. and in case of welded mild steel sheet boxes the wall thickness shall not less than 18 gauge for boxes upto a size 20 cms x 30 cm. above this size 16 gauge MS boxes shall be used. Except where otherwise stated 3mm. thick phenolic laminated sheets shall be fixed on the front with aluminium alloy/brass/cadmium plated iron screws as approved by Site Engineer. Clear depth of the box shall be minimum 60mm.

To facilitate drawing of wires in the conduit, GI Fish wire of 16 SWG shall be provided while laying recessed conduit.

Point wiring shall include all works necessary to complete wiring of a switch circuit of any length from the tapping point on the distribution circuit to the following (via the switch).

- Ceiling rose or contractor (in the case of ceiling / exhaust fan points)
- Back plate (in case of fluorescent fitting with down rods etc).
- Socket outlet (in the case of socket outlet points)
- Lamp holder (in case of wall brackets, bulkhead and similar fittings).
- All civil works like chippiding, making good the damages, drilling holes in walls etc., are to be done by the contractor only.
- The following shall be deeming to be including in the point wiring:-
- Switch
- Ceiling rose or connector as required
- Any special or suitable round block for neatly housing the connector and covering the fan hook in case of fan point.
- Bushed conduit, MS Sleeves where cables or pipes passes through wall etc.
- Earth wire from three-pin socket outlet point/fan regulator to common earth including earth dolly.
- All wood or metal blocks, boards and boxes sunk of surface type, including those required for mounting fan regulator but excluding those under the main distribution switchgear.
- All fixing accessories such as clips, rails screws, raw plugs, wooden plugs etc. as required.
- Connections to ceiling rose, connector socket outlet, lamp holder, switch and fan regulator etc.
- Looping the same switchboard interconnections between points on the same circuit.
- Providing fish wire in conduits while recessed circuiting work is undertaken.

Length per Point

The term "Length per point" in point wiring in the case of the fan and light points shall mean the distance between the switch and ceiling rose, connector or back plate, lamp holder depending upon the fitting, measured along the run of wiring irrespective of the number of wires in the run.

In the case of socket outlet points, the length shall mean the distance between the socket outlet and the tapping point of live wire on the nearest switchboard.

Measurement of Point Wiring

Points because of length per point inclusive of circuit mains shall be classifies
Under:

a)	Average point	:	Length per point not exceeding 10Mtrs.
b)	Special point for Light, Fan and 5A socket outlet points	:	Length per point exceeding 10Mtrs

The rate for average point shall be on a per point basis.

For special points, the extra length of wiring over and above the length of Meters specified shall be measured and paid for. Rate for the same shall be given in the offer separately.

In case of points with more than on light point controlled by the same switch, they shall be measured on a set basis (i.e.) Two lights controlled by one switch shall be considered a set and so on. The distance between the first point and subsequent point shall not be more than 5mts. In case of more than two lights controlled by one switch only the average distance between light points shall be considered.

Additional Consideration for Internal Wiring

The minimum size of pipe shall be 25mm. dia only. The wall thickness shall 2mm. only. The chases in the wall shall be neatly made and in ample dimensions to permit the conduit to be fixed in the manner desired. In case of buildings under construction, conduits shall be burried in the wall before plastering. These shall be grouted and covered with cement and mortar, neatly finished at the plane of the unplastered brick work and scratched for providing key to the plaster and
cured. Under no circumstances finished plastered surfaces shall be allowed to be chased for the conduit work. Before taking up chasing of the wall the routes shall be marked and got approved by Engineer. In case of exposed brick/rubble masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work.

Earthing

Selection and Installation of System and Equipment Earthing

The method adopted for system as well as equipment earthing shall be in accordance with the code of practice for earthing IS:3043-1987 and shall also comply with the relevant clauses of Indian Electricity Rules.

For Plant building and Switch/Control room one main earthing ring shall be provided along the plant/building periphery connected to required number of earth electrodes. The earthing ring shall be taken 1500mm away from building column/wall and shall be laid directly buried in ground. Main earthing ring shall be further cross-connected and a mesh formed depending layout and location of the equipment. The cross-connections shall generally run in cable trenches, or embedded in concrete floor based on the layout. For buildings having a number of floors, separate earthing rings shall be established in each floor.

All non-current carrying metallic parts of various electrical equipment as well as cable armouring metallic conduit/GI pipe system, cable racks/trays brackets, supporting structures etc. shall be effectively earthed. Earthing of medium and high voltage equipment shall be done by means of two separate earth conductors connected either directly to earth electrodes or to an earthing ring irrespective of use of armoured cable or metallic conduit/GI pipe.

Building/technological steel structures, metallic utility pipes shall not be used as earth continuity conductor.

All earthing system shall be so designed as to ensure effective operation of protective gears in case of earth faults. The total earth resistance at any point of the earthing system for substations and main plan buildings shall not be more than one ohm. However, at other points the value shall not exceed 5 ohms.

The earth resistivity values of soil will vary in different areas of the site. For all substations and main plant buildings, number of electrodes to be provided for the earthing system shall be decided after actual measurement of soil earth resistivity at that location. However, after complete installation actual earth resistance shall be measured in all cases and, if required, additional electrodes shall be

provided to achieve the values indicated above. No earth ring shall have less than two earth electrodes.

Earth copper plate shall comprise 600mm x 600mm x 6mm Copper plate at a depth of 3000mm in an earth pit chamber of 600 x 600 x 250mm .

Generally, main earthing rings and earthing leads shall be directly buried in ground. Additional earthing rings wherever provided inside plant buildings/substations and earth continuity conductors shall be taken either exposed on cable racks/trays, structures, walls, ceiling etc. or embedded in concrete depending on installation. Earth conductor directly buried be taken at a depth of 600mm. and shall be provided with one coat of bituminised paint, at all welded joints to prevent corrosion. Earthing ring wherever embedded in concrete shall be laid parallel to the column rows of buildings. Earth continuity conductor embedded in concrete shall generally follow the shortest route and wherever possible shall be taken along pipes embedded for laying of cables. Earth conductors laid on cable racks, trays etc. shall be placed in accessible location keeping adequate clearance to facilitate easy connections. Earth conductors laid along plant/equipment structure, wall, ceiling etc. shall maintain symetry with other installations and shall be uniformly spaced with cables/utility pipes running along the same route. Galvanised MS Saddles shall be used for clamping earth conductors on structures, wall ceiling etc. Flats shall be supported at intervals of 500mm. Welding shall be done wherever earth flats are to be run through rack/cable tray.

As far as possible all earth terminations and connections shall be visible for inspection. Each earthing system shall be so designed that testing of individual earth electrode is easily possible. For earth bus embedded in floor slabs, stub-ups shall be provided at convenient locations near the equipment as well as building columns for connecting earth continuity wires leading to the equipment and structures.

Alternate columns of structural buildings shall be connected to earthing ring.

Where the power to the equipment is fed flexible training cables, the same shall contain one separate earth continuity conductor having the same cross section as that of the current carrying conductor. Earth connections to equipment subjected to movement, vibrations and shocks shall be made by stranded wire having enough loop.

Connection of earthing leads to earth electrodes and terminations of flat earth continuity conductors to equipment shall be made by means of bolting. Connection of stranded earth wire to earth bus as well as to equipment shall be made through crimping type lugs and bolting. Jointing and tapping of flat earth conductor shall be done by means of welding. Termination of earthing flats to building structures, shall be done by means of welding. Termination of earthing flats to building structures, shall be done by means of welding.

Cable screens and armours shall be bonded to earthing system in accordance with IS:1255. Also, metal pipes and conduit system carrying cables shall be bonded and effectively earthed.

Earth conductors shall be kept electrically separated from the metal work of surface pipes which are carrying gases or inflammable liquids.

In explosive and hazardous locations like gas pipelines, fuel oil tanks etc. provisions shall be made for protection against static discharge by suitably connecting the equipment to an earthing system, which is segregated from the Hospital earthing system.

Conductor size adopted for earthing ring shall in no case be less than that of the earth continuity conductors connected to it. The size of earthing leads connected to earth electrodes shall not be less than that of the earthing main.

Conductors used for earthing shall be in no case have cross sectional area less than 4 sq.mm. Stranded GI wire.

All 3-phase equipments shall have duplex earthing. Whereas single-phase equipments shall have only one run.

The minimum size of galvanized GI flat/wire for earthing of various equipment shall be as follows unless otherwise specified-

- Power control centers auxiliary power distribution boards, etc. - 50 x 6 mm
- Sub Power Control Centers – 25 x 6 mm
- Power / Lighting Distribution Boards – 4.0Sq.mm PVC Insulated copper wire

Clearance and Safety

For every electrical switchboard, control panel, power control centers etc., that Require back access the space behind the equipment shall generally be 50mm. This space shall also be adequate to permit at least a 90 Deg. opening of doors or Hinged panels. In such cases where back clearances are provided, there shall be a Passage-way from either end of the equipment clear to a height of 1800mm. Where the equipment are not required to be attended from the back, if Equipment shall be placed along the wall / structure having clearances less than 200mm.

For all switch boards, control panels, power control centers, a clear space of Not less than 1200 mm. shall be providing in front of the equipment. In case, Where the equipment is, provide with draw out unit, a minimum clearance of 2,000mm shall be providing.

For all electrical equipment, minimum clearance headroom of 500mm shall be providing.

All motors located away from the feeding and control panels and for which control desk of posts are not within visible location, shall be provided with readily accessible and easily operated, locally mounted lockable type `stop' pushbuttons in the control circuits.

All electrical equipment operating on 415 V or higher voltage shall be provide with caution notice boards of approved type and shall be affix permanently in a conspicuous position. Where a group of equipment is located within a switch / control room or within a fenced area, the notice board shall be fixed at the entrance.

All moving parts of the equipment that are exposed and liable to cause hazard to the operating and maintenance personnel shall be suitably protected by metallic guards.

In front of the entire switch board rubber mats shall be provide for personnel safety.

Open type control panel or open type busbars shall not be install inside the plant building.

In accordance with the requirement of the Indian Electricity Rules, the following shall be providing

- Danger Boards and shock treatment charts in two languages viz. English and Tamil.

- 750mm wide, tested rubber mats of thickness not less than 19mm shall be provide in front of all switchboards and control panels in accordance with IS 15652:2006 IEC 61111:2009

Tests and Equipments / Installation

GENERAL

The Purchaser / Engineer shall have the right to Inspect / Witness on the equipment or any part there of at various stages of fabrication. Manufacture, sub-assembly, assembly and testing, erection and commissioning. Inspection / test shall be carried out at the supplier's works / his sub – contractor's works and at site as specified.

Inspection of equipment by the Purchaser / Engineer shall be only with a view to ensure that the equipment is fabricated / manufactured, assembled, tested, supplied and commissioned as per approved drawings and prescribed specifications.

Inspection by the Purchaser / his representative shall in no way relieve the supplier of his responsibilities as per the contract and shall be in no way binding on the purchaser / engineer.

Immediately after order placement, the Purchaser / Engineer shall in consultation with the supplier draw up a detailed inspection schedule to fix up the procedure and timing of inspection of various materials components, sub-assemblies, assemblies testing etc.

The supplier shall not despatch any materials from his works until they have been inspected and accepted by the Purchaser / Engineer by issuing a provisional acceptance certificate.

The supplier shall intimate the Purchaser / Engineer at least 2 weeks in advance before any material is ready for inspection /tests. The supplier shall list out all such material / items with their respective weights.

The supplier at his own expense provide free and safe access and all necessary facilities, equipment etc., to facilitate inspection by the Purchaser / Engineer.

Immediately after approval of drawings / documents, the supplier shall give 4 sets of all such drawings / documents to the Purchaser to enable the Purchaser / Engineer to carry out inspection of the equipment.

Purchaser / Engineer may reject the whole or any part of the equipment at any time if after inspection / testing. Purchaser / Engineer at their sole discretion determine the equipment or any part there of to be unsatisfactory or does not fulfil the terms of the contract, Purchaser's / Engineer's decision regarding rejection shall be final and binding on the supplier.

Routine and type test certificates shall be submitted for approval on completion of the tests. Number of copies required for approval and procedure of submission shall be intimated to the supplier.

On successful completion of erection / installation, each item / equipment will be thoroughly inspected by the Purchaser / Engineer for correctness and completeness of installation.

The Site tests, pre commissioning tests and commissioning tests shall be carried out in the presence of the Contractor and the Purchaser / Engineer.

The Contractor shall provide Purchaser/ Engineer with complete test report in a form approved by the Engineer / Purchaser.

Test results obtained at site shall be compared with factory test results to ensure the condition of the equipment.

TESTING

Manufacture's test certificates shall be furnished by the supplier for all bought out materials, components etc.

Wherever such test certificates are not available, the item shall be got tested by the supplier at his own expense at the government recognized laboratories mutually agreed upon.

The main equipment and components shall be carefully examined to determine their conformance with this specification with respect to material and workmanship, finish marking, dimensions, arrangement, and to assess its conformance with other requirements stated or reasonably implied and not covered by specific tests.

Complete tests shall be made in factory by the contractor to ensure that the performance and operating characteristics of the equipment are satisfactory and to determine whether or not guarantee have been met.

At the conclusion of all test procedure the equipment shall be examined for signs of wear, cracks, distortion or incipient damage of any sort and any defects shall be corrected before the equipment is shipped / commissioned.

In the event of failure of the product or any part thereof to fully meet any inspection or test requirement specified, the Contractor shall notify the Purchaser / Engineer, if he wishes to repair and / or use such product or part.

The tests to be carried at Works / Site for various items shall be as indicated against each item.

Factory inspection shall be carried for power panel of 415V supply and HT Panel

POWER DISTRIBUTION BOARDS / LIGHTING DISTRIBUTION BOARDS

Routine tests as per applicable standards shall be carried out at Contractors' works. The minimum tests at works and at site shall be as follows:-

A. AT WORKS

a) Power frequency high voltage withstand test.

b) Insulation Resistance Test.

c) Dimensional tests

d) Operational Tests

e) Tests to prove interchangeability of similar parts

B. **AT SITE**

a) Power frequency high voltage withstand test.

b) Insulation Resistance Test.

c) Operational Tests

d) Tests to prove interchangeability of similar parts.

TESTING AND COMMISSIONING OF POWER DISTRIBUTION EQUIPMENTS.

In addition to the checks and tests specified earlier or later the following shall be applicable for all Power Distribution equipments.

After installation but before any power supply in connected, the contractor shall make a complete mechanical and electrical check of the system. These shall include, but not restricted to the following:-

MECHANICAL CHECKS

Visually inspect all equipment / items for defects if any, and check equipment numbers against approved drawings to ensure that equipment has been correctly located and proper installation is done.

Check, name plate details and wiring diagrams indicated on the equipments viz switch boards, disconnecting switches load break switches, PDBs, etc., for conformity with the data given in approved drawings.

Check that all moving parts, drive motors, linkages in the disconnecting switches, breakers are properly lubricated by approved / recommend type of lubricant.

Check for mounting of all separately supplied accessories against approved GA Drawings for equipment viz. Breaker, disconnecting switch, busduct, Rising Main etc.

ELECTRICAL CHECKS

VISUAL / MECHANICAL

a) Check for the phase sequence from Transformer, LT Busduct and LT Switch Board.

b) Check for proper bus joint and connections for tightness

c) Check all power cable connection for tightness and proper support.

d) Check drive motors turn freely by hand.

e) Check padlocking of all operating cabinets.

f) Check proper gasketing of outdoor, installed equipment, operating cabinets etc. Busduct end terminations, inspection openings, joints between standard erections, Switchboards, PDBs, DBs.

VISUAL / ELECTRICAL

a) Check all plug in contacts for alignment and grip for HT and LT Breakers.
b) Clean moving and fixed contacts of LT Breakers, Contactors, and Switch Fuse Unit with CRC 2 – 26.
c) Check the rating of Power and Control Fuse against approved drawings. Fuses shall be undamaged and fit for service.

d) Check for voltage rating of auxiliary equipment viz. Closing and tripping coils of breakers, auxiliary supply of all protection and auxiliary relays, spring charging / power drive motors against approved drawings.
e) Insulation resistance tests as IS 2259 1963

TESTS FOR INTERNAL WIRING

AT SITE

Insulation Resistance Tests at

a) Individual circuits
b) Individual MCB and FUSE DISTRIBUTION BOARDS
c) Each Panel Boards, Sub – Panel Boards
d) Main Incoming ACBs

NOTE:

All tests shall be carried out with final appliances / equipments connected and disconnected and with 1000 V Megger.

Conditions of Contract

The quoted rates shall be inclusive of all Liaisoning / Incidental charges with the respective departments wherever applicable and No additional charges will be given. Scope includes preparation, submission of Application Forms and other associated works with necessary documents and working drawings to CEIG / CEA / TANGEDCO / TNERC / MNRE & TEDA for obtaining approval for drawing and getting Safety Certificate, approval for Energisiation, availing service connections as per Single Line Diagram

The existing walls shall be cut to conceal the conduits.

After installation of concealed conduits, repair patchwork and repainting of all damaged surfaces to mach existing finish shall be carried out

Repainting of all walls and ceilings to restore finish surfaces, where the electrical work has occurred shall be done.

The complete ratings of each equipment, the main service panel, branch circuit panels, quantity and sizes of conductors shall be included in the relevant as built drawings.

Separate as built lighting and power layouts shall be provided.

Floor plans shall be drawn in 1: 100 scale and the details of main electrical room etc. shall be provided 1: 50 scale.

All metallic housings, panel boards, junction boxes, pull boxes, receptacles, Lighting outlets, switches, metal conduits and other non – current carrying Metallic bodies shall be bonded with equipment grounding conductors.

It shall be ensured that the ground resistance is less than 05 Ohms.

After installation, the ground resistance of the installed grounding shall be tested and ensured that it is 05 Ohm or less.

All neutral conductors are isolated from the ground down stream from the Main Service Panel

It shall be ensured no other conductor shall have white or grey and green Color insulation other than the neutral and ground respectively as indicated above.

It shall be ensured that the installation contractor obtains the necessary construction permits from the city or local authorities as required

All drawings, specifications, Bill of Materials, Bill of Quantities, cost estimate and other information shall be provided only in English Language which is only acceptable.

All Manufacturer / Type and ratings of main distribution panels are included in the one line diagram

TECHNICAL SPECIFICATIONS FOR ON GRID SOLAR PANEL SYSTEM

Solar PV Modules

The cell of the modules shall be polycrystalline. The capacity shall be considered as **320 Wp** per module. The PV modules shall qualify IEC-61215 or IS-14286 and IEC-61730. The proposed PV modules have test certificates issued from accredited test laboratories of MNRE (Ministry of new and renewable energy). Test certificates issued by IEC accredited laboratories are also acceptable. The proposed PV modules shall be manufactured in India.

Each PV module used in this project must use an RF (Radio frequency) identification tag. The information must be mentioned in the RFID tag used in each module as per guide lines of MNRE which must be inside the laminate and able to withstand harsh environment condition.

If higher capacity Solar Power Panel (> 320Wp) is used, the quantity of solar panels should be such that the total power output (10 kWp, 15 kWp, 20 kWp & 30 kWp) is maintained.

Technical specification of the PV Module shall include but not limited to the following:

Sl. No	Item	Description
1.0	Certification	i) IEC 61215 or IS 14286 ii) IEC 61730
1.1	Test certificate issuing authority.	NABL/ IEC Accredited Testing Laboratories or MNRE accredited test centers (preferably the latest).
2.0	PV Cell	
2.1	Type	poly crystalline
2.2	Size	156mm x 156mm
3.0	PV Module	
3.1	Rating at STC	320Wp, 72 cells (without any negative tolerance)
3.2	Efficiency	Minimum 16%
3.3	Fill factor	Minimum 70%
3.4	Withstanding voltage	1000V DC
3.5	Glass	Toughened
3.5.1	Thickness	3.2 mm (minimum)

3.5.2	Type	High transmission, low iron, tampered & textured
3.6	PV Module Junction Box	
3.6.1	Protection level	IP 65 or above
3.7	Bypass Diode	
3.7.1	System Voltage (Vsys)	1000 V dc
3.7.2	Number	3 numbers
3.8	Module Frame	
3.8.1	Type	Anodized aluminum frame

3.0 PV Array

Specification of the PV Array shall include but not limited to the following:

Sl. No	Item	Description
1.0	Nominal Capacity	10kWp, 15 kWp, 20 kWp & 30 kWp.
2.0	PV Module interconnection connector	MC-4
3.0	PV Module interconnection cable and array cable	PV 1-F standard / NEC standard "USE-2 or RHW-2" type (double insulated)
4.0	PV array String Voltage	Compatible with the MPPT Channel of the inverter
5.0	Number of Parallel String against	02 Nos (Maximum)

4.0 Array Structure

i) PV Array shall be installed at the Roof top of the Indian Bank, Branches / buildings at the respective Locations given in the tender.

ii) PV Array structures shall be of GI with combination of either of I, C, L or T sections MS flat as per structure design requirement. The structure should be capable of withstanding a wind load of 180 km/hr after installation (Structural design document to be submitted by the contractor)

iii) Weight of the Metallic part of PV Array structure excluding nuts and bolt must be minimum same as the Weight of the total PV Module.

iv) Structural shall be corrosion resistant and electrolyticaly compatible with the materials used in the module frame, its fasteners, nuts and bolts.

v) The array structure shall be made of hot dip galvanized MS structure of minimum galvanizing thickness 120 micron (Test certificate to be submitted by the contractor from standard testing laboratory to prove the thickness of galvanization)

vi) Structures shall be supplied complete with all members to be compatible for allowing easy installation.

vii) The module mounting structure shall have to be designed and fabricated with optimum tilting angle considering the site conditions.

viii) The s structure shall be designed for simple mechanical a n d electrical installation. It shall support Solar Photo Voltaic modules at a given orientation, absorb and transfer the mechanical loads to the ground.

ix) All fasteners for supporting conduits, nut & bolts shall be made with stainless steel of grade SS314 except foundation bolts and the nuts and bolts to be used for connection of earth strip with module mounting structure which will be of MS (GI Coated).

x) Supporting structures including module Mounting structure shall have to be adequately protected against all climatic condition. The array structure shall support SPV modules at a given orientation and absorb and transfer the mechanical loads to the columns properly.

xi) The structures shall be designed for simple mechanical and electrical installation. There shall be no requirement of welding or complex machinery at the installation site. Required civil work or support platform is absolutely essential to install the structures, detailed engineering drawings and instructions for civil and other works shall got approved from the competent authority before carried out at the site.

xii) The Specification of the GI sections, flats must be as per IS 808

xiii) The supplier shall specify installation details of the PV modules and the support structures with appropriate diagrams and drawings.

5.0 PV Array Junction Box (AJB)

Array Junction Box (AJB) shall have to be used for termination of string prior connecting array with each inverter. The desired specification of the PV Array Junction Box and accessories shall include but not limited to the following:

Sl No	Item Description	Desired Data
1.0	Enclosure	
1.1	Degree of Protection	IP65 with UV Protected
1.2	Material	Polycarbonate.
1.3	Withstanding voltage	1000V DC
1.4	Withstanding Temperature	100 ^{O}C
1.5	Accessories mounting arrangement	DIN Rail
1.6	Number of Strings entry	As may be required
2.0	Cable Entry and Exit	
2.1	Position	Bottom at cable entry and exit
2.2	Cable Entry and Exit connector type	MC 4 Connector (PV Array String cable)
2.3	Cable gland	Earthing cable entry
3.0	Surge Protecting Device (SPD)	
3.1	Type	DC
3.2	Approved Make	ABB / OBO bettrman / Legrand
3.3	Protection class	Type B+C
3.4	Number of set	As may be required as per string Design
3.5	System Voltage	Matched with System Voltage 1000 V DC
4.0	Fuse with fuse holder	
4.1	Position	Positive and negative terminal for each series string
4.2	Type	Glass fuse, for PV Use only

4.3	Rating	Current: Minimum **1.25** times the rated short circuit current of the string Voltage: Minimum **1000 V DC**

6.0 Grid Connected Inverter

The inverters shall be of string inverter. The proposed 10kWp shall be connected solar PV power plant shall be connected with grid. As such, the inverters shall be compatible to operate with existing utility supply. The PV system shall comprise of **10 KVA (or higher) Solar Invertor**

Specification of inverter shall include but not limited to the following:

Sl. No.	Operating Parameter	Desired specification
1.0	Type	Grid connected String Inverter
2.0	Usage	Specially used for PV system
3.0	Standards	
3.1	Efficiency Measurement	IEC 61683/ Equivalent BIS Std.
3.2	Environmental testing	IEC 60068-2 (1,2,14,30) / Equivalent BIS Std.
3.3	Interfacing with utility grid	IEC 61727
3.4	Islanding Prevention Measurement	IEC 62116
3.5	Type Test certificate issuing authority **(for item no 3.1 , 3.2,3.3 and 3.4)**	NABL/ IEC Accredited Testing Laboratories or MNRE approved test centers.
4.0	**Input (DC)**	
4.1	PV array connectivity capacity	10,15,20,30 kWp (minimum)
4.2	MPPT Voltage range	Compatible with the array voltage
4.3	Number of MPPT Channel	2 no (Minimum)
5.0	**Output (AC)**	
5.1	Nominal AC Power output	10 ,15,20,30 kVA or as per site condition of approved capacity
5.2	Number of Grid Ph	3Ø
5.3	Adjustable AC voltage range	Programmable as per grid condition 360V-
5.4	Frequency range	47-53 Hz
5.5	AC wave form	Sine wave
5.6	THD	Less than 3%
5.7	Switching	High frequency transformer / transformer less
6.0	General Electrical data	
6.1	Efficiency (Maximum)	95 %
6.2	Sleep mode consumption	Less than 5 W
7.0	**Protection**	
7.1	DC Side	1. Reverse-polarity protection 2. Reverse current to PV array protection, over voltage, Under voltage protection

7.2	AC side	1. DC inject protection to grid less than1% 2. Over voltage and Under voltage 3. Over current 4. Over and under grid frequency protection, 5. Anti Islanding protection
7.3	Isolation Switch	1. PV array Isolation switch (DC)
7.4	Ground fault detection device (RCD) which can detect changes in ground current. Rating shall be as suitable	To be provided for transformer less inverter.
8.0	Display	
8.1	Display type	If any
8.2	Display parameter	
8.2.1	DC	Voltage Current Power
8.2.2	On grid connected mode	Line status Grid voltage Grid frequency Export Power Cumulative Export Energy
9.0	Interface (Communication protocol)	Suitable port must be provided in the inverter for i) On site upgrade of Software, ii) On site dumping data from the memory, iii) Web based remote monitoring system
10.0	Web monitoring	Matched with the monitoring and data logging system
11.0	Mechanical Data	
11.1	Protection Class	IP 65 or higher
11.2	Operating ambient temperature	$0\ ^0$ C to 60^0C
11.3	Cooling	Natural / forced cooling

7.0 Web enable on line data logger and Remote Monitoring Unit:

Web enable data logging system may be an integrated part of the inverter or a separate unit. The data logging system includes **MPPT wise PV array monitoring** system also. The data Logger should have the provision of recording **the data of solar insolation (the amount of solar radiation reaching in a given area), PV cell temperature and ambient temperature and associated electrical parameters** at different stages to study performance of system as well as to study status of the system at a particular instant. The data logger should have required transducer to monitor and record the required system data. **The data logger should be provided with an insolation sensor and a module temperature sensor, ambient temperature sensor matched with the system**.

The data logger shall have reliable battery backup and data storage capacity (minimum two days data) to record all sorts of data simultaneously round the clock. Web based Remote Monitoring system must be compatible with data logger.

The Web based monitoring system should have the provision of graphical representation of the data shall include but not limited to the following:

7.a – Web based monitoring system:

Sl. No.	Operating Parameter	Desired specification
1.0	Input data	PV Power PV Energy
2.0	Meteorological data	Insolation Module Temperature Ambient Temperature
3.0	Output data	
3.1	Inverter	Export Power Export energy

All data shall be recorded chronologically date wise. The data file should be MS Excel/XML/PDF/or any readable form compatible and should have the facility of easy download.

8.0 ACDB Panel

Output of the Inverter shall be terminated in ACDB Panel (indoor wall mounting type) through 32/63/100/125 Amps 415V 4 pole MCCB at the incoming side (Inverter side). The outgoing side (Grid side) shall be connected to the spare feeder available in the Main MV panel at the basement through 32/63/100/125 Amps 415V 4 pole MCCB. The set of AC surge suppressor (Surge protection Device) shall be connected at the outgoing bus.

9.0 Energy Meter: (As per TNERC Order No: 03 dated 25/03/2019)

Two nos of Energy Meters to be installed. One is for measuring solar power generation and the other is to measure import and export of energy. The First Meter, Solar Generation Meter shall be placed after the invertor at the ground floor of the premises to facilitate easy access for meter reading. The Second meter shall be bi-directional meter which will replace the existing meter at the branch and used for commercial settlement of energy imported and exported. The First and second meter will have to be installed at the same location where existing meter for recording consumption of energy is installed.

The cost of new/additional meters provided for the net feed-in scheme and the installation and testing charges shall be borne by the Bank (Invoice of M/s TANGEDCO to be submitted in this regard). For Procurement of Meters the distribution licensee (M/s TANGEDCO) shall procure, test and install the meters. However Liasoning with M/s TANGEDCO for procurement and installation of Energy Meters at the site to be done by the contractor only (as per Price Bid (SlNo:13)).

If M/s TANGEDCO or M/s TNERC hosts the lists of manufacturers of energy meters in their website, the contractor shall procure the energy meter from the market (in the same Technical Specification and rate prescribed by M/s TANGEDCO) (Purchase Bill of the Energy Meter in the rate prescribed by M/s TANGEDCO to be submitted to the Bank). The Positioning, sealing, testing, commissioning of energy meters will be guided by the same provisions as applicable to consumer meters in the Central Electricity Authority's metering regulations. The Contractor is wholly responsible for liaisoning with M/s TANGEDCO during the calibration, testing & commissioning of energy meters procured by them as per the Technical Specifications. The liaisoning rates shall be quoted in the Price Bid (Sl No:13).

10.0 Cables & Wirings:

The Specification of wiring material of PV Power plant shall include but not limited to the following:

Sl No	Item	Description
A	DC Cable	
1.1	Conductor	Tinned annealed stranded flexible copper according to IEC 60228
1.2	Standard	PV-1F / 2 PfG 1169/08.2007 / VDE Standard
1.3	Make	LAPP/Top Solar/Nexans/ Schneider
B	AC Cable	
2.1	Rated Voltage	1.1Kv
2.2	Construction	
2.2.1	Type	Armored or unarmored as per
2.2.2	Conductor	Stranded flexible copper
2.2.3	Insulation	PVC
2.2.5	Standard	IS : 1554 -1
2.3	Make	Polycab/KEI/Finolex/Havells/RR cable or equivalent
C	PVC Conduit tees, bends etc (Hard & flexible)	
3.0	Standard	ASTM D 1785 u PVC
3.1	Ambient Temperature	0 ^{O}C to 50 ^{O}C
3.2	Type	UV stabilized , temperatures, Shock proof
3.3	Make	Oriplast /Supreme or equivalent
D	GI Pipe	
2.0	Make	TATA- B class

Notes:

(i) All the Array Junction Boxes shall be located at the rear side of the solar array.

(ii) The equipment / structure of the equipment fixed on the array structure then suitable insulation must be provided between Array structure and the equipment and equipment structure.

(iii) The minimum clearance of the lower edge of the equipments from the developed ground level shall be maintained as standard practice.

11.0 System, Equipment, Array structure

i. Array Structure must be earthed with GI Strip

ii. The complete earthing system shall be electrically connected to provide return to earth from all equipment independent of mechanical connection.

iii. The equipment grounding wire shall be connected to one grounding electrode per PV power plant.

iv. Test point shall be provided for each earth pit.

v. An earth bus and a test point shall be provided inside the room / location where we are installing the inverter and combiner panel.

vi. Earthing system design should be as per the standard practices and conforming IS-3043.

vii. The earth electrode shall be as per relevant standard

viii. The Code of Practice Earthing shall be IS 3043:1987

ix. Necessary provision shall be made for bolted isolating joints of each earthing pit for periodic checking of earth resistance.

x. Minimum four (04) numbers of earth pits. Earthing Pit Cover Needs to be provided. The Resistance value of the each Earth pit should be submitted.

xi. Earth Grid must be made by inter connection of earth pit through GI Strip. The size of the GI earth strip must be minimum **25 x 3 mm**. The thickness of the galvanization should not be less than 610gr/M2.

12.0 Lightning Protection

Lightning protection shall be installed to protect the building and the solar panels / modules from lightning as per relevant IS Standard. Design shall be submitted for approval before installation

13.0 Signage:

Safety Signage: Safety Signage must be provided mentioning the level and type of voltage and symbols as per IE Rule at different position as may be required.

The Solar PV System Caution Stickers shall be fixed in the following locations.

(a) On the Main LT Panel were the solar power is terminated.
(b) Near PV Modules / Junction Box / Combiner panel / Inverter / Soar Generation Meter.
(c) And signage at locations as per the requirement of CEA/TANGEDCO

The above stickers shall be non-corrosive caution label with the following text:

WARNING – DUAL POWER SOURCE EB & SOLAR

The size of the caution label shall be min of 105mm (width) x 20mm (height) with white letters on a red background.

14.0 Provision for Module Cleaning

Module Cleaning: Necessary arrangement and equipment is to be provided to facilitate easy cleaning of the PV Modules

15.0 Fire Buckets and Fire Bucket holding stand

Fire Bucket of minimum quantity eight (08) numbers and Fire Bucket Stand of minimum quantity two (02) shall be provided at Array field. Each fire Bucket holding stand (Triangular type) shall have the arrangement to hold four (04) numbers of fire buckets. The Fire Bucket stand must be as per IS 2546. The stand shall be installed at the rare side of the PV Array. The minimum technical specification is a follows:

Bis Specification	IS 2546
Fire Bucket Capacity	10 Litres
Fire Bucket Body Material	Galvanized Mild Steel Sheet
Body Thickness	1 mm

16.0 Spares, Tools and Measuring Instruments:

The minimum number and different type of spares, tools and measuring instruments must be supplied under this project within the contract value. Also any special tools, spares, measuring instruments if required as may be shall be provided by the contractor within the contract value.

17.0 Operation and Maintenance (O&M)

i. Cleaning of solar modules with soft water, wet and dry mops: Monthly once (Yearly 12 Times). The Solar Panels to be cleaned monthly once as per the instructions of Banks Engineer. (The signed (Bank /Contractor) service report should be submitted monthly to Banks Engineer).
ii. DC String / Array and AC Inverter monitoring: Continuous and computerized.
iii. AC Energy monitoring: Continuous and computerized.
iv. Visual Inspection of the plant: As and when required.
v. Functional Checks of Protection Components and Switchgear:
vi. Inverter, transformer, data acquisition, energy meters and power evacuation checks: Monthly once.
vii. Support structure and terrace water-proofing checks:
viii. O & M log sheet shall be provided and maintained: Continuous and computerized.
ix. The repair/replacement work shall be completed within 72 hours from the time of identification / reporting of the fault.
x. A Monthly performance report of the plant inclusive of energy generation data shall be provided.

18.0 Warranties and Guarantees

Warranties and Guarantees

1	Solar Modules	10 years free replacement guarantee against material defect or craftsmanship
2	Solar Modules	90% power output for 10 years and 80% power output for 25 years
3	Inverter	Workmanship/product replacement - 5 years, service - 25 years
4	PV Array Installation	Structural -25 years
5	Balance of System / Plant – Parts and workmanship	Parts and Workmanship – 10years, service – 25 years
6	Power Evacuation and Metering Equipment	Workmanship / product replacement – 10 years, service- 25 years

19.0 Standards

Standards	
IEC 60364-7-712 - Electrical Installations of Buildings	Requirements for Solar PV power supply systems
IEC 61727 or similar	Utility Interface Standard for PV power plants > 10 kW
IEC 62103, 62109 and 62040 (UL 1741)	Safety of Static Inverters - Mechanical and Electrical safety aspects
IEC 62116	Testing procedure of Islanding Prevention Methods for Utility-Interactive PV Inverters
PV Modules	IEC 61730 - Safety qualification testing, IEC 61701 - Operation in corrosive atmosphere
IEC 61215	Crystalline Silicon PV Modules qualification
String/Array junction boxes	IP65, Protection Class II, IEC 60439-1, 3
DC/AC distribution boxes	Rated for IP54
Static Watt Hour Meter (AC)	IS 13779-1999
Central Inverter	Rated for IP54
Surge Protection Devices	Type 2, DC 1000V rated
PV Module/string/string combiner box interconnects	MC4 compatible. DC 1000V rated
All DC and AC cables, conduits, cable trays, hardware	Relevant IS
Earthing System	Relevant IS
PV Array support structure	Relevant IS
Lightning Protection	Relevant IS

.

GUARANTEED TECHNICAL PARTICULARS (GTP)

(to be completely filled and submitted along with technical bid)

PV MODULE (GTP)

Sl. No	Item	Specification (AS PER	AS OFFERED
1	Certification	i) IEC 61215 or IS 14286	
		ii) IEC 61730	
1.1	Test certificate issuing authority.	NABL/ IEC Accredited Testing Laboratories or MNRE accredited test centers (preferably the latest).	
2	PV Cell		
2.1	Type	poly crystalline	
2.2	Size	156mm x 156mm	
3	PV Module		
3.1	Rating at STC	320Wp, 72 cells (without any negative tolerance)	
3.2	Efficiency	Minimum14%	
3.3	Fill factor	Minimum 70%	
3.4	Withstanding voltage	1000V DC	
3.5	Glass	Toughened	
3.5.1	Thickness	3.2 mm (minimum)	
3.5.2	Type	High transmission, low iron, tampered & textured glass with anti reflective coating.	
3.6	PV Module Junction		
3.6.1	Protection level	IP 65 or above	
3.7	Bypass Diode		
3.7.1	System Voltage (Vsys)	1000 V dc	
3.7.2	Number	3 numbers	
3.8	Module Frame		
3.8.1	Type	Anodized aluminum frame	
4	**PV Module : MAKE offered**		

PV ARRAY (GTP)

For Solar Power Plant:

Sl. No	Item	Specification (AS PER TENDER)	AS OFFERED
1	Nominal Capacity	10 kWp	
2	PV Module interconnection connector	MC-4	
3	PV Module interconnection cable and array cable	PV 1-F standard /NEC standard “USE-2 or RHW-2” type (double insulated)	

4	PV array String Voltage	Compatible with the MPPT Channel of the	
5	Number of Parallel String against each MPPT Channel	02 Nos	

PV ARRAY JUNCTION BOX (GTP)

Sl No	Item Description	Specification (AS PER TENDER)	AS OFFERED
1	Enclosure		
1.1	Degree of Protection	IP65 with UV Protected	
1.2	Material	Polycarbonate.	
1.3	Withstanding voltage	1000V DC	
1.4	Withstanding Temperature	100 0C	
1.5	Accessories mounting	DIN Rail	
1.6	Number of Strings entry	As may be required	
1.7	Approved Make	Hensel/Spelsberg/ABB/Cooper busman	
2	Cable Entry and Exit		
2.1	Position	Bottom at cable entry and exit	
2.2	Cable Entry and Exit connector type	MC 4 Connector (PV Array String cable)	
2.3	Cable gland	Earthing cable entry	
3	Surge Protecting Device		
3.1	Type	DC	
3.2	Approved Make	OBO Betterman / ABB/ Legrand	
3.3	Protection class	Type B+C	
3.4	Number of set	As may be required as per string Design	
3.5	System Voltage	Matched with System Voltage 1000 V DC	
4	Fuse with fuse holder		
4.1	Position	Positive and negative terminal for each series string	
4.2	Type	Glass fuse, for PV Use only	
4.3	Rating	Current: Minimum **1.25** times the rated short circuit current of the string Voltage: Minimum 1000 V DC	

GRID CONNECTED INVERTER (GTP)

A) INVERTOR:

Sl. No	Operating Parameter	Specification (AS PER	AS OFFERED
1	Type	Grid connected String	
2	Usage	Specially used for PV	
3	Standards		
3.1	Efficiency Measurement	IEC 61683/ Equivalent BIS	

3.2	Environmental testing	IEC 60068-2 (1,2,14,30)	
		/ Equivalent BIS Std.	
3.3	Interfacing with utility grid	IEC 61727	
3.4	Islanding Prevention	IEC 62116	
3.5	Type Test certificate issuing authority (for item no 3.1 , 3.2,3.3 and 3.4)	NABL/ IEC Accredited Testing Laboratories or MNRE approved test	
4	**Input (DC)**		
4.1	PV array connectivity capacity	12 kWp (Min)	
4.2	MPPT Voltage range	Compatible with the array	
4.3	Number of MPPT	2 nos	
5	**Output (AC)**		
5.1	Nominal AC Power output	As per kWp at site	
5.2	Number of Grid Ph	3Ø	
5.3	Adjustable AC voltage range	Programmable as per grid condition 360V- 455V	
5.4	Frequency range	47-53 Hz	
5.5	AC wave form	Sine wave	
5.6	THD	Less than 3%	
5.7	Switching	High frequency transformer / transformer	
6	General Electrical data		
6.1	Efficiency (Maximum)	95%	
6.2	Sleep mode consumption	Less than 5 W	
7	**Protection**		
7.1	DC Side	1. Reverse-polarity	
		2. Reverse current to PV array protection, over voltage, Under voltage protection	
		3. Over current	
7.2	AC side	1. DC inject protection to grid less than1%	
		2. Over voltage and Under voltage	
		3. Over current	
		4. Over and under grid frequency protection,	
		5. Anti Islanding protection	
7.3	Isolation Switch	1. PV array Isolation	
7.4	Ground fault detection device (RCD) which can detect changes in ground current. Rating shall be as suitable for inverter	To be provided for transformer less inverter.	
8	Display		
8.1	Display type	-	
8.2	Display parameter		

8.2.1	DC	Voltage Current Power	
8.2.2	On grid connected mode	Line status	
		Grid voltage	
		Grid frequency	
		Export Power	
		Cumulative Export Energy	
9	Interface (Communication protocol)	Suitable port must be provided in the inverter	
		for	
		i) On site upgrade of Software,	
		ii) On site dumping data from the memory,	
		iii) Web based remote monitoring system	
10	Web monitoring	Matched with the monitoring and data	
11	Mechanical Data		
11.1	Protection Class	IP 65 or higher	
11.2	Operating ambient	0 0 C to 600C	
11.3	Cooling	Natural / forced cooling	
12	**MAKE offered**		

WEB BASED REMOTE MONITORING SYSTEM (GTP)

Sl. No	Operating Parameter	Specification (AS PER TENDER)	AS OFFERED
1	Input data	PV Power	
		PV Energy	
2	Meteorological data	Insolation	
		Module Temperature	
		Ambient Temperature	
3	Output data		
3.1	Inverter	Export Power	
		Export energy	

CABLES & WIRINGS (GTP)

Sl. No	Description	Specification (AS PER TENDER)	AS OFFERED
A	DC Cable		
1.1	Conductor	Tinned annealed stranded flexible copper according to IEC 60228 class 5	
1.2	Standard	PV-1F / 2 PfG 1169/08.2007 / VDE Standard E PV 01:2008-02 /Equivalent	
1.3	Make	LAPP/Top Solar/Nexans/ Schneider	

B	AC Cable		
2.1	Rated Voltage	1.1kV	
2.2	Construction		
2.2.1	Type	Armored or unarmored as per requirement	
2.2.2	Conductor	Stranded flexible copper	
2.2.3	Insulation	PVC	
2.2.5	Standard	IS : 1554 -1	
2.3	Make	RR Cable/ Polycab/LAPP/ Havell's or equivalent	
C	PVC Conduit tees, bends etc (Hard & flexible)		
3	Standard	ASTM D 1785 u PVC	
3.1	Ambient Temperature	0 0C to 50 0C	
3.2	Type	UV stabilized , temperatures, Shock proof chemical resistant	
3.3	Make	Oriplast /Supreme or equivalent	
D	GI Pipe		
2	Make		

ADDITIONAL SPECIAL TERMS AND CONDITION

1.0 Field Proven Inverter

The proposed string inverter must be field proven in Indian atmosphere. The string inverter of the proposed manufacturer must be used in any project in India and in operation on or before 31st December 2015. Also there must be a good maintenance setup of the proposed inverter manufacturer with having sufficient numbers of qualified service engineers (Degree / Diploma engineers) and well equipped set up with instruments, tools and tackles at Tamil Nadu or Salem city. The maintenance setup of the proposed inverter manufacturer may be inspected by authority, if required.

2.0 Equipment and Material

Equipment and material shall comply with description, rating, type and size as detailed in this specification. Equipment and materials furnished shall be complete and operative in all respect. All accessories, which are necessary for safe and satisfactory installation and operation of the equipment, shall be furnished. All parts shall be made accurately to standard gauges so as to facilitate replacement and repair. All corresponding parts of similar equipment shall be interchangeable. Contractor shall carefully check the available space and the environmental conditions for installation of all equipments available at site and shall design the system accordingly.

3.0 Mode of Execution

The PV power plant shall be procured as a complete package. The entire work shall have to be executed on **turnkey basis.**

4.0 Materials and Workmanship

Qualified, experienced people should be deployed to install the **PV Power Plant**. All materials shall be of the best quality and workmanship capable of satisfactory operation under the operating and prevailing climatic conditions of respective. Unless otherwise specified, they shall conform in all respect to the latest edition of the relevant code and standards.. The project must be supervised by a qualified Civil Structural Engineer/ Engineering firm and Electrical /Electronics Engineer so that the work shall be as per drawing and related IS/IEC Code. The work shall be performed confirming safety precaution of all level of worker execute the project. The name and the qualification of the project engineers must be submitted to authority after placement of order. **The qualification of the supervising engineers must be minimum diploma or degreed in respective stream.**

5.0 Testing and Inspection

- Material Inspection will be carried out after submission of all test reports /certificates and after completion of the manufacturing work, against formal intimation from the contractor. The contractor shall, give notice of any material being ready for testing and the authority Bank / Engineer-In-charge/ bank, if desired, shall attend at the contractor's premises and may proceed with the routine tests. The material shall have to be dispatched at site after inspection and clearance from the purchaser. The inspection setup and instruments must be provided by the contractor within the contract value. The necessary charges for Site Testing, Transportation, accommodation and any other expenses shall be borne by the Contractor only.

Factory Testing:

- **A Factory Test Report (FTR) shall be supplied with the unit after all tests. The FTR shall include detailed description of all parameters tested qualified and warranted. The report must contain measurement of phase currents, efficiencies, harmonic content and power factor, also should include all other necessary tests/simulation required. Tests may be performed at 25, 30, 75 and 100 percent of the rated nominal power.**

Site Testing:

a. The PCU shall be tested to demonstrate operation of its control system and the ability to be automatically synchronized and connected in parallel with a utility service.

b. Operation of all controls, protective and instrumentation circuits shall be demonstrated by direct test if feasible or by simulation operation conditions for all parameters that cannot be directly tested.

c. Special attention shall be given to demonstration of utility service interface protection circuits and functions, including calibration and functional trip tests of faults and isolation protection equipment.

d. Operation of start up, disconnect and shutdown controls shall also be tested and demonstrate. Stable operation of the PCU and response to control signals shall also be tested and demonstrated.

6.0 Commissioning

After the erection and testing of the equipment/works as per above, commissioning of the plant and works shall be carried out and here the term "Commissioning" shall mean the activities of functional testing of the complete system after erection and testing, including tuning or adjustment of the equipment for optimum performance and demonstrating to the Purchaser that the equipment performance meets the requirements of the specifications.

7.0 Comprehensive Warrantee and Maintenance

The contractor must ensure that the goods supplied under the contract are new, unused and of most recent or current models and incorporate all recent improvements in design and materials unless provided otherwise in the contract.

The warranty period **the complete PV Systems** will be **60 (sixty)** calendar months from the date of completion of Defects liability period of **one year** from date of commissioning of plant**.** The contractor shall remain liable to replace any defective parts that may develop in the plant of his own manufacture or that of his sub-contractors under the conditions provided **for** by the contract under proper use, and arising solely from faulty design, materials or workmanship, provided always that such defective parts as are not, repairable at site and are not essential in the meantime to the maintenance in commercial use of the plant are promptly returned to the contractor's works at the expense of the contractor unless otherwise arranged.

The maintenance includes Routine, Preventive, Breakdown & Capital Maintenance the details are as follows but not limited:

Routine, Preventive, Breakdown & Capital Maintenance:

8.0 Routine and preventive maintenance:

Routine and preventive maintenance shall include cleaning of PV Module on regular basis , checks and maintenance activities such as tightening of all electrical connections ,daily, weekly, fortnightly, monthly, quarterly, half yearly, and yearly basis which are required to be carried out on all the components of the power plant to minimize breakdowns and to ensure smooth and trouble free running of the power plant. The supplier shall be responsible to carry out routine and preventive maintenance and replacement of each and every component / equipment of the power plant and he shall provide all labour, material, consumables etc. for routine and preventive maintenance at his own cost.

9.0 Breakdown maintenance:

Breakdown maintenance shall mean the maintenance activity including repairs and replacement of any component or equipment of the power plant which is not covered by routine and preventive maintenance and which is required to be carried out as a result of sudden failure/breakdown of that particular component or equipment while the plant is running. The supplier shall be responsible to carry out breakdown maintenance of each and every component of the power plant and he shall provide the required manpower, materials, consumables, components or equipment etc. for breakdown maintenance at his own cost irrespective of the reasons of the breakdown/failure

10.Capital maintenance:

Capital Maintenance shall mean the major overhaul of any component or equipment of the power plant which is not covered by routine, preventive and breakdown maintenance which may become necessary on account of excessive wear & tear, aging, which needs repair/replacement. The capital maintenance of power plant and all civil structures shall normally be planned to be carried out on an annual basis. For this purpose a joint inspection by the supplier and purchaser shall be carried out of all the major components of the power plant, about two months in advance of the annual maintenance period, in order to ascertain as to which components of the power plant require capital maintenance. In this regard the decision of the purchaser will be final and binding. However, if the condition of any plant and component warrants its capital maintenance at any other time, a joint inspection of the purchaser and supplier shall be carried out immediately on occurrence of such situation and capital maintenance shall be carried out by arranging the shutdown of the plant/part of the plant, if required, in consultation with concerned authorities. The decision of the purchaser shall be final and binding. Capital maintenance also includes replacement of defective lights fans under the project supplied by the contractor. The capital maintenance includes painting, of mechanical structure, civil structure.

The contractor shall under take necessary maintenance/troubleshooting work of the Solar PV Power Systems. Down time shall not be more than 72 working hours from time of occurrence. Adequate measures should be taken for prevention of wear and tear of the machines. Solar PV Power System is to be designed to operate with a minimum of maintenance.

The scope of Support Service provides preventive maintenance as & when necessary within the contract period and break down maintenance in the event of malfunctions, which prevent the operation of the power system or part of it within the stipulated time period & free replacement of spares required for maintenance. Party will provide the A list of Spare parts & measuring instruments are The contractor will submit warrantee certificates of the work & spare parts and materials at the time of submission of completion report. *If any defect is found within the warrantee period, contractor will be liable to repair or replace the same at his own cost and risk, within three (72 hours) days from the date of complaint lodged by the authority or by the user themselves.*

11.0 End Users Training

The Contractor shall arrange for training at site for the end users / employer. The duration of training shall be minimum **five days**. The contractor shall provide training materials at least seven days before commencement of training programme. **The training shall be the part of contract and no extra cost shall be provided for organizing the training programme**.

12.0 Handing Over

The work shall be taken over by authority upon successful completion of all tasks to be performed at site(s) on equipment supplied, installed, erected, commissioned AND RUN SUCCESSFULLY FOR CONSECUTIVE **30 DAYS** AT A STRETCH by the contractor in accordance with provision of this order. During handing over complete project work, the contractor shall submit the followings for considering final payment.

i. All As-Built Drawings &design

ii. Detailed Engineering Document with detailed specification, schematic drawing, and test results, manuals for all deliverable major items, Operation, Maintenance & Safety Instruction Manual and other information about the project

iii. Certificate issued by the structural & civil engineer/firm having engineer with minimum LBS/ESE/EBA License for structural design of PV Array.

iv. Bill of Materials

v. Inventory of spares at project site

vi. Completion certificate as per prescribed format provided by authority

13.0 CEA / CEIG Inspection

The contractor shall submit all the necessary drawings, SLD etc to CEA / Govt Authorities and arrange for inspection of the installation and obtain their certification. **Rectifications if any pointed out by CEA/CEIG/TEDA/Govt. Authorities in the installed equipments / details shall be carried out by the contractor without any extra claim.**

14.0 Operation & Maintenance (O&M)

The bidder shall be responsible for operation and maintenance of the Roof top Solar PV system for a period of 05 years (in addition to DLP of 1 year).

During this period, the bidder has to **clean the solar panels monthly once** and submit a report to Bank. Care should be taken such that the solar panels are maintained neat and tidy always such that optimum Power Generation is maintained.

15. Metering and Grid Connectivity

Metering and grid connectivity of the roof top solar PV system under this scheme would be the responsibility of the bidder in accordance with the prevailing guidelines of the concerned Distribution Company / TANGEDCO / TNERC / CEA (if available by the time of implementation). Bank could facilitate connectivity; however the entire responsibility lies with bidder only i.e obtaining clearance / liaisoning etc.

THIS PAGE LEFT BLANK INTENTIONALLY

TECHNICAL SPECIFICATION FOR

FIRE FIGHTING SYSTEM

INTENT OF SPECIFICATION

This specification is intended to cover design, residual, engineering, manufacture, test and inspection at works, delivery to site properly packed for transportation, erection, testing, commissioning, performance demonstration at site and handing over to purchaser of Fire Protection System as indicated in the schedule of Requirement and scope of work and as required for reliable and effective fire protection of this building.

A.01.01 This specification also includes complete earthwork, i.e. excavation and back filling for the entire buried piping for hydrant and water spray system.

A.01.02 The specification also includes the supply of erection and commissioning of spares as specified and additional recommended spares for three (3) years trouble free operation of the plant and special tools and tackles.

A.01.03. This specification also makes it obligatory for the contractor for arranging and obtaining necessary clearance / approval from all statutory authorities.

A.01.04. It is not the intent to completely specify all the details of design and construction herein. Never the less the equipment and installation shall confirm to high standard of engineering, design, and workmanship in all respect and shall be capable of performing continuous satisfactory operation and acceptable to the purchaser as well as to the various statutory authorities. In case of any violation of the above contract, the purchaser reserves the right to change / reject / modify the equipment / system during detail engineering.

A.01.05. Wherever material or article is specified or described by the name of particular brand, manufacturer or vendor, the specific item mentioned shall be understood as established type function and quality desired. Other manufacturer's product will be considered provided sufficient information is furnished to allow the purchaser to determine that the product proposed is equivalent to those brand.

A.01.06. The entire system shall be designed and engineered by the Bidder based on the guidelines furnished in the specification, various codes / standards. Bidder's experience and also good engineering practice. Items and quantities, which have been furnished in this specification, are tentative and indicative only. During quoting, the Bidder shall vet the above Bill of Material and may furnish additional items necessary for satisfactory operation of the system.

A.01.07 Supplies and services to be covered under this tender specification and the conditions thereof are detailed in the subsequent sections of the specifications. In case of conflict among various sections, subsections, documents, drawings the same shall be referred to purchaser whose decision shall be final and binding to the Bidder. In all cases, the best advantages will go to the purchaser.

BUILDING DETAILS AND DESIGN CONSIDERATION

I. SYSTEM SPECIFICATION & WRITEUP

CONCEPT

Providing fire suppression system in a building is an attempt to extinguish the fire while it is still small, or to limit its growth in order to prevent it from becoming large and spreading to other parts of the building. Water is the most common and convenient fire-extinguishing agent. However, the most suitable extinguishing system whether water, powder or gas will be dependent on the nature of the combustible materials.

The Fire Hydrant system is the most effective, efficient and ultimate means of extinguishing very large fires, which can prove to be devastating. The main advantage of Fighting Fires with Fire Hydrant System is its accessibility and penetration capability, since fires can be fought from a very large distance and to very high reach ability. Many a time the water from the Hydrants through appropriate nozzle may also be used as shield (Water shield) in protecting the Fire Fighter against fire and smoke when evacuating persons in a room engulfed by fire.

The Hydrant network is pressurized with water at a definite pressure and is maintained in readiness for any eventuality. Once the hydrant valve is manually opened during fire, the fall in pressure in the pipe line is sensed by the pressure switches activating the pumps, thereby ensuring continuous supply of water and pressure at the outlets (Hydrant Points).

YARD HYDRANTS

For fighting fires from out side the building at strategic locations on perimeter of the building there are yard (external) hydrants have been proposed for every 30 m of periphery of the building. The yard hydrants are provided with hose cabinet in which 2 x 15Mts. fire hoses, branch pipe and nozzle are stored.

AUTOMATIC SPRINKLER SYSTEM

Automatic sprinkler system is considered to be the most effective and economical way to apply water from fixed systems. It is designed to act upon a fire at a pre-determined temperature by measure of water spray. It could either extinguish the fire or control its spread. The extinguishing mechanism of sprinkler water spray includes combustible materials to prevent further fire spread and displacement of combustible vapour and oxygen by steam. The sensitivity of a sprinkler glass bulb varies and is identified by different color.

Sprinklers have been designed for ceiling level with Sprinkler riser, piping network, Sprinkler control valve, Floor control valves etc. All sprinklers are 68 deg. Temperature rating and pendant-recessed type also upright and sidewall through type sprinkler shall be envisaged wherever required as per site. The Sprinklers are designed to cover 9 to 12 Sq. m each and design density of water is 5 LPM / Sq. m for assumed area of 360 Sq.m. The sprinkler system and hydrant system are fed by common pump. The sprinkler mains at each zone consisting with Flow switch which will transfer audio / visual indications to Fire alarm panel in case of water flow in the pipes.

Sl. No	Description	As per NBC

1	Type of Occupancy	Business Building
2	General Classification	Group E
3	Type of Building	Office & Residence
4	Systems to be provided	Yard hydrants, Internal Hydrants, Sprinklers & Fire extinguishers
5	Interval of Yard Hydrant and Hydrant pressure	Every 30 Mtr interval and 3.5 Bar at the remotest point.
6	Fire water pump house & tanks	Shall be accommodated at Basement
7	Pump capacity for both Hydrant and Sprinkler system	**At Below Ground Level:** 1No. Main pump of 97Cu.M at 70 MWC. 1No. Jockey Pump of 10.8Cu.M at 70 MWC. 1No. Common Standby pump of 97Cu.M at 70 MWC. **At Terrace Level:** 1No. Terrace Pump of 27Cu.M at 35 MWC
8	Fire water tank capacity	Ground level. 50 cum. Terrace Tank 5 cum.
9	Power supply.	Main Electric pump – 420V 3Ph –1no. Jockey Pump – 420 V, 3Ph – 1no. (Star delta starter mechanism)

II DESIGN PHILOSOPHY

Fire Protection System mainly envisages providing protection to this Business/residential buildings.

Brief system description indicative of the nature of various systems is provided below.

1.0 TYPE OF SYSTEMS

Following are the various Fire Protection Systems proposed for protection:

Fire Hydrant System (Internal & External)

Automatic Sprinkler System at Office Floor

Fire Extinguisher

2.0 GENERAL REQUIREMENTS:

Sl.No (1)	Description (2)	Residential Building (A-3)		Business Building (E)	
		Upto 15m in height (3)	> 15m in height & upto 35.0M (4)	Above 10m but not exceeding 15m in height (5)	> 15m in height& upto 24.0M

					(6)
1.	Fire Extinguisher	Required	Required	Required	Required
2.	Fire Aid Hose Reel	Required	Required	Required	Required
3.	Wet Riser	Not Required	Not Required	Required	Required
4.	Down Comer	Not Required	Required	Not Required	Not Required
5.	Yard Hydrant	Not Required	Not Required	Not Required	Required
6.	Automatic Sprinkler System	Not Required	Not Required	Not Required	Required
7.	Manually operated electronic fire alarm systems	Not Required	Required	Required	Required
8.	Automatic detection & alarm system	Not Required	Not Required	Required	Required
9.	Under Ground Water Storage Sump	Not Required	Not Required	50,000 litres	1,00,000 litres
10.	Overhead water tank	5,000 litres	25,000 litres	5,000 litres	10,000 litres
11.	Pump Room at Ground Level	Not Required	Not Required	1 No. Electric & Diesel Pump of capacity 1620 lpm & one diesel pump of capacity 180lpm.	1 No. Electric & Diesel Pump of capacity 2280 lpm & one diesel pump of capacity 180lpm.
12.	Pump at terrace level	450 lpm @ 3.5kg/sq.cm	900 lpm @ 3.5kg/sq.cm	450 lpm @ 3.5kg/sq.cm	Not Required

Note:
Being this building is involved in business activities, we suggest you to follow the requirements in Column No. 5.

3.0 HYDRANT SYSTEM PHILOSOPHY

The hydrant system has been designed to cater to the single fire demand at a time. The pumping philosophy shall be as follows:

Fire pumps shall be installed in firewater pump room. Pumps shall have positive suction having common header.

The hydrant & sprinkler system header shall be fed by one jockey pump (JP) of 10.8 Cu.M /Hr. (180 LPM) capacity and one electrically operated main pump set of 97 Cu.M/Hr (1620 LPM). There shall be one diesel engine driven standby pump of same capacity.

Stopping of the jockey pump sets shall occur automatically either due to restoration of system pressure sensed by pressure switches or due to the operation of interlocking circuits provided within the local control panel by which main fire pumps comes into operation.

Stopping of main pump sets shall only be done manually by operation of the respective push buttons on local control panels.

External hydrants called courtyard hydrant shall be spaced at intervals of 30 Mtr. (maximum) around the periphery of the main building. Courtyard hydrants shall be provided with hose box & two hoses of 15 m length, nozzle & branch pipes. The underground pipe will be of MS medium grade, coated and wrapped as per relevant IS specification.

4.0 SPRINKLER SYSTEM PHILOSOPHY:

A Sprinkler system has two functions to perform, i.e. to detect a fire and then provide an adequate distribution of water to control or extinguish it. The suction of the pump-sets are connected to a tank of 50,000Ltrs capacity (common tank to Hydrant and Sprinkler system). The delivery of these pump-sets are connected to a common manifold and further connected the risers and a network of piping will be kept under pressure and whenever Sprinkler bulb breaks, Water sprinkled immediately and the reduction of pressure automatically sensed thereby switching ON the Pump.

The pump-sets can be either switched ON automatically or manually depending upon the selector switch in the MCC / Auto start panel.

Flow switches will be installed in all the risers of sprinklers and these flow switches are connected to a fire alarm panel. This Fire Alarm panel will give indication whenever the sprinkler operates indicating the exact floor / area.

Sprinkler Data

Coverage of Sprinklers

Sprinkler rating	:	68 & 79 Deg.C
Sprinkler point design	:	16 / 18 sprinklers.

Sprinkler system shall be tapped off from pumps considered for hydrant/Sprinkler system.

5. FIRE EXTINGUISHERS

5.1 Portable Fire extinguishers of various types will be located in the following areas:

Pump Room

Office Floor

Residential Floor

5.2 Type of Fire Extinguishers

ABC type dry chemical powder

Carbon dioxide

Mechanical Foam

APPLICABLE CODES & STANDARDS

Unless specifically mentioned otherwise, all the applicable Codes and Standards published by the Bureau of Indian Standards and their subsequent revision shall govern in respect of design, workmanship, quality and properties of materials and method of testing; standards listed below shall be applicable, in particular: NBC Part IV-Fire Protection System, 2005 and TAC Fire Protection Manual / 1998 (Guidelines only)

IS-1239	:	Specification for MS / GI Pipes
IS-778/780/2906	:	Specifications for Gun Metal gate, globe, and check Valves for water supply.
IS-800	:	Specifications for Structural steel
IS-3589	:	Specifications for ERW black pipes for water, gas and sewage for pipes above 150 NB.
IS-814	:	Specifications for covered electrodes for metal are welding of structural steel.
IS-4927	:	Specifications for Canvas Hose Pipes.
IS-1641	:	Specifications for C.I.screwed fittings.
IS-903	:	Specifications for Branch pipes (Long Pattern)
IS-3844	:	Code of practice for installation of internal Fire Hydrant in Multistoried Building.
IS-5290	:	Specifications for hydrant landing valves.
IS-903	:	Specifications for coupling double male double Female instantaneous pattern for fire fighting.
IS-2217	:	Recommendation for providing first aid fire fighting arrangement in public buildings.
IS-1879	:	Malleable iron fittings (Parts I to X)
IS-1200	:	Method of measuring of building & civil Engineering Works (water supply, plumbing drain & sanitary fittings)
IS-1538	:	Specifications for cast iron fittings for pressure Pipes for water, gas and sewage
IS-4853	:	Recommended practice for radiographic inspection of fusion welded butt Joints in steel pipes.

IS-636	:	Synthetic, jacketed hose pipes.
IS-1520	:	Electrically operated multistage / multi outlet pump.
IS-2198	:	Control Panels.
IS-2159	:	Hot dip galvanising of iron and steel
IS-5	:	Specification for painting

IV. EQUIPMENT SPECIFICATION

D.00.00 **I. WET RISER CUM DOWN COMER / SPRINKLER SYSTEM**

D.01.00 **FIRE PUMPSETS**

D.01.01 The pumps shall be of horizontal end suction, top discharge centrifugal pump. The speed of motor driven pump shall be 2900 RPM and the Engine driven pump shall be 1800 to 2100 RPM.

D.01.02 Pump shall preferably be designed to have the best efficiency at the specified duty point. The pump shall be suitable for continuous operation at any point within the "Range of Operation" i.e. 0% to 150% of rated capacity.

D.01.03 The pump shall be driven by drive unit directly coupled. A heavy duty coupling along with coupling guard shall be provided between the pump and drive unit.

D.01.04 The pump shall be capable of furnishing not less than 150% of rated capacity at a head of not less than 65% of the rated head.

D.01.05 The shut-off head shall not exceed 120% of rated head.

D.01.06 The drive unit power rating shall be the maximum of the following requirements.

i. 15% margin over the pump shaft input power at the rated duty point.
ii. 5% margin over the pump shaft input power required to drive the pump at 150% of its rated discharge

D.01.07 The pump set shall be of securely mounted on a robust base frame and shall be free from vibration at all variations of load.

D.01.08 The pump shall also be linked to re-circulation pipeline required for minimum flow through the pump during its operation without any discharge through headers.

D.01.09 The pump shall be provided with a nameplate indicating delivery head, capacity and RPM.

D.01.10. The material of construction of pump shall be as under:

i. Casing	:	Cast Iron, IS:210, Gr 25
ii. Impeller	:	Bronze IS: 318, Gr LTB1
iii. Wearing Rings	:	Bronze
iv. Shaft Sleeve	:	S/S Type AISI 410

v. Stuffing Box	:	FG 260 (Gr.25)
vi. Gland	:	FG 260 (Gr. 25)
vii. Gland packing	:	Graphited Asbestos rope
viii. Shaft	:	Stainless Steel AISI 410
ix. Base frame	:	Fabricated M.S

D.02.00 **JOCKEY PUMPSETS**

D.02.01 The pump shall be horizontal end suction top discharge centrifugal pump.

D.02.02 The pump shall be single / multistage.

D.02.03 The pump base frame shall be fabricated out of MS channels

D.02.04 The base frame shall accommodate both the pump and the motor.

D.02.05 The pump shall be suitable for automatic operation

D.02.06 Jockey pump drive motor shall be suitable for frequent start / stop operations as required by the system.

D.02.07 The pump shall be provided with a name plate indicating delivery head, capacity and RPM.

D.02.08 The material of construction of pump shall be as under:

i. Casing	:	Cast Iron, IS:210, Gr 20
ii. Impeller	:	Cast Iron
iii. Base frame	:	Fabricated M.S

Bidder shall confirm the adequacy of space requirement for pumps and associated piping as indicated in the tender drawings

D.03.00. **MOTORS**

D.03.01. The motors for the wet riser & jockey pumps shall be of general purpose, constant speed, and sized for the maximum output at an ambient temperature of 40 Deg C.

D.03.02. The motor for electrical driven pump sets shall be of TEFC type.

D.03.03. The motors shall be wound of class ‘F’ insulation.

D.03.04. The motors shall be rated for continuous duty. They shall also be suitable for long period of inactivity.

D.03.05. The operating speed for the Electrical pump / Jockey pump motor shall be of 2900 RPM.

D.03.06. The motors shall be suitable for electric supply of 415V, 3 phases, 50 Hz and shall run continuously at rated input over the entire range of voltage and frequency variations as under:

RANGE OF VARIATION

i. Voltage	:	10%

ii. Frequency : 5%
iii. Combined voltage frequency : 10% (Absolute sum)

D.03.07. Motors shall be designed for direct on line starting.

D.03.08. Motors shall be effectively grounded and shall be provided with two separate and distract grounding pads, each complete with tapped hole galvanized bolt and washer for connection to station ground conductors

D.03.09 Motors shall confirm to IS: 325

D.04.00 **CONTROL PANEL FOR THE MOTOR DRIVEN STANDBY PUMPSET AND JOCKEY PUMPSET.**

D.04.01. The starting switchgear for the motor driven pump set shall be suitable for star delta/direct on line starting.

D.04.02. The control circuit for the electrical driven firefighting pump set shall be designed for automatic operation i.e., whenever the pressure reduces in the system, the pumps shall automatically starts. The stopping of the pumps is 'Manual'.

D.04.03. The control circuit for the Jockey pump set shall be designed that whenever pressure reduces the pump shall start automatically and when pressure reaches rated system pressure then it should automatically switched OFF.

D.04.04. Auto/Manual switch shall be provided for both the electrical driven firefighting pump set & Jockey pump set so that the pump sets can be started/stopped manually also.

D.04.05. The panel shall be provided with the Voltmeter and ammeter with indicating `R' `Y' `B' Lamps.

D.04.06. The control panel shall be of welded construction, fabricated from sheet metal having 2.03 (14 SWG) thickness and shall be dust and varnish proof.

D.04.07. The Panel shall be completely factory wired absolutely ready in all respect for installation at site and incoming power cables to be laid by main electrical contractor for which un drilled bottom gland plate shall be provided. The internal wirings of the panel shall be carried out with 650 V grade stranded copper wire of size rated for the current in the corresponding circuit. The minimum size of the wire shall not be less than 1.5 Sq.mm stranded copper. The wiring termination shall be done using ferrules having indelible at the termination to reduce the possibility of short circuit between various wires. The contractor shall be solely responsible for proper functioning of the equipment supplied. The internal control wiring shall be done with FRLS cable.

D.04.08. Neoprene or equivalent rubber gaskets shall be provided at all openings.

D.04.09. All the components used in the Panel shall be of reputed makes.

D.04.10. Nameplate shall be provided at the Panel.

D.04.11. MCCBs shall be provided for the panels. All the protection circuits shall be removed. The panels shall have 2 Nos. of incoming MCCBs with mechanical inter-locking facility.

D.04.12. 2 (two) numbers earthing connection shall be provided for the panel. The earthing of the panel shall be done as per the rules and regulations.

D.04.13 Adequate number of potential free contacts shall be provided for connecting to the BAS system.

D.05.00 **DIESEL ENGINE**

D.05.01 The engine shall be of the compression ignition mechanical direct injection type, capable of being started without the use of wicks, cartridges, heater plugs or ether, at an engine room temperature of 7 Deg. C. And shall accept full load within 15 seconds from the receipt of the signal to start.

D.05.02. The engine shall be naturally aspirated, supercharged or turbo charged and either air or water-cooled. In the case of charge air-cooling by means of a belt-driven fan or of a belt driven auxiliary
Water pump there shall be multiple belts such that should half the belts break, the remaining belts would be capable of driving the fan or pump.

D.05.03. The engine shall be provided with an adjustable governor to control the engine speed within 10% of its rated speed under any condition of load upto the full load rating. The governor shall be set to maintain rated pump speed at maximum pump load.

D.05.04. Engines, after correction for altitude and ambient temperature shall have bare engine horsepower rating equivalent to the higher of the following two values.

a. 20% in excess of the maximum brake horsepower require driving the pump at its duty point.

b. The brake horsepower required to drive the pump at 150% of its rated discharge.

D.05.05. The coupling between the engine and the pump shall allow each unit to be removed without disturbing the other.

D.05.06. **STARTING MECHANISM**

Provision shall be made for two separate methods of engine starting viz.,

a. Automatic starting by means of a battery powered electric starter motor incorporating the axial displacement type of pinion, having automatic repeat start facilities initiated by a fall in pressure in the water supply pipe to the sprinkler and/or hydrant installation. The battery capacity shall be adequate for ten consecutive starts without recharging with a cold engine under full compression.

b. Manual starting by
i. Crank handle, if engine size permits.
or
iii. Electric starter motor.

D.05.07. **BATTERY CHARGING**

The means of charging the batteries shall be by a 2-type trickle and boost charger with manual selection switch and the batteries shall be charged in position.

D.05.08. **COOLING SYSTEM**

The cooling system shall be of heat exchange type.

D.05.09. **FUEL SYSTEM**

Engine shall be provided with a fuel oil tank fitted with a level indicator and having adequate capacity to hold sufficient fuel oil for minimum two (2) hours of full load run.

The fuel oil tank shall be constructed of welded steel. The tank shall be above the inlet of fuel injection pump of the diesel engine to ensure adequate pressure at suction of injection pump.

The fuel oil tank shall be provided with a sludge and sediment trap. So that the same is not carried to the injection pump. Adequately sized inspection and cleaning hole shall be provided to felicitate maintenance.

Pipeline carrying fuel oil shall be independent for each engine and gradually sloped from the tank to the injection pump. Any valve in this line shall be placed adjacent to the tank and kept locked in open position.

Pipe joints shall be welded only and shall not be soldered. No plastic pipes shall be used.

The design of complete fuel oil system shall be free of air pocket in any part of the pipe work, fuel pump, sprayers / injectors, filter system, etc., Use of screwed plugs shall be permitted where air relief is essential with approval of Architect/Employer.

D.05.10. **AIR FILTERATION**

The air intake shall be fitted with a filter of adequate to prevent foreign matter entering the engine.

D.05.11. **EXHAUST SYSTEM**

The exhaust shall be fitted with a suitable silencer to keep the total backpressure within the engine maker's recommendation. The exhaust system shall also be free from any condensate flowing into the engine.

D.05.12. **ENGINE SHUT-DOWN MECHANISM**

This shall be of manual operation to bring the engine to starting position after use.

D.05.13. **ACCESSORIES**

The engine shall be mounted on a frame of fabricated steel construction. Adequate access shall be provided to the big end and main bearings, camshaft and governor drives water jacket, etc.

Indicator cocks shall be mounted directly on the cylinder head and located in such a manner as to permit preparation of the indicator cards without removing the valve operating gear covers.

D.05.14. **TOOLS**

A standard tools kit shall be provided with the engine and kept at handy place all times.

D.05.15. **SPARE PARTS**

The following spare parts shall be supplied with the engine and kept at handy places.

a. Two sets of fuel filters, elements and seals.
b. Two sets of lubricating oil filters elements and seals.
c. Two sets of belts (where used).
d. One complete set of engine joints, gaskets and hoses.
e. Two injector nozzles.
f. One complete set of piston rings for each cylinder.
g. One inlet valve and one exhaust valve.

D.06.00. **AUTO START CONTROL PANEL FOR DIESEL ENGINE**

D.06.01. The Auto-start control panel shall have the following:

i. Auto/Manual selector switch for pump set.
ii. Manual start/stop push button.
iii. Indicating lamps showing power is on and run/stop.
iv. Voltmeter/Ammeter in battery charging circuit.

D.06.02. The control panel shall be of welded construction, fabricated from sheet metal having 2.03 (14 SWG) thickness and confirm to IP 54 construction.

D.06.03. Neoprene or equivalent rubber gaskets shall be provided at all openings.

D.06.04. The Auto Start panel shall have both trickle & Boost charger to charge the batteries.

D.06.05. The Panel should be designed and compatible with the make of the diesel engine offered.

D.06.06. Nameplate of approved design shall be furnished for panel and for each instrument or device mounted on the panel.

D.06.07. The panel shall have provision of cable entry at the Top plate.

D.06.08. 2 (two) numbers opposite earthing connection shall be provided for the panel. The earthing of the panel shall be done as per the rules and regulations.

D.07.00. **PIPES AND FITTINGS**

D.07.01. The use of Pipes in the execution shall be as follows:

BURIED PIPES & ABOVEGROUND PIPES (WET RISER CUM DOWN COMER SYSTEM)

The pipes shall be of Mild Steel ERW Pipes as per IS: 1239 Part-I, medium grade up to 150 NB and below or IS: 3589 for pipes of sizes 200 mm and above with IS mark in both the cases.

D.07.02. Minimum thickness of steel pipes IS: 3589 shall be as follows:

Pipe Size NB (mm)	200	250	300	350	400
Minimum wall thickness (mm)	6.35	6.35	6.35	6.35	6.35

D.07.03. All fittings to be used in connection with steel pipelines shall be as per IS: 1239, Part-II, `Mild Steel tubular and other wrought steel pipe fittings. All Fittings shall be of heavy quality. Fittings with sizes above 150 mm shall be fabricated from pipes conforming to IS: 3589 or steel plates having thickness not less than those specified in the IS: 3589. Minimum three pieces meter bends shall be used.

BURIED PIPES & ABOVEGROUND PIPES (SPRINKLER SYSTEM)

The pipes shall be of Mild Steel ERW Pipes as per IS:1239 Part-I, heavy grade up to 150 NB and below or IS:3589 for pipes of sizes 200 mm and above with IS mark in both the cases.

D.07.04. Minimum thickness of steel pipes IS: 3589 shall be as follows:

Pipe Size NB (mm)	200	250	300	350	400
Minimum wall thickness (mm)	6.35	6.35	6.35	6.35	6.35

D.07.05. All fittings to be used for sprinkler system upto 50mm shall be of forged steel fitting socket weld able type ANSI B16.11 and fittings above 50 mm shall be of heavy grade MS.

D.07.06. Welded construction shall be adopted for steel pipelines unless specified otherwise.

D.07.07. Hangers and supports shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipelines movements as necessary. All guides, anchors, braces, dampers, expansion joint and structural steel to be attached to the building/structure/trenches etc., shall be provided. Type of hangers and components for all piping shall be selected by Contractor and approval obtained from the Purchaser/Architect before commencement of the work.

D.07.08. All piping system shall be capable of withstanding the maximum pressure arising from any condition of testing (as stipulated) and operation, including water hammer effects.

D.08.00. **COATING AND WRAPPING:**

Steel pipelines to be laid underground buried in the soil shall be protected against corrosion by means of coating & wrapping as per IS: 10221.

D.08.01. The above coating and wrapping shall be carried out in systematic manner such that uniform thickness of coating is obtained as per IS specification.

D.08.02. Buried pipelines shall be laid in general with top of pipe 1(one) meter below the ground level. Where soil conditions are not satisfactory, masonry or equivalent supports shall be provided at regular intervals.

D.09.00. **VALVES**

D.09.01. **SLUICE VALVES**

i. Gate / Sluice valve shall be as per IS:14846 (PN 1.6)

ii. The sluice valves shall be provided with hand wheel, position indicator and locking facility.

iii. Sluice valves shall be provided with back seating bush to facilitate gland renewal during full open condition.

iv. Sluice Valves shall be with IS mark.

D.09.02. **NON-RETURN VALVES**

The Non-Return Valve shall be of CI body swing check & waffer type.

D.10.00 **BUTTERFLY VALVES**

Butterfly valves shall be slim seal type with an integrally moulded elastomer body liner. The valve shall be designed to outperform loose liners, the elastomer line is moulded directly in the body bore and vulcanized in – situ, making it last the entire life of the valve. The slim seal is available in different combinations of body, liner and disc material to suit a wide of line fluids, a size range of 50 to 600mm and a pressure rating upto PN 1.6.

D.11.00. **HYDRANT COMPONENTS**

D.11.01. **HYDRANT VALVE**

a. Hydrant valve shall be of single headed/double headed with 75 mm NB flanged inlet, 63 mm female inst. oblique outlet as per IS: 5290

b. The material of construction shall be as follows:

i. Body	:	Gunmetal.
ii. Trim	:	Leaded tin bronze as per IS:318, Grade-2.
iii. Hand Wheel	:	Cast Iron FG 200 as per IS:210.
iv. Washer, Gasket	:	Rubber as per IS:638.
v. Quick coupling connection:		Leaded tin bronze as per IS:318.Grade-2.
vi. Spring	:	Phosphor Bronze as per IS:7608.
vii. Male Blank cap.	:	Leaded tin bronze as per IS: 318.Grade-2.
viii. Chain	:	G.I.

D.11.02. **BRANCH PIPE:**

Branch pipe shall be of gunmetal short, 63 mm male instantaneous inlet, made threaded outlet, 20 mm bore nozzle with IS: 903.

D.11.03. **HOSES**

The hoses shall be 63 NB with heavy quality gunmetal coupling confirming to IS: 903 with ISI mark. Hoses shall be RRL type with IS: 636 type 'A', 100% polyester, resistance to fungus formation. Hoses shall be externally coated with red synthetic elastomeric compound, which provides resistance to moisture meldew fungus and protection against heat and abrasion. Hoses shall be of 15 M / 7.5 M long and each hose shall be provided with a male and female coupling, gunmetal, 63 mm (2 1/2") size, heavy quality bearing conforming to IS:903 with IS mark.

D.11.04. **HOSE REEL**

i. Hose reel shall be of type 'A' wall mount type, swinging complete with 19 mm bore, high pressure braided rubber hose 30 M. long, 6 mm bore shut off nozzle and 25 mm dia inlet valve, confirming to IS: 884.

ii. The material of construction for various components shall be as per IS: 884.

D.11.05. **HOSE BOXES**

Hose box for yard hydrants shall be fabricated from fibreglass sheet materials with glass panel, lock & key. The size of the hose box shall be 750 mm x 600 mm x 250 mm and capable of accommodating 2 Nos. of 15 Mtr. Hoses and 1 No. branch pipe. The hose box shall be provided with double door with glasses, lock, 2 keys and a break glass, recess for keys. The colour of the hose box shall be red.

D.11.06 **HOSE FRONT DOOR**

In each floor, in each riser, tapping will be taken and in this tapping, a hydrant valve and hose reel is connected and required hoses and the branch pipe will be kept. The entire arrangement will be inside the duct. For covering the duct, a door shall be provided with anodized aluminium frames and glass panel.

D.11.07 **FIRE BRIGADE CONNECTION**

The fire brigade inlet connection shall be of Two-way type incorporating non-return valves on the external hydrant ring main and also shall be provided for the fire-fighting sump. The two ways fire brigade inlet connection shall be accommodated in a glass fronted MS box made of 18 gauge MS sheet. The inside portion of the box shall be painted with one coat of zinc rich primer and two coats of white enamel paint. The outside shall be painted with one coat of zinc rich primer and two coats of red enamel paint. The box shall be also provided with lock and key. Fire Brigade connection shall confirm to IS: 5131.

D.11.08. All the hydrant components i.e. hydrant valve, Hoses with coupling, branch pipe shall have ISI approval.

D.11.09 **FLOW SWITCH**

Flow switches will be mounted in a horizontal section of pipe where there is a straight horizontal line of at least 10 pipe diameter on upstream side and 5 pipe diameter on down stream side of the flow switch. Flow switch shall accommodate a micro switch with at least 1 NO and 1 NC contacts and the same shall be actuated by metallic bellows sealed pivoted paddle. The instrument shall be weather proof with IP52 when the cover and suitable cable gland are properly fixed. The flow switch shall be suitable for mounted on 150/100mm-dia pipeline. The flow switches shall be provided for sprinkler system.

D.11.10 **SPRINKLER HEADS**

The sprinkler heads shall be rated for 68 deg.C. Pendent type Sprinkler. Sprinkler shall be provided with escutcheon plate and sprinkler shall have approval of FM / UL.

D.11.11 **ORIFICE PLATES**

Orifice Plates shall be provided wherever required on wet riser system to limit the pressure to 5 Kg. per Sq.Cm.

D.11.12 **Cables**

All cables specified in the Schedule of Quantities shall have Outer sheath with Fire retardant low smoke (FRLS) PVC compound to reduce the Fire hazard. The FRLS outer sheath material shall meet the following requirements:

a. Oxygen Index - 29 when tested at 27 + 2°C as per ASTM – D – 2863 - 77

b. Temperature Index - Minimum 250°C at Oxygen Index 21 – as per NES 715.

c. Flammability - As per IEC – 332 – 1. It shall also pass Flammability Test as per Class F3 of Swedish Standard SS – 424 - 1475.

d. Smoke Density - Smoke density rating shall not be More than 60%. When tested as per ASTM – D – 2843 – 77 (1988).

e. Acid gas generation - Less than 20% by weight as per IEC – 754 – 1.

The sheath shall be resistant to water, UV radiation, fungus, termite and rodent attacks. The colour of the outer sheath shall be black.

II. 10.11.13 **EARTHING**

This specification covers the supply, installation testing and commissioning of earthing system.

1. STANDARDS (Indian Standards)

IS 3043	:	Code of Practice for earthing
Safe Earthing	:	As per IS – 3043
Electricity Rules	:	National Electric code
Earthing for Lightning Protection	:	As per IS - 2309.

2. GENERAL REQUIREMENTS

The plant shall be provided with complete earthing system comprising earth electrodes in conjunction with earth grid.

3. DETAILS OF EARTHING SYSTEM

Unless otherwise specified main earthing shall not be less than 50 x 6 mm Cu. Flat wherever buried.

The minimum size of earthing conductor of various equipment shall be as follows:

a.	2500 kVA Transformer Neutral	-	50x6mm cu flat
b.	Transformer body & HT Panel body	-	50 x 6 mm Cu Flat
c.	Main Earth Bus	-	50 x 6 mm Cu Flat
d.	PCC/LT Switch boards body	-	50 x 6 mm Cu Flat
e.	Distribution Panels	-	25 x 3 mm Cu Flat
f.	Interconnections Earth pit to Earth pit	-	50 x 6 mm Cu. Flat

4. EARTH ELECTRODE

Earth electrodes shall be erected 1.5 Mts away from the building edge and minimum spacing between the electrodes shall be maintained as per IS: 3043.

5. EARTHING LAYOUT

Earthing conductors in outdoor areas shall be buried atleast 600mm below finished grade level unless stated otherwise.

Wherever earthing conductors cross cable trenches, underground service ducts, pipes, tunnels, etc. it shall be laid minimum 300 mm below and shall be re-routed in case it fouls with equipment structure foundations.

Tap-connections from the earthing grid to the equipment/structure to be earthed shall be terminated on earthing terminals of the equipment/structure, if the equipment is available at the time of laying the grid, otherwise, "earth riser" shall be provided near the equipment foundation/ pedestal for future connections to the equipment earthing terminals.

Earthing conductors along their run on cable trench ladder columns, beams, walls, etc. shall be supported by suitable clearing at intervals of 750 mm. Earthing conductors along cable trenches shall be cleared to the wall nearer to the equipment. Cable trays and supports shall be connected to the earth mat at every 10 meters interval. Wherever it passes through walls, floors, etc. GI sleeves shall be provided for the passage of the conductor.

Earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building.

6. EQUIPMENT EARTHING

All electrical power items shall be earthed by two separate and distinct earth connections from main earth bus.

Earthing pads shall be provided by the supplier of the apparatus/equipment at accessible position. The connection between earthing pads and the earthing grid shall be made by short and direct earthing lead free from links and splices.

Electrical continuity shall be ensured by bonding the different sections of hand-rails and metallic stairs.

Metallic pipes, and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system.

Metallic conduits shall not be used as earth continuity conductor. Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam, conduits, pipes etc. and steel reinforcement in concrete, it shall be bonded to the same.

Cable end boxes, glands, etc. shall be connected to the earthing conductor running along with the supply cable which, in turn, shall be connected to earthing grid conductor at minimum two points.

The metallic screens of the single core cable, shall be connected to earth at one end only.

7. JOINTING

Earthing connections with equipment earthing pads shall be bolted type. Contact surface shall be free from scale, paint enamel, grease, rust or dirt. Two bolts shall be provided for making each connection. Bolted connections, after being checked and tested shall be taped with PVC tape.
Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.

8. GENERAL

Excavation and refilling of earth necessary for laying of underground earth bus and earth pipes shall be the responsibility of the Contractor.

All earth electrodes shall be tested for earth resistance by means of standard earth resistance tester.

Earthing resistance of the main bus shall be measured after connecting all the electrodes to the bus and the resistance shall not exceed one (1) ohm.

III. 10.11.14 INSTALLATION

1.0 GENERAL

The electrical installation shall be complete in all respects and any item not included in the specification but essential for proper installation and functioning of the electrical system shall deemed to be included in the scope of the specification whether specifically mentioned or not.

The system under the scope of work shall conform to the latest codes and standards as amended in the respective technical specification and schedule of works. Nothing in the specification shall be construed to relieved the successful tenderers from the responsibilities where specifically mentioned in the tender or not.

The following standards as amended shall also to be covered.

Installation

All electrical works shall comply with following standards:

IS – 10028 – Code of Practice for installation of transformers.
IS – 732 – Code of Practice for electrical wiring installation.
IS – 5216 – Guide for safety procedures & practices in electrical work.
IS – 10118 – Code of practice for section, installation and maintenance of LT Switch, switch gears & control gears. Workmanship shall be highest standard and quality.

Equipments

All equipments shall be installed strictly in accordance with manufacturers instructions / drawings.
All LT panels shall be erected on suitable base frame.
Distribution boards shall be erected on wall such that height of top of board will be at 1800 mm.

Switch boards / MCC's shall be erected with a front clearance of not less than 1000 mm and a clearance of not less than 750 mm at the rear clearance of there are cable entries or with a rear clearance of less than 200 mm in case there are no cable entries or attachments at the rear.

Cables

Cable shall be taken on trays fixed on ceiling / wall.
Cable tray shall be of Galvanised iron with welded runs.
All cable shall be provided with punched aluminium identification tags at both ends.

Earthings

Earthing shall be as per IS 3043.
All electrical power items shall be earthed by two separate and distinct earth connections from main earth bus.
General grounding shall be done to achieve earth resistance of less than 1 Ohms.
Special grounding shall be done to achieve earth resistance of less than 5 Ohms.
Earth electrodes shall be erected 1500 mm away from the building edge and minimum spacing between the electrodes shall be 3000 mm.
Earth electrodes – 38-mm dia 3 m long Cu.plate earthing. The size of copper plate earthing shall be 600 x 600 x 3mm.
Size of earth
Main earth bus : 50 x 6 mm Cu.Flat

Type of Wiring

Service building electrical rooms: Concealed wiring using PVC conduit
AHU & Staircase areas, Basement : Concealed wiring using PVC conduit
Office areas, Ground floor, lift shaft: Open conduit wiring using MS conduit above false ceiling & concealed wiring below false ceiling.

IV. 2.0 CABLING

No cable shall be laid along side a water main. Spacing equal to the diameter of the cable shall be maintained between adjacent power cables.

Selection of cable drums for each run shall be so planned as to minimise straight through joints. In each cable run, extra length shall be kept at a suitable point to enable one straight through joint to be made, should the cable develop a fault at a later date.

All due care shall be taken during unreeling, laying and termination of cable, to avoid damage due to twist, kink and sharp bends, etc. Wherever cables pass through floor or through wall openings, it shall be taken through GI. pipe sleeves. The open ends of the sleeves shall be sealed by cold setting Fire Proof sealing compound after cables are pulled through them to prevent spread of fire entry of vermin and ingress of water.

While laying cable, cable rollers shall be used at an interval of 2.0 Mts. The cables shall be pushed over the rollers by a gang of people positioned between rollers. The cable shall not be pulled from the end without intermediate pushing arrangement. The bending radius shall not be less than that specified by the manufacturer.

Each cable shall be provided with an identification tags at entrance and exit from any equipment. The tag shall be of aluminium, with the number punched on it and securely attached to the cable by not less than two turns of GI wire.

Single core cables shall be laid in trefoil formation and clamped with trefoil clamps at every 600mm intervals.

All multi core cables shall be secured to the cable tray by clamps at every 600mm intervals.

Cables from overhead cable trays to the equipment shall be taken in prefabricated cable tray with cover/GI Pipe sleeves.

2.1 Direct In Ground

Power and control cables laid directly in ground shall be laid generally conforming to the requirements of code of practice IS:1255. Generally cables shall be taken at a depth of 750mm from finished ground level and shall be provided at least 150mm sand cushioning both at top and bottom and brick protection.

Control cables shall be laid touching each other without any horizontal spacing. However the distance of the control cable from the nearest power cables shall be 150mm. Power and control cables shall be laid separately in groups.

Wherever power or control cables crosses fire hydrant or any other pipelines of earth flat the cable shall be taken 300mm below the pipeline.

After laying of cables, the trench shall be back filled with good excavated soil and well rammed in successive layer not less than 300 mm depth. The width of the trench shall be

in accordance with the number of cables to be laid and in no case shall be less than 300 mm.

Cast Iron cable route markers (Cast Iron) shall be provided at every 100M intervals and at bends.

2.2 Laid On Cable Tray

The cables inside the plant buildings shall be taken on trays fixed on the ceiling.
Cable trays shall be of prefabricated GI (2.0mm thick) with necessary accessories like Tees/Bends etc. and shall be supplied along with fasteners.
Cable trays shall be hot dip galvanised as per IS: 2629.

The top tray shall be provided with cover if required.

Galvanised angle supports for trays shall be welded to insert plates. The support shall be spaced at 1500 mm centres.

Cables inside the premises shall be taken on cable trays running on ceiling.

Vertical spacing between cable racks/trays shall be minimum 300 mm. Different voltage grade cables shall be laid in separate trays when trays are arranged in tiers.

Contractor shall include in their scope of supply all Insert plates, Anchor fasteners, etc. required for the laying of cable trays. Fastening on walls/RCC columns shall be by Anchor Fasteners only.

2.3 Cable Termination

Termination and jointing of XLPE (FRLS) /PVC armoured cables shall be by means of compression method using double compression type glands and compression type lugs. Control cables are to be terminated by means of terminal lugs, the same shall be of tinned copper compression type.

Cable tails shall be sufficiently long to run all cores to the farther most terminal and then back to the appropriate point of connection.

3.0 EARTHING

The overall earth resistance of the system shall not be greater than one (1) ohm.

All panels, Distribution boards shall be provided with two (2) independent earth connections of adequate capacity to discharge the max. earth fault current.

The size of Earth bus and earth electrode shall be as per specification and as per schedule.

Minimum spacing between earth electrodes shall be provided as per IS:3043.

Water stops shall be provided wherever earthing conductor enters the building from outside, below grade level.

4.0 INSPECTION

After completion of erection/installation, each piece of equipment shall be thoroughly inspected in the presence of Contractor for correctness and completion of erection and operation.

5.0 STATUTORY REQUIREMENTS / APPROVAL FROM STATUTORY AUTHORITIES

Work for electrical installation shall be carried out in accordance with this specification and complying with the relevant statutory requirements and national standards. It shall be the responsibility of the contractor to obtain approvals of Electrical authorities and satisfy them regarding the compliance with relevant regulations for this scope of work.

The work should be carried out only under the supervision of licensed supervisors. The licenses possessed by the Contractor's supervisor shall be made available to the Client for scrutiny before commencement.

D.12.00. INSTRUMENTATION

D.12.01. PRESSURE GAUGE

i. Pressure gauge sensing elements shall be of continuous `C' bourdon type.
ii. Gauges shall be of 150/100 mm diameter dial stored enamel black finish case.
iii. Normal process pressure shall be gauged within 70% of full scale reading of the scale range.
iv. Accuracy shall be within 1.0 % of full scale range.
v. Gauges shall have internal and external stop pegs for cover range protection of 125% of maximum range and zero point respectively.
vi. All gauges shall have bottom connection for local mounting.

D.12.02. PRESSURE SWITCH

Pressure switches shall be used to control the operation of the main fire pump and the jockey pump. The pressure switches shall be of bellows type with required differential as per the system (Schematic offered and the range shall be adjustable and suitable for the operation of the pumps).

D.12.03 VALVE CHAMBER

The internal dimensions of the valve chamber shall be 1m x 1m x 1.2 m depth. Adequate PCC's shall be provided and then valve chamber shall be constructed with brickwork of 9 inches thick. The cover slab shall be of RCC with CI cover of heavy duty. Adequate rungs shall be provided for getting down into the valve chamber.

D.13.00. PORTABLE FIRE EXTINGUISHER

D.13.01. Portable Extinguishers of the following types shall be installed.

1. Co2 type
2. ABC Powder type
3. Foam type

D.13.02. **Co2 TYPE**

a. The Co2 Extinguisher shall be ISI mark, with initial charge with high-pressure cylinder, complete with wheel type valve, internal discharge tube, with high-pressure discharge hose with horn and suspension brackets. The extinguisher shall have ISI mark of 2878 and capacity shall be 4.5 Kgs.

b. The Co2 Extinguisher of 22.5 kg. Capacity shall have ISI mark 2878 and necessary wheel valve, discharge hose and shall be mounted on lightweight rubber tyre wheels.

D.13.03. **FOAM TYPE (MECHANICAL TYPE)**

a. The foam extinguishers of 9 Ltrs. Shall be with solution of 6% concentration with Co2 gas cartridge for making and exploring the foam compound with discharge hose and nozzle, upright type with IS:10204.

b. The 50 Ltr. Foam extinguishers shall be with IS: 5507 complete with gunmetal cap, discharge hose, initial charge mounted on trolly.

D.13.04 **ABC POWDER TYPE**

The ABC Powder Type shall be with IS: 13849. The Extinguishers shall be stored pressure dry powder, 5 Kg. capacity complete with initial charging of ABC type powder pressurized with dry nitrogen, fitted with squeeze type valve assembly, pressure gauge, discharge nozzle and mounting bracket.

E.00.00**. ERECTION, TESTING AND COMMISSIONING**

E.01.00. PIPING

E.01.01. GENERAL

a. For Steel pipelines, welded construction shall be adopted unless specified otherwise

b. Hangers and supports shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipelines movements as necessary. Approval to the type of hangers and components for all piping selected by contractor shall be obtained from the Employer/Architect before commencement of work.

c. All piping system shall be capable of withstanding the maximum pressure arising from any condition of testing (as stipulated) and operation, including water hammer effects.

d. While erecting field run pipes, the contractor shall check the accessibility of valves, instrument tapping points, and maintain minimum head room requirement and other necessary clearance from the adjoining work areas.

e. Modification of pre-fabricated pipes, if any, shall have to be carried out by the contractor at no extra charge to the Purchase/Employer.

f. All pipelines shall be given proper slope towards the drain point.

g. External and internal attachment to piping shall be designed so as not to cause flattening of pipes of excessive localized stresses.
h. All pipelines shall be identified by means of colour bands and direction arrows in consultation with the Architect.

E.01.02. END PREPARATION

a. For steel pipes, end preparation for butt welding shall be done by machining / flame cutting.

b. Socket weld end preparation shall be sewing/machining.

c. For tees, laterals, mitre bends and other irregular details cutting templates shall be used for accuracy.

E.01.03. PIPE JOINTS

a. In general, pipes having sizes 50 mm and over shall be joined by butt welding, pipes having 40 mm size of less shall be joined by socket weld able fittings.

b. Flanged joints shall be used for connection to vessels, equipment, flanged valves and also on straight lengths of pipeline at strategic points to facilitate erection and subsequent maintenance work.

E.01.04. OVER GROUND PIPING

Piping to be laid over ground shall be supported on supports. Support details shall have to be approved by the Employer/Architect.

E.01.05. PAINTING

Above ground pipes shall be coated with one coat of zinc rich primer and 2 (two) coats of synthetic enamel of `Fire Red' colour. The pipeline surfaces shall be manually cleaned of rust / millscales by wire brush, carborandum tips etc., Use of Whipping hammer, emery paper shall be done to clean pitted areas.

E.01.06. WELDING

a. Before welding, the ends shall be cleaned by wire brushing, filing or grinding. Each weld-run shall be cleaned of slag before the next run is welded.

b. Welding at any joint shall be completed uninterrupted. If this cannot be followed for some reason, the weld shall be insulated for slow and uniform cooling.

c. Welding shall be done by manual oxy-acetylene or manual shielded metal arc process.

d. As far as possible welding shall be carried out in flat position. If not possible, welding shall be done in a position as close to flat position as possible.

e. The root of butt joints shall be such as to achieve full penetration with the complete fusion or root edges. The weld projection shall not exceed 3 mm inside the pipe.
f. On completion of each run crater, weld irregularities, slag etc., shall be removed by grinding or chipping.

g. During the process of welding, all movements, shocks, vibration or stresses shall be carefully avoided in order to prevent weld cracks.

E.02.00. TEST AT SITE

E.02.01. PIPING

After the entire pipeline is erected, the pipeline shall be subjected to a hydrostatic test at 1.5 times the working pressure for a period of 2 (Two) hours. The test should be made in the presence of and to the satisfaction of the Employer's / Consultant's representative. Defects noticed in the test should be repaired or if necessary defective work should be replaced with new work. Tests shall be repeated until work is done satisfactorily. 10% of the total welding joints shall be tested for 'Radiographic' and the test results / films shall be submitted for approval. Any defects under welding have to be rectified by the Contractor free of cost.

E.02.02. WET RISER SYSTEM

After erection at site, the complete system shall be subjected to tests to show satisfactory performance in line with the requirements of specification and as per instruction of Employer/Consultant. The following tests shall be under taken in particular.

a. Automatic starting of all fire pumps by operating the test valves.
b. Operation of yard hydrant/internal hydrants and testing of sequential starting of all the fire pumps.
c. Testing of the complete system / equipment.

E.02.03. SPRINKLER SYSTEM

After erection, sprinkler system shall be tested to show the satisfactory performance in line with the requirement of the specification and as per instruction of the employer / consultant. However, the following tests shall be undertaken in particular.

a. Automatic starting of sprinkler pumps by actuating the sprinkler head in anyone of the zones as specified by the consultant / employer.

b. Automatic starting of all fire pumps without breaking the sprinkler bulb by operating test valves in the pump house.

c. Complete sequence of sprinkler annunciation panel shall be activated for the system requirement.

E.03.00. MANUALS

3 copies of manuals shall be submitted duly indexed with complete technical data sheet of each piece of equipment installed. The manuals shall be well bound and shall contain the following:

i. Table of Contents.

ii. Design data/standards.

iii. ‘As built’ drawings.

iv. Manufacturer’s catalogues, installation and maintenance brochure.

v. Spare parts list.

LEFT BLANK INTENTIONALLY

TECHNICAL SPECIFICATION

FOR

ELEVATOR

STANDARDS

STANDARDS COMPLAINCE: All work shall be performed in accordance with the latest edition of EN81/IS 14665 - Safety rules for construction and installation of electric Elevators, including published supplements; and such local codes as may be applicable.	
INDIAN STANDARD	
IS 14665 : Part 1 : 2000	Electric Traction lifts - Part 1 : Guidelines for Outline Dimensions of Passenger, Goods, Service and Hospital lifts
IS 14665 : Part 2 : Sec 1 and 2 : 2000	Electric Traction lifts - Part 2 : Code of Practice for Installation, Operation and Maintenance - Section 1 : Passenger and Goods lifts - Section 2 : Service lifts
IS 14665 : Part 3 : Sec 1 and 2 : 2000	Electric Traction lifts - Part 3 : Safety Rules - Section 1 : Passenger and Goods lifts - Section 2 : Service lifts
IS 14665 : Part 4 : Sec 1 to 9 : 2001	Electric Traction lifts - Part 4 : components - Section 1 : s Buffers - Section 2 : Guide Rails and Guide Shoes - Section 3 : Car-frame, Car, Counterweight and Suspension ? Section 4 : Safety Gears and Governors ? Section 5
IS 14665 : Part 5 : 1999	Electric Traction lifts - Specification - Part 5 : Inspection Manual
IS 15785: 2007	Installation and maintenance of lifts without conventional machine rooms - Code of Practice
IS 15330:2003	Installation and maintenance of lifts for handicapped persons - Code of Practice
NBC 2016	PART 8 SECTION 5 : Installation of Lifts & Escalators
EUROPEAN STANDARD	
EN 81	EUROPEAN STANDARDS FOR ELECTRIC TEACTION LIFTS
EN 115	EUROPEAN STANDARDS FOR ESCALATORS & TRAVALATORS
CIBSE GUIDE D: 2010	TRANSPORTATION SYSTEMS IN BUILDINGS
LOCAL STANDARD	
Local Lift Rules	

ON SITE TESTING SHALL BE CARRIED OUT INLINE WITH THE RECOMMENDATIONS OF ABOVE STANDARDS AND SHALL BE DULY APPROVED BY THIRD PARTY INDEPENDENT INSPECTORS APPOINTED BY US.

ELEVATOR SPECIFICATION

SL NO	SPECIFICATION	PASSENGER LIFT
1.00	BASIC DETAILS	
1.01	EQUIPMENT NOMENCLATURE	P1
1.02	EQUIPMENT TYPE	MACHINE ROOM TYPE
1.03	ZONE	No Zone
1.04	NO. OF UNITS	1 NO.
1.05 A	CONTROL SYSTEM	SIMPLEX
1.05 B	GROUPING	SIMPLEX ELEVATOR
1.05 C	GROUPED WITH	NOT GROUPED
1.06	CAPACITY NOT LESS THAN	544 KG X 8 PAX
1.07	SPEED NOT LESS THAN	1 MPS
1.08	NO OF STOPS / OPENINGS	06 / 06
1.09	SERVICE FLOORS	G,L1,L2,L3,L4,L5
1.10	NON SERVICE FLOOR	Nil
1.11	EMERGENCY EXIT FLOORS	Nil
1.12	FRONT OPENING FLOORS	G,L1,L2,L3,L4,L5
1.13	REVERSE OPENING FLOORS	Nil
1.14	TRAVEL(M) (APPROXIMATE)	15.3 M
1.15	HOISTWAY SIZE AVAILABLE AS PERARCH.DRW (Tolerance +0 MM/-50 MM (SHAFT TOLERANCE IS INDICATIVE AND FOR PLANNING PURPOSE ONLY)	1750 MM +0/-50 WIDE X 1750 MM +0/-50 DEEP
1.16	MACHINE LOCATION	ABOVE HOIST WAY IN SEPARATE MACHINE ROOM
1.17	CONTROL	ATTENDENT
1.18	PIT DEPTH REQUIRED	1800 MM
1.19	COUNTER WEIGHT SAFETY ON ACCOUNT OF HANGING PIT	NOT APPLICABLE
1.20	OVERHEAD REQUIRED	4115 MM
1.21	POWER REQUIREMENT	3 PHASE - 415 VOLTS, 50 HERTZ, 4 WIRE 1 PHASE - 220 VOLT, 50 HERTZ
1.22	COMBINED VOLTAGE AND FREQUENCY VARIATION	+/-10
1.23	CAR TYPE	WIDE
1.24	CLEAR CABIN INTERNAL SIZE	1300 MM WIDE X 1100 MM DEEP
1.25	CLEAR CABIN INTERNAL HEIGHT BELOW FALSE CEILING	2300 MM
1.26	MINMUM ACCEPTABLE CAR AREA IN SQ.M	1.31 SQM ~ 1.45 SQM

1.27	CAR DOOR WIDTH	800 MM
1.28	CAR DOOR HEIGHT	2100 MM
1.29	LANDING DOOR WIDTH	800 MM
1.30	LANDING DOOR HEIGHT	2100 MM
1.31	NON STANDARD ENTRANCE HEIGHT FLOORS	Nil
1.32	STRUCTURAL ENTRANCE WIDTH X HEIGHT	1000 MM WIDE X 2200 MM DEEP
1.33	FLOORING WEIGHT ALLOWANCE	100 KG
2.00	CABIN DETAILS & FINISHES:	
2.01	CAR ENCLOSURE - REAR PANEL	STAINLESS STEEL HAIRLINE FINISH IN 304 GRADE
2.02	CAR ENCLOSURE - LEFT SIDE PANEL	STAINLESS STEEL HAIRLINE FINISH IN 304 GRADE
2.03	CAR ENCLOSURE - RIGHT SIDE PANEL	STAINLESS STEEL HAIRLINE FINISH IN 304 GRADE
2.04	CAR ENCLOSURE - FRONT RETURN PANEL	STAINLESS STEEL HAIRLINE FINISH IN 304 GRADE
2.05	CAR ENTRANCE	AUTOMATIC POWER OPERATED
2.06	CAR DOOR TYPE	2 PANEL CENTER OPENING
2.07	CAR DOOR FINISH	STAINLESS STEEL HAIRLINE FINISH IN 304 GRADE
2.08	VISION PANEL	NOT REQUIRED
2.09	CABIN WEIGHT ALLOWANCE	NOT APPLICABLE
2.10	LANDING DOOR TYPE	2 PANEL CENTER OPENING
2.11	LANDING DOOR FINISH IN GROUND FLOOR	STAINLESS STEEL HAIRLINE FINISH IN 304 GRADE
2.12	LANDING DOOR FINISH IN ALL OTHER FLOORS	STAINLESS STEEL HAIRLINE FINISH IN 304 GRADE
2.13	VISION PANEL	NOT REQUIRED
2.14	ENTRANCE JAMB TYPE	NARROW - 50MM
2.15	LANDING ENTRANCE FRAME FINISH IN GROUND FLOOR	STAINLESS STEEL HAIRLINE FINISH IN 304 GRADE
2.16	LANDING ENTRANCE FRAME FINISH IS OTHER FLOORS	STAINLESS STEEL HAIRLINE FINISH IN 304 GRADE
2.17	DOOR OPERATOR	ACVVVF DOOR OPERATOR
2.18	CAR & LANDING SILL	EXTRUDED HARD ALUMINIUM
2.19	FIRE RATING FOR LANDING DOORS	60 MIN FIRE RESISTENT RATING
2.20	DOOR PROTECTION	INFRA RED SCREEN OF MINIMUM 75 BEAMS. THE LOWEST BEAM SHOULD BE AT 25 MM ABOVE THE FLOOR LEVEL AND THE HIGHEST BEAM SHOULD BE AT 1823 MM.
2.21	FLOORING	25 MM RECESS - FLOORING BY OTHERS
2.22	BUMPER RAIL - SS FLAT BAR MOUNTED 330 MM TO CENTRE OFRAIL FROM CAB FLOOR.	NOT REQUIRED
3.00	EQUIPMENT SPECIFICATION :	
3.01	PRIME MOVER	GEARLESS PERMANENT MAGNET SYNCHRONOUS MOTOR

3.02	ROPING TYPE	02:01
3.03	DRIVE MOTOR CONTROLLER - CUBICLE RATING IP 22	MICRO PROCESSOR BASED ACVVVF
3.04	TYPE OF HOIST MOTOR	**PM MOTOR**
3.05	BRAKE SYSTEM	**ELECTRO MECHANICAL BRAKE**
3.06	TYPE OF GROUP OPERATION	**SIMPLEX**
3.07	DOOR MOTOR TYPE & CONTROL	**ACVVVF**
3.08	COUNTER WEIGHTS	**CAST IRON BLOCKS**
3.09	POSITION OF COUNTER WEIGHTS	**REAR CWT**
3.10	CAR RAILS /CWT RAILS	**MACHINED T SECTIONS**
3.11	TYPE OF CAR GUIDE	**SLIDING TYPE GUIDE SHOE**
3.12	TYPE OF COUNTER WEIGHT GUIDE	**SLIDING TYPE GUIDE SHOE**
3.13	LOAD COMPENSATION (if required)	**ENCAPSULATED CHAIN WITH GUIDE IN THE PIT**
4.00	SAFETY FEATURES:	
4.01	CAR SAFETY	**GRADUAL**
4.02	LANDING DOOR LOCK	**ELECTRO MECHANICAL**
4.03	EMERGENCY BRAKE RELEASE	**REQUIRED**
4.04	OVER SPEED PROTECTION	**BI DIRECTIONAL OVER SPEED GOVERNOR**
4.05	SAFETY BUFFERS IN PIT	**OIL BUFFER /SPRING BUFFER**
4.06	PROVISION FOR EMERGENCY OPENING OF LANDING DOOR AT EACH FLOOR	**REQUIRED**
5.00	INDICATORS ,SIGNAL FEATURES & OPERATING DEVICES	
5.01	CAR	
5.02 A	NO. OF CAR OPERATING PANELS	**ONE ON THE FRONT RETURN PANEL**
5.02 B	PRIMARY COP	**THE MAIN COP SHALL CONSIST OF FLOOR BUTTONS , INTERCOM, ALARM, DOOR OPEN & DOOR CLOSE BUTTONS ALONG WITH A SERVICE CABINET . THE INDICATOR SHALL BE MOUNTED ON THE TOP PORTION OF THE PANEL. THE COP SHALL BE FULL HEIGHT**
5.02 C	AUXILLARY COP	**NA**
5.02 D	TYPE OF CAR OPERATING PANEL	**WITH FACE PLATE**
5.02 E	FINISH OF FACE PLATE (COP)	**STAINLESS STEEL HAIRLINE FINISH**
5.02 F	THICKNESS OF FACE PLATE (COP)	**3 MM**
5.02 G	BUTTON TYPE	**MICRO MOTION CLICK TYPE VANDAL PROOF WITH BRAILLE MARKINGS**
5.02 H	CABIN CAR ILLUMINATION	**ATTRACTIVE DOWN LIGHTS - MINIMUM 50LUX AT FLOOR LEVEL AND ON CONTROL DEVICES.**
5.02 I	LIGHTING FIXTURES	**COLD WHITE OR WARM WHITE COLOUR LED BASED LIGHTS WITH BUILT IN TRANSFORMERS (3 PIECES 1 W LUXEON LED) IN ALUMINIUM CASING WITH A BEAM ANGLE OF 30 DEGREES**
5.02 J	FALSE CEILING	**MANUFACTURER SHOULD PROVIDE MINIMUM 5 OPTIONS FOR SELECTION**
5.02 K	ATTENDANT OPERATION WITH KEY SWITCH	**REQUIRED**
5.02 L	FAN CONTROL	**REQUIRED**
5.02 M	PRESS & SPEAK THREE WAY, BUILT IN INTERCOM (INCLUDING WIRING UPTO BUILDING CONTROL ROOM)	**REQUIRED**
5.02 N	CAPACITY PLATE	**REQUIRED**

5.02 O	EMERGENCY DISPLAY ENGRAVED IN STAINLESS STEEL PLATE OF 3 MM THICK	**REQUIRED**
5.02 P	CAB VENTILATION a) CROSS FLOW FAN -2 NOS NOT MORE THAN 0.33 W PER CUBIC FEET PER MIN AT MAXIMUM SPEED) b) NATURAL VENTILATION THERE SHALL BE A MINIMUM AIR HANDLING CAPACITY TO PROVIDE ONE AIR CHANGE PER MINUTE BASED ON THE NET INSIDE CAR VOLUME.	**REQUIRED**
5.02 Q	NO SMOKING SIGNAGE	**REQUIRED**
5.02 R	DISPLAY UNIT IN EACH CAR WITH 50 MM HIGH NUMERALS, ON THE COP	**DOT MATRIX /16 SEGMENT DIGITAL**
5.02 S	HANDRAIL	**REQUIRED ROUND TYPE ON THREE SIDES**
5.03	HALL POSITION INDICATION IN ALL FLOORS	**DOT MATRIX /16 SEGMENT DIGITAL**
5.04	HALL POSITION INDICATION IN MAIN LOBBY FLOOR	**DOT MATRIX /16 SEGMENT DIGITAL**
5.05	NUMBER OF HALL BUTTON RISERS IN EACH FLOOR	**ONE RISER PER FLOOR**
5.06	HALL CALL BUTTONS TYPE AT ALL FLOORS	**VANDAL PROOF BUTTONS IN STAINLESS STEEL FINISH WITH BRAILLE MARKINGS**
5.07	FULL WIDTH HALF HEIGHT CLEAR MIRROR	**REQUIRED ON REAR SIDE**
5.08	CAR TOP BARRICADE MIN 700 MM TO 1100 MM AS PER CODE	**REQUIRED**
5.09	EMERGENCY LIGHT WITH 30 MINUTES BACK AND Ni-Cd BATTERIES ILLUMINATING 3 W LED LAMPS	**REQUIRED**
5.10	TRAVELLING CABLE - FLAT TYPE WITH MINIMU 10% SPARE CORES, FRLS, HALOGEN FREE WITH INBUILT `CAT 6E / FIBER OPTIC / CO- AXIAL CABLE FOR CAMERA, VOICE AND DATA (REQUIREMENT OF CAT 6E / FIBER OPTIC / CO-AXIAL WILL BE SELECTED BY THE CLIENT BASED ON THE END SYSTEM)	**REQUIRED**
5.11	LIFT IDENTIFICATION (STYLE & TYPE AS PER CLIENTS CHOICE)	**NOT REQUIRED**
5.12	CABIN VENTILATION AT SKIRT LEVEL .	**REQUIRED**
5.13	CABIN TOE GUARD - PAINTED GI SHEET FOR 1 MM THICK	**REQUIRED**
5.14	FULL HEIGHT LANDING FASCIA - PAINTED GI SHEET FOR 1 MM THICK	**REQUIRED**
5.15	CROSS FLOW BLOWER .	**REQUIRED**
5.16	EMERGENCY ALARM CAN BE OPERATED BY PRESSING A BUTTON IN THE CAR. POWER SUPPLY IS OBTAINED FROM Ni-Cd BATTERIES.	**REQUIRED**
6.00	OPERATING FEATURES	
6.01	Full collective operation Registered car and hall calls are answered in the order in which the landings are reached.The direction of travel is established by the first registered car command or hall call.	**REQUIRED**
6.02	Advanced Door Opening To improve performance time, the doors will begin opening as the car approaches a landing.	**REQUIRED**
6.03	Fireman operation During a fire when the fireman `s switch is activated the car call of all cars and all calls are cancelled and the cars immediately returns to a pre determined floor.	**FIRE LIFT**

	The designated fire lift then responds only to car calls which facilitates fire fighting and rescue operations.	
6.04	Firemens emergency Return Upon activation of the fireman`s switch or a key switch or the buildings smoke/fire sensors, all calls are cancelled, all cars return to a specified evacuation floor and the doors then open for the safe exit of the passengers. The activation of the Smoke/ fire alarm in any other floor shall bring the elevator to the Ground floor and the activation of Smoke/ Fire alarm in the ground floor shall bring all the elevators to another predetermined floor.	**REQUIRED**
6.05	Safe landing operation If a car has stopped between floors due to some equipment malfunction, the controller checks the car and if its considered safe to move the car, the car will move to the nearest floor at a lower speed and the doors will open.	**REQUIRED**
6.06	Next landing operation If the Elevator do not open fully at destination floor, the doors close the car automatically moves to the next or nearest floor where the doors will open.	**REQUIRED**
6.07	No Correction Mode After power failure and ARD operation when the power supply is resumed, Elevator should continue to attend Car / Hall Calls without going to terminal floor for re setting the floor position reference.	**REQUIRED**
6.08	Top of Car Inspection The inspection operation switch and its push buttons and an emergency stopping device shall be placed on the car roof that they are readily accessible.	**REQUIRED**
6.09	Hand operation In the event the elevator is stuck in between floors, a brake release device should be provided to open the brakes and allow the car to move in a controlled manner and bring it to level.	**REQUIRED**
6.10	Emergency Brake release and manual Rescue operation In the event the elevator is stuck in between floors, a brake release device should be provided to open the brakes and allow the car to move in a controlled manner and bring it to level.	**REQUIRED**
6.11	Motor Overheat Protection Self protection mode will be achieved if the temperature of the motor exceeds the preset value due to the heat made by motor itself or the high temperature in the environment. The car stops at the nearest floor, once the temperature falls down to normal, the car will recover.	**REQUIRED**
6.12	Overload holding stop with indicator If the load exceeds the rated load, the sound signal will be given out by Speaker and `OVERLOAD` will be displayed, the car door will not close, the elevator will not start. The overload condition is removed when the weight of the car falls below the rated load.	**REQUIRED**
6.13	Over load Bypass When a car is loaded to a predetermined percentage of capacity, weight sensing devices are activated, causing the car to bypass further hall calls.	**REQUIRED**
6.14	Door Hold Button Pressure on the Door Hold Button in the car operating panel opens the door, reverses the door and keeps the door open for a specified adjustable door hold time.	**NOT REQUIRED**
6.15	Door open/close button light Door open/close button will be highlighted if the buttons are pressed.	**REQUIRED**

6.16	Separate Hall & Car call door times The time that an elevator door remains open after a stop defers between hall & carcalls. Generally more time is needed for a car to respond to hall calls.	**REQUIRED**
6.17	Reopen with Hall Call Button operation Closing doors can be opened by pressing the hall button corresponding to the travel direction of the car.	**REQUIRED**
6.18	Door Load Detector When excessive door load has been detected while opening or closing, the doors immediately move in the reverse direction.	**REQUIRED**
6.19	Repeated door -close Should an obstacle prevent the doors closing, the doors will repeatedly open and close until the object is removed.	**REQUIRED**
6.20	Door Nudging If the doors are prevented from closing for a fixed period of time a buzzer sounds and the doors begin to close at slow speed.	**REQUIRED**
6.21	Door time protection close If the car door does not close completely within an adjustable time after the door close command, the elevator will enter the mode: Remove itself from group operation, i.e. Extinguish hall or car direction lanterns. Hall calls will be assigned to other elevators in the group. open its doors and sound the buzzer in the car- operating panel. attempt to close the doors again after three unsuccessfull retries, the car will be shut down with its doors open and deenergized. Pending car calls will be cleared.	**NOT REQUIRED**
6.22	Automatic door speed control The system monitors the actual door load conditions at each floor and automatically adjust the door speed and torque accordingly.	**REQUIRED**
6.23	Door sensor self diagnosis operation Failure of non-contact door sensors is checked automatically, and if a problem is diagnised, the door close timing is delayed and the closing speed is reduced to maintain elevator service and ensure passenger safety.	**REQUIRED**
6.24	Car arrival chime On each floor , a bell ring will be given out when the car stops approaches at the destination floor.	**REQUIRED**
6.25	Voice Guidance System Information on elevator service such as current floor or service direction will be heard by the passengers inside the car. The system will alo make announcements on the emergency operations	**REQUIRED**
6.26	Car call erase Before the car starts the registration of a car or operation can be cancelled by double click of this button. After the car starts the registration cancelling will not be allowed.	**REQUIRED**
6.27	False call cancelling If the number of registered car calls does not correspond to the car load, all calls are cancelled to avoid unnecessary stops.	**REQUIRED**
6.28	Car Travel Time Evaluation Cars are allocated to hall calls by considering the number of car calls that will reduce passenger waiting time in each hall and the travel time of each car.	**NOT REQUIRED**
6.29	Automatic Hall call registration If one car cannot carry all waiting passengers because it is full, another car will automatically be assigned for the remaining passengers.	**REQUIRED**
6.30	Main Floor Parking An available car always parks on the main floor with the doors open to reduce the passenger waiting time.	**REQUIRED**

6.31	Immediate Prediction When a passenger has registered a hall call, the best car to respond to that call is immediately selected. The corresponding hall lantern lights up and chime sounds once to indicate which lift doors will open.	**NOT REQUIRED**
6.32	Continuity of service A car experiencing trouble is automatically withdrawn from group operation to maintain an overall group performance.	**NOT REQUIRED**
6.33	Car Fan/Light shutoff- Automatic If there are no calls for a specified period the car ventilation fan/lighting will automatically be turned off to conserve energy.	**REQUIRED**
6.34	Terminal floor protection When the lift arrives at the terminal floor, and the speed exceeds the imaginary speed line calculated from control system, the car would be forced to decelerate and stop at the terminal floor.	**REQUIRED**
6.35	Regenerative Drive For energy conservation, power generated by a traction machine can be harnesed using regenerative drives and converted to electrical power to be used by other electrical systems in the building.	**NOT REQUIRED**
6.36	CCTV Cable An additional FIBER OPTIC / Co- Axial / CAT-6E cable to be used for close circuit television monitoring. This system enables the security personnel to monitor the movement inside the elevator. this will be effective in preventing criminal and mischievous acts inside the elevator. CCTV System including external wiring will be by others.(Type of cable will depend on the end user requirement)	**REQUIRED**
6.37	Group indicator panel / Supervisory Panel A panel installed inside the engineering room or anyother location inside the building helps to monitor each elevator status and operation status and operations using indicators. Scope includes wiring upto Chief Engineer`s room.	**NOT REQUIRED**
6.38	Energy saving operation (No. of Cars) To save energy, the number of service cars is automatically reduced to some extent but not so much that it adversely affects passenger waiting time.	**NOT REQUIRED**
6.39	Emergency Exit On car top An emergency trap door in the car roof to permit the rescue and evacuation of passengers. The exit should measure at least 0.50 M x 0.70 M	**NOT REQUIRED**
6.40	Automatic Rescue Device This device is used for rescue operation in case of power shut down, it is powered by a rechargable battery when a sudden power cut happens, a sound signal will comfort the trapped passengers, then the car will move towards to the near floor, keep the door open, meanwhile trapped passengers can get out of the car.	**REQUIRED**
6.41	Energy saving operation (Allocation control) When a call is registered, the system controls car assignment considering near - future traveling distance of all elevators to conserve the energy.	**NOT REQUIRED**
6.42	Potential Free Contacts All elevators are to be provided with a dry-contact interface. Customer can use it to monitor the elevator status and the signal to be indicated are : a. Emergency stop switch in the cabin or any other elevator safety activated signal. b. Operation of alarm bell signal. c. Firemen`s emergency operation signal. d. Car position status. e. Indications of faulty conditions.	**NOT REQUIRED**

	f. Indications of equipment operation. g. Run / Stop status	
6.43	ACCESS CONTROL Necessary dry contacts shall be provided for interphase with access control system. The elevator vendor shall terminate these potential free contacts in the pit of every elevator. There shall be a over rider provided in the service cabinet of the specific elevator. Integration with access barriers shall also be possible.	**NOT REQUIRED**
6.44	EMERGENCY BATTERY OPERATED POWER SUPPLY FOR ALL LIFTS A invertor based battery operated emergency power supply source should be provided on top of the cabin and connected to the emergency alarm, emergency light, fan and intercom. The required backup is for additional 1 hour beyond the default half a hour provided for individual items	**REQUIRED**
6.45	HIGH-DEFINITION LCD DISPLAY UNIT THAT HAS THE FOLLOWING FUNCTIONS : a. Floor and travel directions of lift b. User / time based messages c. Lift status messages d. Date / time e. Time based pictures/videos f. Floor directory messages g. MPEG 1 and MPEG 4 play back h. Portrait view i. Remote configuration THE MINIMUM VIEWING AREA SHOULD BE 228 MM W X 304 MM H.CONTRAST RATIO OF 400:1 OPERATING ON 12 V DC THIS CAN BE USED AS A MEANS OF PROVIDING IN-HOUSE INFORMATION OR AS A MEANS OF PUBLIC RELATIONS THE COP TO INDICATE, SERVING FLOORS	**NOT REQUIRED**
6.46	Flashing Hall lanterns A Hall lantern which corresponds to a cars service direction Flashes to indicate that a car will soon arrive.	**NOT REQUIRED**
6.47	Bank Separation operation Hall buttons and the cars called by each button Can be divided into several groups for independent group control operation to serve special needs or different floors.	**NOT REQUIRED**
6.48	Back-up operation for group control An operation by car controllers, which automatically starts to maintain elevator operation in the event that a micro processor or transmission line in the group controller has failed.	**NOT REQUIRED**
6.49	VIP OPERATION A specified car is withdrawn from group control operation for vip service operation. When activated , the car responds only to the existing car calls, moves to the specified floor and parks there with the doors open. the car then responds only to the car calls.	**NOT REQUIRED**
6.50	OPERATION FOR EMERGENCY : The car upon the activation of exclusive button on the car operating panel the elevator transports , the bed/medical equipment etc. exclusively to a preprogrammed emergency floor without responding to other calls.	**NOT REQUIRED**
6.51	RETURN	

	Upon activation of primary and/or secondary wave seismic sensors, all cars stop at the nearest floor, and park there with the doors open to facilitate the safe evacuation of passengers.	**NOT REQUIRED**
6.52	FLOOD EMERGENCY RETURN: Upon activation of flood sensors, all cars stop at the nearest floor, and park there with the doors open to facilitate the safe evacuation of passengers.	**NOT REQUIRED**
6.53	ELEVATOR MONITORING SYSTEM: Each elevator status can be monitored and controlled using an advanced web based technology which provided an interphase through personal computers. It should be possible to turn on /off the elevators and change the service floors using this system. Scope includes wiring upto Chief Engineer`s room and all hardware including PC (common for whole project)	**NOT REQUIRED**

TECHNICAL DATASHEET ELEVATOR

SL NO	SPECIFICATION	PROPOSED Construction of G+1 floors Indian Bank, Institutional Building at Konur Village Namakkal -Remarks	PAPL COMMENTS
1	MOTOR KW RATING		
2	STARTING CURRENT - AMPS		
3	RUNNING CURRENT - AMPS		
4	KVA RATING		
5	HEAT EMISSION IN MACHINE ROOM - KCAL		
6	NOISE LEVEL IN CABIN - DB		
7	NUMBER OF MAIN ROPES - NOS.		
8	SIZE OF MAIN ROPES - MM		
9	SIZE OF GOVERNOR ROPE - MM		
10	BUFFER TYPE		
11	SAFETY SYSTEM		
12	COUNTER WEIGHT MATERIAL - AS PER TENDER		
13	DECORATION WEIGHT CONSIDERED FOR FLOORING - KG		
14	MACHINE ROOM AIRCONDITIONING		
15	CABIN HEIGHT UNDER FALSE CEILING FROM TOP OF FLOORING - MM		
16	CABIN HEIGHT UNDER ROOF FROM TOP OF FLOORING - MM		
17	CAR TOP CONTROLS		
18	FALL PROTECTION ON CAR TOP AND HEIGHT AS PER TENDER REQUIREMENT		PLEASE PROVIDE THE POWER DETAILS FOR
	PROVISION FOR ACCESS CONTROL		

19	SYSTEMBOTH IN CAR AND IN THE LANDING AS PER TENDER REQUIREMENT		CLIENT REQUIREMENT
20	ALL THREE PHASE EQUIPMENTS SHOULD BE DOUBLE EARTHED. THREE PHASE POWER EARTHING SHOULD BE CONNECTED SEPARATELY WITH INDEPENDENT BOLT AS PER INDIAN CODE REGULATIONS. EARTHINGS CAN BE EITHERIN COPPER OR IN GI TO MEET THE REQUIREMENT.		
21	EMERGENCY STOP SWITCH IN PIT AT TWO LOCATION		
22	PIT LADDER UP TO HEIGHT OF 1300MM FROM LAST LANDING		
23	COUNTER WEIGHT SCREEN GUARD IN THREE LOCATION - PIT , OVER HEAD ANDAT THE POINT WHERE THE CAR AND COUNTER WEIGHT CROSS EACHOTHER.		

SITEWORKS

SL NO	SPECIFICATION	REQUIREMENT	PROPOSED Construction of G+1 floors Indian Bank, Institutional Building at Konur Village Namakkal -Remarks	PAPL COMMENTS
1.00	MINOR BUILDERS WORK	BY ELEVATOR VENDOR		
1.01	SAFETY BARRICADES DURING ERECTION	BY ELEVATOR VENDOR		
1.02	STEEL ITEMS - M/C. BEAMS, SILL ANGLES, BUFFER SUPPORT CHANNELS, CAR & CWT BRACKETS,FASCIAS, TOE GUARD,SEPARATOR BEAMS ETC.	BY ELEVATOR VENDOR		
1.03	SCAFFOLDING	BY ELEVATOR VENDOR		
1.04	PIT LADDER	BY ELEVATOR VENDOR		
1.05	STORE ROOM - ENCLOSURE, SAFTY AND SECURITY BY (ONLYSPACE WILL BE PROVIDED BY OWNER)	BY ELEVATOR VENDOR		
1.06	LIFT LICENSE	BY ELEVATOR VENDOR		

1.07	UP TIME GUARANTEE	99%		
1.08	RESPONSE TIME FOR ATTENDINGTHE BREAK DOWN FROM THE TIME INTIMATION IS MADE	1 HOUR		
1.09	RESPONSE TIME FOR RECTIFICATION FROM THE TIMEOF ATTENDING TO THE CALL	2 HOURS		

TEST CERTIFICATE

SL NO	SPECIFICATION	Remarks
	TEST CERTIFICATES	
1	GOVERNOR	
2	MACHINE	
3	BUFFER	
4	CONTROLLER	
5	AUTOMATIC RESCUE DEVICE	
	TYPE TEST CERTIFICATES	
1	DOORS	
2	TRAVELING CABLE	
3	HOISTWAY WIRING	
4	MAIN ROPE	
5	GOVERNOR ROPE	
6	CAR RAIL	
7	COUNTER WEIGHT RAILS	
	ON SITE TESTS	
1	LOAD TEST	
2	OVER SPEED GOVERNOR	
3	BUFFER COMPRESSION TESTS	
4	PMT READINGS	

APPROVALS ELEVATOR

SL NO	SPECIFICATION	PROPOSED Construction of G+1 floors Indian Bank, Institutional Building at Konur Village Namakkal - Remarks
	CAR FINISHES	
1	CABIN	
2	CEILING	
3	COP & BUTTONS	
4	CAR DISPLAY	
5	FLOORING	
6	CAR DOOR	

	LANDING FINISHES	
1	DOORS	
2	LANDING DISPLAY / DCS PANEL	
3	HALL CALL BUTTON	
4	HALL LANTERN	
	DRAWING APPROVAL	
1	SHAFT PLAN	
2	SECTION	
3	ENTRANCE VIEW	
4	MACHINE ROOM LAYOUT	
5	OTHER COMPONENTS SUCH AS BEAM GROUTING, HOISTING HOOK / BEAM, ELECTRICAL LINE DIAGRAM ETC..	

INNOVATIONS

SL NO	**SPECIFICATION**	**PROPOSED Construction of G+1 floors Indian Bank, Institutional Building at Konur Village Namakkal - Remarks**
1	IS REGENERATIVE DRIVE PAR OF YOU?RE YOUR SPECIFICATION	
2	MANUAL RELEASE LEVER FOR RESCUE PROVIDED IN CONTROL PANEL IN TOP LANDING IN MACHINE ROOMLESS ELEVATORS	
3	SAFETY SWITCH IS PROVIDED FOR THE MANUAL CRANKING WHEEL IN THE MACHINE ROOM - WHEN THE CRANKING WHEEL IS REMOVED FROM ITS POSITION FOR ANY RESCUE PROCESS A SAFETYSWITCH AUTOMATICALLY CUTS OFF POWER TO THE ELEVATORS	
4	ALL GEARLESS MACHINES HAVE EMBEDDED PM MAGNETS & NOT GLUED	
5	DC DOOR MOTOR IS PROVIDED	
6	ELEVATORS ARE IOT READY	
7	CAR TOP EMERGENCY IS PROVIDED	

APPROVED PARTS

MOTOR /MACHINE	OTIS , KONE ,SCHINDLER ,CROMPTON , SIEMENS, KINETIC
DRIVE	OTIS , KONE ,YASHIKAWA ,HITACHI ,TOSHIBA , MITUSBISHI ,FUJI , SCHINDLER
DOORS	OTIS , KONE ,SCHINDLER ,WITTUR , FERMATOR

RAILS	MONTEFERO ,SIEMATIC
ROPES	USHAMARTIN
SS PANELS	TATASTEEL , JSW & SAIL
BATTERY	EXIDE ,AMARON ,FUJI ,AMCO

ADDITIONAL FEATURES

SL NO	SPECIFICATION	PROPOSED Construction of G+1 floors Indian Bank, Institutional Building at Konur Village Namakkal - Remarks
1	BIGGER CAPACITY PROVIDED THAN THE TENDER SPEC.	
2	HIGHER SPEED PROVIDED THAN THE TENDER SPEED.	
3	BETTER DISPLAYS PROVIDED THAN THE TENDER SPECIFICATION.	
4	ADDITIONAL WARRANTY PROVIDED THAN THE TENDER SPECIFICATIONS.	

LIST OF APPROVED MAKES OF MATERIALS

List of Material of
Approved Makes / Brands

The contractor shall quote for the best of the materials specified below with ISI mark wherever applicable. The contractor shall obtain prior approval from the Bank / Architect before placing order for the specific materials agencies. In case of non availability of any of the approved/specified materials/agency during the execution of the work, the Bank /Architect may approve suitable equivalent brand/agency and his decision shall be final and binding on the contractor and the price variations If any shall be adjusted accordingly.		
LIST OF CIVIL WORK MATERIALS		
1	Grey Cement (43 or 53 Grade)	UltraTech / A.C.C / Ramco / Coramandel
2	White Cement	Birla White / J.K.white
3	Putty	Birla White Putty / JK Wall putty
4	Steel (Thermo Mechanically Treated Steel) High strength deformed bars	TATA / SAIL / JSW
5	Clay Bricks	Table moulded clay bricks of crushing strength not less than 35 kg / sq cm approved by Engineer / Architect.
6	200MM AND 100 MM THICK SOLID CONCRETE BLOCK WORKS	Good quality locally available material approved by Engineer / Architect
7	Teakwood Panel Main Frame and Shutter	Ghana teak wood 2nd Quality
8	Bank internal ,Dormitory and toilet doorframe Teak wood	Ghana teak wood 2nd Quality
9	Bank internal ,Dormitory and toilet doorframe water proof flush door with lamination two site	Century / Anchor / Archid / Green
10	Main Door heavy duty SS Ball Bearing Butt Hinges ,Brass Mortise Locks & Latches, SS Tower bolt, Handle & Stopper.	Hardware – Godrej / Ebco / Hettich / Hebba
11	Bank internal, Bedroom and Toilet heavyduty SS Ball Bearing Butt Higes, Brass Mortice Locks, Cylindrical Lock & Latches, Tower Bolt with Handle.	Hardware – Godrej / Ebco / Hettich / Hebba
12	UPVC frame for windows, Ventilator, glazing	Fenesta / Kommerling, with Saint Gobin glass
13	Water proofing material / compound.	Pidilite / Sika / DR. Fixit / Cico
14	ceiling paint material Premium emulsion paint With primer	Asian paint-Classic emulsion / Nippon / Dulux paint / Berger
15	Internal wall paint Premium emulsion with primer	Asian paint-Classic emulsion / Nippon / Dulux paint / Berger
16	External paint (ACE) emulsion paint With primer	Asian Ultima Range / Nippon / Dulux / Berger
17	window Grill of synthetic enamel paint with corrosion protection (zinc	Asian paint / Nerolac paint / Dulux / Berger

	chroming)	
18	Melamine Polish	Asian paint / MRF / Nerolac / Dulux / Berger
19	External Texture paint Finish(frontelevation)	Asian Paints Apex ULTIMA allura range / Axo noble Dulux, DuluxWeather Shiled Textured Finishes
20	ACP CLADDING (In Front/Side Elevation)	Alucobond / Eurobond
21	Vitrified tiles	RAK / NITCO / Johnson / Khajaria
22	Granite (Bank 1st Floor & Staircase Area, and Lift Wall Gladding with	Good quality available material approved by Engineer / Architect
23	Decorative Concrete Parking Tile 38 mm	Basant Beton / Eurocon
24	Iterlocking Paver Block	Basant Beton / Eurocon
25	MS Rolling Shutter & Grills	Good quality locally available material.

WATER SUPPLY AND DRAINAGE

LIST OF APPROVED BRAND / MAKE / MANUFACTURE

PORCELAIN WARES	:	PARRYWARE / ROCA / HINDWARE / KOHLER
U.P.V.C. PIPES	:	ASTRAL / ASHIRWAD / SUPREME / FINOLEX
P.V.C. FITTINGS	:	ASTRAL / ASHIRWAD / SUPREME / FINOLEX
C.P.FITTINGS / TOILET ACCESSORIES	:	JAQUAR / SCHELL
BALL VALVES	:	RB / ZOLOTO / LEHRY / LEADER
CPVC PIPES	:	ASTRAL / ASHIRWAD / SUPREME / FINOLEX
GATE VALVES	:	LEADER / ZOLOTO / LEHRY / RB
FLUSHING CISTERN (CONCEALED)	:	GEBERIT
MIRROR	:	PARRYWARE / MODIGUARD / ASAHI
BUTTERFLY VALVES	:	LEADER / ZOLOTO / LEHRY
PUMPS	:	GRUNDFOS / ITT / KIRLOSKAR
Y STRAINER	:	ZOLOTO / LEHRY / TECHNO
PRV	:	RB / HAWK / LEHRY
WATER METER	:	TOSHNIWAL / EUREKHA
CHECK VALVE / NON-RETURN VALVE	:	LEADER / ZOLOTO / LEHRY
FRP MANHOLE COVER	:	HP STRONG DRAIN
PRESSURE GAUGE	:	H-GURU, WIKA
LEVEL INDICATOR	:	LEHRY
PVC ENCAPSULATED FOOTREST.	:	TCS / EQUAL APPROVED MAKE
R.C.C. PIPES	:	MAHALAKSHMI SPUN PIPES / INDIAN HUME PIPE WITH ISI
STORAGE HEATERS	:	RACOLD / VENUS
BRACKET SUPPORTS	:	LOCALLY FABRICATED
CONNECTION PIPE-PVC	:	USING ASTRAL / ASHIRWAD / SUPREME / FINOLEX
PVC FITTINGS (MOULDED)	:	USING ASTRAL / ASHIRWAD / SUPREME / FINOLEX

LIST OF APPROVD MAKES - FIRE SUPRESSION SYSTEM

I. WET RISER CUM DOWN COMER / SPRINKLER SYSTEM

1.	Pumps		Kirloskar / Mather & Platt / Greaves
2.	Motor		ABB / Siemens
3.	Diesel Engine		Kirloskar / Greaves Cotton
4.	Motor Control Panel / Diesel Auto Start Panel		Creative switch gear/ Bright Engineering / Excel / Lotus controls / Chennai control system / Hallmark controls & security systems
5.	Pipes		Jindal /Tata / Zenith
6.	Butterfly fly & Ball Valve		Keystone / Audco / Lehry / leader / Zoloto
7.	Sluice Valve		Kalpana / Sarkar / Kirloskar
8.	Expansion Joints		Cori / Kanwal
9.	Hydrant Valve & Branch Pipe		Newage / Sukan / Winco / Shah Bhogilal
10.	Fire Brigade Inlets		Newage / Shah Bhogilal
11.	RRL Hoses		Newage / Chataria / Shah bhogilal
12.	Hose Box		Newage / Eversafe / Eqv.
13.	Pressure Gauge		H.Guru / Wika
14.	Pressure Switch		Indfos / Switzer
15.	Cables		Polycab / CCI / Universal / Finolex
16.	Alarm Valve, Sprinklers		HD / Tyco / Viking
17.	Flow Switches		System Sensor / Switzer / Emerson / Endress+ Hauser
18.	Paint		Asian Paint / Shalimar / Berger
19.	Pipe Fittings		VS / BM / Equivalent
20.	Supports		Hitech / Sarathi
21.	Nuts & Bolts		Precision / Unbrako / Equivalent
22.	Extinguishers		Minimax / Safex / Cease fire / Usha fire
23.	Non return valve		Audco / Keystone / Lehry / Normex
24.	Coating and Wrapping		IWL pypkote
25.	Air release valve		Newage / Zoloto / Lehry
26.	Strainer		Procedeyne / Zoloto/ Advance/ Fluid line
27.	Flexible Hose		HD Fire / Viking / Tyco

LIST OF APPROVED MAKES - ELECTRICAL SYSTEM

Sl.No	Description		Approved Makes
1	Cutouts	..	Sethco
2	Moulded Case Circuit breakers - Rate Service Voltage -690Volts, TPN switches / Switch Fuse units / Fuse Switches and HRC fuses	..	Siemens / Schneider / ABB / Legrand
3	Miniature Circuit Breaker Distribution Boards	..	Legrand / Hager / Schneider / Siemens
4	Miniature Circuit Breakers / Isolators / Residual Current Circuit Breaker or Residual Current Circuitwith Overload breakers / Contactors		Legrand / Hager / Schneider / Siemens
5	Indicator	..	Teknic / Vaishnov
6	Indicating Meters and Mesasuring Digital Meters	..	Conserve, Secure, Rishab, Elecon
7	Current transformers		AE / Kappa
8	Selector switches		Kaycee / L&T / ABB
9	Indicating lamps	..	Teknic with LED lamps
10	Power, Control cables	..	RR Kable / Polycab / Seichem / KEI
11	Terminations	..	Jainsons / Dowells
12	PVC Insulated Copper Conductor Wires	..	Finolex / RR Kable / Polycab
13	Cables and Wires for DC Power	..	LAPP / Top Solar / Nexans / Schneider
14	PVC Conduits with Accessories	..	Avon Plast / Essorke / EMJay
15	MS Conduits with Accessories	..	Gupta / Bharat
16	Switches / Sockets / Electronic Regulator and RJ 11 Telephone and Co Oxial Television Outlets	..	Anchor Roma / Legrand Mylinc / Schneider Livia / Crabtree
17	IP54 Plug & Socket with MCB / Rotary Switch	..	Legrand / Clipsal
18	Industrial Plug & Socket with MCB / Rotary Switch	..	Legrand / Clipsal
19	Telephone cables - Unarmoured	..	Delton / Lapp Kabel
20	TV Cable	..	Finolex / Comscope
21	Ceiling Fan	..	Usha / Grompton / Bajaj
22	Exhaust Fan	..	Almonard / Ebm Nadi / Rexello
23	Light Fixtures	..	Philips / Wipro / Osram
24	Fire Extinguisher	..	Alert / Tyco / Minimax / Newage / Ceasefire
25	Power Capacitors	..	Schneider / Siemens
26	Diesel Generator Set	..	Cummins / Kirloskar Green
27	Panel Board / AC DB	..	Local fabrication with test certificate from CPRI
28	Surge Protection Devices	..	OBO Bettermann / Legrand / Schneider

29	Lightning Protection System	..	OBO Bettermann
30	Cable Tray	..	OBO Bettermann
31	Fasteners	..	Hilti / Fisher
32	RMU	..	Siemens / CGL / Schneider
33	Solar PV Cells	..	Vikram Solar / Warre / Emmvee / HHV / Tata / Adani / REC / Sun Power / Panasonic / Trina Solar / Bosch / Q Cells
34	Solar Inverter	..	Delta / ABB / Schneider / Refusol / Kaco / SMA .
35	External duty Weather Proof Junction Boxes with terminals and glands	..	Hensel / Spelsberg / ABB / Cooper busman
36	PV Module interconnecting Connector	..	Tyco / Cooper busman / MC
37	Ethernet switch	..	Amp / Dax / Cisco / Logitec
38	Cat-6 cable	..	Amp / Avaya / Beldon / Krone Communication / Molex / Dax / Cisco
39	Data logging System	..	Delta / ABB / Schneider / Kaco Monitoring / SMA / Energy Recommerce / Refusol / Energy Tracking lic
40	Paints	..	ICI / Asian / Berger / Kansai Nerolac

THIS PAGE LEFT BLANK INTENTIONALLY