GUJARAT MINERAL DEVELOPMENT CORPORATION LTD
(A Govt. of Gujarat Enterprise)
CIN :L14100GJ1963SGC001206
GST :24AAACG7987P1ZT

TENDER NO. : 17/BVN/ARC/CIVIL MAINTENANCE WORK/2020
(Re invite)

Annual Maintenance Contract for Two years for the Miscellaneous Civil works
(Repairs and Maintenance work as an when required)
at Colony and Mines Premises at
GMDC Lignite Project Bhavnagar
TAL: GHOGHA , DIST: BHAVNAGAR

TECHNICAL BID-III

GENERAL TECHNICAL SPECIFICATIONS

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LIST OF I.S. CODES

Materials used shall conform to appropriate standards specified by the Bureau of Indian Standards and unless otherwise specified, these standards will form a part of these specifications. In particular, the following or latest standards should be referred to

AGGREGATE:

IS: 383-1970	Coarse And Fine Aggregate From Natural Sources For Concrete
IS: 515-1959	Natural And Manufactured Aggregates For Use In Mass Concrete
IS: 1607-1977	Methods For Test Sieving
IS: 2386	Methods of Test For Aggregates For Concrete
Part-I-1963	Particle Size And Shape
Part-II-1963	Estimation of Deleterious Materials And Organic Impurities
Part-III-1963	Specific Gravity, Density, Voids, Absorption And Bulking
Part-IV-1963	Mechanical Properties
Part-V-1963	Soundness
Part-VI-1963	Measuring Mortar Making Properties of Fine Aggregates
Part-VII-1963	Alkali Aggregate Reactivity
Part-VIII-1963	Petrographic Examination

CEMENT:

IS: 269-1989	33 Grade Ordinary Portland Cement
IS: 455-1989	Portland Slag Cement
IS: 1489-1991	Portland Pozzolana Cement
IS: 4031-1999	Methods of Physical Tests For Hydraulic Cement
IS: 4032-1985	Method of Chemical Analysis of Hydraulic Cement
IS: 4082-1996	Stacking And Storage of Construction Materials And Components At Site
IS: 8041-1990	Rapid Hardening Portland Cement
IS: 8043-1991	Hydrophobic Portland Cement
IS: 8112-1989	43 Grade Ordinary Portland Cement
IS: 9103-1979	Admixtures For Concrete
IS: 12269-1987	53 Grade Ordinary Portland Cement
IS: 12330-1988	Sulphur Resisting Portland Cement

REINFORCED CONCRETE AND PRESTRESSED CONCRETE:

IS: 432 - 1982	Mild Steel And Medium Tensile Steel Bars And Hard-Drawn Steel Wire For Concrete Reinforcement.
IS: 456-1978	Code of Practice For Plain And Reinforced Concrete
IS: 516-1959	Method of Test For Strength of Concrete
IS: 816-1969	Code of Practice For Use of Metal Arc Welding For General Construction In Mild Steel
IS: 1139-1966	Hot Rolled Mild Steel Medium Tensile Steel And High Yield Strength Steel Deformed Bars For Concrete Reinforcements
IS: 1199-1959	Methods of Sampling And Analysis of Concrete
IS: 1343-1980	Code of Practice For Prestressed Concrete

IS: 1566-1982	Hard Drawn Steel Wire Fabric For Concrete Reinforcement
IS: 1785-	Plain Hard Drawn Steel Wire For Prestressed Concrete
Part-I-1983	Cold Drawn Stress Relieved Wire
Part-II1983	As Drawn Wire
IS: 1786-1985	High Strength Deformed Steel Bars And Wires For Concrete Reinforcement
IS: 2090-1963	High Tensile Steel Bars Used In Prestressed Concrete
IS: 2751-1979	Recommended Practice For Welding of Mild Steel Plain And Deformed Bars For Reinforced Construction
IS: 3370-1965	Code of Practice For Concrete Structures For The Storage of Liquids
IS: 4925-1968	Concrete Batching And Mixing Plant
IS: 4926-1976	Ready Mixed Concrete
IS: 5525-1969	Recommendations For Detailing of Reinforcement In Reinforced Concrete Works
IS: 5892-1970	Concrete Transit Mixers And Agitators
IS: 6006-1983	Uncoated Stress Relieved Strand For Prestressed Concrete
IS: 9077-1979	Code of Practice For Corrosion Protection of Steel Reinforcement In RB And RCC Construction
IS: 9103-1979	Admixtures For Concrete
IS: 10297-1982	Code of Practice For Design And Construction of Floors And Roofs Using Precast Reinforced / Prestressed Concrete Ribbed Or Cored Slab Unit
IS: 13620-1993	Fusion Bonded Epoxy Coated Reinforcing Bars
BRICK MASONRY:	
IS: 1077-1992	Common Burnt Clay Building Bricks
IS: 1725-1982	Soil Based Blocks Used In General Building Construction
IS: 1905-1987	Code of Practice For Structural Use of Un-Reinforced Masonry
IS: 2180-1988	Heavy Duty Burnt Clay Building Bricks
IS: 2185-1979	Concrete Masonry Units: Hollow And Solid Concrete Blocks
Part-I-1983	Hollow And Solid Light Weight Concrete Blocks
Part-II-1984	Autoclaved Cellular Aerated Concrete Blocks
IS: 2212-1991	Code of Practice For Brick Work
IS: 5482-1969	Autoclaved Cellular Concrete Blocks
IS: 5751-1984	Specification For Precast Concrete Coping Blocks
IS: 10360-1982	Lime-Pozzolana Concrete Blocks For Paving
LIME AND MORTAR:	
IS: 712-1984	Building Limes
IS: 1624-1986	Method of Field Testing of Building Lime
IS: 1625-1971	Code of Practice For Preparation of Lime Mortar For Use In Buildings

IS: 1635-1992	Code of Practice For Field Slaking of Building Lime And Preparation of Putty
IS: 1861-Part-I (Sect.1) 1990	Guide For Manufacture of Lime In Vertical Mixed-Feed Type Kilns: From Lime Stone
IS: 1861- Part-II-1977	Guide For Manufacture of Lime In Vertical Mixed-Feed Type Kilns: From Lime Shell
IS: 4832	Specification For Chemical Resistant Mortars
Part-I-1969	Silicate Type
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Part-III-1968	Sulphur Type

DOORS AND WINDOWS:

IS: 1003-	Timber Panelled And Glazed Shutters
Part-I-1991	Doors Shutters
Part-II-1994	Windows And Ventilators Shutters
IS: 1081-1960	Code of Practice For Fixing And Glazing of Metal (Steel And Aluminium) Doors, Windows & Ventilators
IS: 1361-1978	Steel Windows For Industrial Buildings
IS: 1948-1961	Aluminiurn Doors, Windows And Ventilators
IS: 2191	Wooden Flush Door Shutters (Cellular And Hollow Core Type)
Part-I-1973	Plywood Face Panels
Part-II-1966	Steel Door Frames

FLOOR AND FLOOR FINISHING:

IS: 658-1982	Code of Practice For Magnesium Oxychlorlde Composition Floors
IS: 777-1988	Glazed Earthenware Wall Tiles
IS: 1196-1978	Code of Practice For Laying Bitumen Mastic Flooring
IS: 1197-1970	Code of Practice For Laying of Rubber Floors
IS: 1443-1972	Code of Practice For Laying And Finishing of Cement Concrete Flooring Tiles
IS: 2114-1984	Code of Practice For Laying- I n-S itu -Terrazzo Floor Finish
IS: 2792-1964	Code of Practice For Design And Construction of Stone Slab Over Joist Floor
IS: 3365-1965	Floor Polishing Machines
IS: 4971-1968	Recommendations For Selection of Industrial Floor Finishes

ROOF AND ROOFING MATERIAL:

IS: 459-1992	Corrugated And Semi Corrugated Asbestos Cement Sheets
IS: 730-1978	Hook Bolts For Corrugated Sheets Roofing
IS: 1661-1972	Code of Practice For Application of Cement And Cement Lime Plaster Finishes
IS: 2115-1980	Code of Practice For Flat-Roof Finish: Mud Phuska
IS: 2118-1980	Code of Practice For Construction of Jack Arch Type of Building Floor Or Roof
IS: 2119-1980	Code of Practice For Construction of Brick-Cum-Concrete Composite (Madras

	Terrace) Floor or Roof
IS: 2204-1962	Code of Practice For Construction of Reinforced Concrete Shell Roof
IS: 2527-1984	Code of Practice For Fixing Rainwater Gutters And Down Pipes For Roof Drainage
IS: 3007	Code of Practice For Laying of Asbestos Cement Sheets
Part-I-1964	Corrugated Sheets
Part-II-1965	Semi Corrugated Sheets
IS: 3036-1992	Laying Lime Concrete For A Waterproofed Roof Finish - Code of Practice

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IS: 458-1988	Precast Concrete Pipes (With And Without Reinforcement)
IS: 553-1984	Resin (Gum Resin)
IS: 651-1992	Salt Glazed Stoneware Pipes And Fittings
IS: 729-1979	Specification For Drawer Locks, Cupboard Locks And Box Locks
IS: 778-1984	Copper Alloy Gate, Globe And Check Valves For Water Works Purposes
IS: 780-1984	Sluice Valves For Water Works Purposes
IS: 781-1984	Cast Copper Alloy Screw-Down Bib Taps And Stop Valves For Water Services
IS: 782-1978	caulking Lead
IS: 783-1985	Code of Practice For Laying of Concrete Pipes
IS: 784-1978	Prestressed Concrete Pipe (Including Fittings)
IS: 1172-1993	Code of Basic Requirements For Water Supply, Drainage And Sanitation
IS: 1239-1992	Mild Steel Tubes, Tubulars And Other Wrought Steel Fittings
IS: 1536-1989	Centrifugally Cast
IS: 1537-1976	Vertically Cast Iron Pressure Pipes For Water, Gas And Sewage
IS: 1592-1989	Asbestos Cement Pressure Pipes
IS: 1626-1994	Asbestos Cement Building Pipes And Pipe Fittings, Gutters And Gutter Fittings And Roofing Fittings
IS: 1726-1991	Cast Iron Manhole Covers And Frames
IS: 1742-1983	Code of Practice For Building Drainage
IS: 1952-1963	Methods of Chemical Analysis of Nickel Anodes
IS: 2065-1983	Code of Practice For Water Supply In Buildings
IS: 2470-1985	Code of Practice For Installation of Septic Tanks
IS: 2556-1994	Vitreous Sanitary Appliances (Vitreous China)
Part-I-1994	General Requirements
Part-II-1994	Specific Requirements of Wash Down Water Closets
Part-III-1994	Specific Requirements of Squatting Pans
Part-IV-1994	Specific Requirements of Wash Basins
Part-V-1994	Specific Requirements of Laboratory Sinks
IS: 2556-1995 PART-VI	Specific Requirements of Urinals And Partition Plates
Part-VII-1995	Specific Requirements of Accessories For Sanitary Appliances
Part-VIII To XV	Wash Down Water-Closets, Bidets, Foot Rests, Shower-Rose, Xv Foot Traps For

	Squatting Pans, Integrated Squatting Pans, Universal Water Closets
IS: 2692-1989	Ferrules For Water Services
IS: 2963-1979	Specification For Copper Alloy Waste-Fittings For Wash Basins And Sinks
IS: 3114-1994	Code of Practice For Laying of Cast Iron Pipes
IS: 3597-1998	Concrete Pipes - Method of Test
IS:4111-1986	Code of Practice For Ancillary Structures In Sewage System
Part-I-1986	Manholes
Part-II-1967	Flushing Tanks
Part-III-1967	Inverted Siphon
Part-IV-1968	Pumping Stations And Pumping Mains (Rising Main)
IS: 4127-1983	Code of Practice For Laying of Glazed Stoneware Pipes
IS: 4984-1995	High Density Polyethylene Pipes For Water Supply
IS: 5531-1988	Cast Iron Specials For Asbestos-Cement Pressure Pipes For Water, Gas And Sewage

STRUCTURAL STEEL:

IS: 226-1975	Structural Steel (Standard Quality)
IS: 412-1975	Expanded Metal Steel Sheets For General Purpose
IS: 800-1984	Code of Practice For General Construction In Steel
IS: 801-1975	Code of Practice For Use of Cold Formed Light Gauge Steel Structural Members In General Building Construction
IS: 806-1968	Code of Practice For Use of Steel Tubes In General Building Construction
IS: 807-1976	Code of Practice For Design, Manufacture Erection And Testing (Structural Portion) Cranes And Hoists
IS: 814-1991	Covered Electrodes For Manual Metal Arc Welding of Carbon And Carbon Manganese Steel
IS: 816-1969	Code of Practice For Use of Metal Arc Welding For General Construction In Mild Steel
IS: 817-1966	Code of Practice For Training And Testing of Metal Arc Welders
IS: 822-1970	Code of Procedure For Inspection of Welds
IS: 919-1993	ISO System of Limits And Fits
IS: 961-1975	Structural Steel (High Tensile)
IS: 1148-1982	Hot Rolled Steel Rivet Bars (Up To 40 Mm Dia.) For Structural Purpose
IS: 1149-1982	High Tensile Steel Rivet Bars For Structural Purposes
IS: 1161-1998	Steel Tubes For Structural Purposes
IS: 1181-1967	Qualifying Tests For Metal Arc Welders
IS: 1367-1980	Technical Supply Conditions For Threaded Steel Fasteners
IS: 1393-1961	Code of Practice For Training And Testing of Oxy-Acetylene Welders
IS: 1442-1964	Covered Electrodes for Metal Arc Welding of High Tensile Structural Steel
IS: 1608-1995	Mechanical Testing of Metals - Tensile Testing

IS: 1977-1996	Low Tensile Structural Steel
IS: 2062-1992	Steel For General Structural Purposes

MISCELLANEOUS:

IS: 1020-1963	Conversion Tables For Ordinary Use
IS: 1200(PART-I TO XXV)	Mode of Measurements of Building Works And Civil Engineering Works
IS: 1255-1983	Code of Practice For Installation And Maintenance of Power Cables up to And Including 33 KV Rating
IS: 1256-1967	Code of Practice For Building Byelaws

SPECIFICATIONS - MATERIALS

GENERAL:

The contractor under this contract commits himself to use best quality material and assume full responsibility for the quality of all material incorporated or brought for incorporation in the work. The work shall be executed in accordance with the best engineering practice and as per instructions of Engineer-in-Charge. All materials shall conform to respective Indian Standards.

Contractor shall allow in his rates for all the wastages in all the materials.

1. **WATER:**
   Water shall be potable, fresh, clean, and free from impurities and chemicals injurious to the work and be from an approved source. Contractor shall provide and maintain sufficient storage accommodation for the water as and where directed by Engineer-in-charge.

2. **EARTH:**
   For filling and terracing, the earth shall be free from all rubbish, organic or vegetable growth including roots, seeds, etc. and be approved by the Engineer-in-charge. All clods shall be broken down. **Black cotton clayey soil or any expansive soil shall not be used for any filling work, under any circumstances.**

3. **LIME:**
   The lime shall be best hydraulic lime or of quality, approved by the Consulting Engineer / Engineer-in-charge, obtained by burning kankar properly and shall be free from unburnt pieces, ashes and other injurious impurities. It shall be brought on site in unslacked condition and shall be slacked in fresh sweet water and ground in a mortar mill at site as per the instructions of Engineer-in-charge, lumps removed and be protected against the admixture of extraneous matter such as earth, leaves and seeds. Where the particular brands of lime are required, it will be specified in the Bill of Quantities for the respective items.

   After slaking, the lime should be screened through a screen of 2mrn mesh; unslacked lime weighs about 1060 Kg. per Cmt. It expands on slaking and then weighs about 640 Kg. per Cmt. when fresh, increasing to about 800 Kg. per Cmt. after 10 days. This gives a test for freshness.

   Lime that is more than 14 days (or shorter period as may be decided by Engineer) old after slaking shall be rejected.

   All lime that has been in any way damaged by rain, moisture, dust or any other causes will be rejected, and all that has been rejected must be removed from the site of works within 24 hours of its rejection.

4. **SAND:**
   Sand shall be from river or from any other source approved by the Consulting Engineer / Engineer-in-charge and shall be dry, clean, sharp, coarse and free from salt, earth and such other impurities. It shall be washed with clean water. The soluble contents shall not exceed 0.5% by weight if tested by settlement in water. For concrete work, the sand shall be coarser than for masonry work. Sand shall be used after screening as directed by the Engineer-in-charge.

   The sand shall conform to IS: 383-1970, fineness modulus shall not be less than 2.5.

5. **BRICKS:**
   The bricks shall be 1st class bricks and of uniform size (9" x 4 1/2" x 3"). Alternatively bricks as per IS: 1077-1976, clause 5.1, the standard size of which is (19 cm x 9 cm x 9 cm), and which shall be table moulded from approved kilns of quality approved by the Engineer-in-charge, shall be used.

   It shall be well evenly burnt for getting brick which are sound, hard and with sharp edges and corners, and which shall give a ringing sound when struck with a metal. It shall be free from the grit and other impurities such as lime, iron and deleterious salts. No brick with 24 hours of

immersion in water shall absorb more than 20% of its weight. Common buildings bricks shall have compressive strength of 50 Kg./Sq. Cms., unless otherwise specially permitted.

6. **SURKHI:**

Surkhi shall be prepared from 2nd class bricks as above or brickbats of the same bricks by grinding them to a fine powder with an electrical or animal driven grinding mill. The quality shall conform to IS: 1344. Surkhi shall be stored in weather proof shed and on a brick paving.

7. **NEEROO:**

Neeroo shall be made out of the best quality of hydraulic lime, slacked with fresh water and heated. The lime shall be reduced to fine powder by grinding in a mortar mill with 160 turns.

8. **STONE:**

Stone for masonry shall be the best of its kind, sharp, angular, free from flakes and cavities and of quality approved by the Architect. No discoloured, weathered or water worn stone shall be used.
Stone in foundation shall be from local quarries or from any other place as approved by the Architect,

All stones for outside stone work shall be the best of its kind, sound, durable, free from flaws, cracks, veins, crystals, minerals, salt, cavities or other defects and shall be of uniform texture. All stones shall be property bonded in the work.

9. **COARSE AGGREGATE:**

This shall be machine crushed from hard (granite) trap stone, grading of aggregate shall be within the limits to produce a dense mix, and shall conform to IS: 383 & IS: 515; mix will work into position without segregation and without excessive quantity of water being required. It also shall be strong and durable and shall be free from any clay films and other adherent/coating. It shall be washed with clean water if required by the Engineer-in-Charge.

This shall be well graded between the limit as specified in the items of the work and the grading tests shall be carried out. Aggregates shall be screened, if required by Engineer-in-Charge to obtain proper proportion to his approval. The quality shall conform to IS: 383-1970.

10. **CEMENT:**

Portland Pozzolana Cement conforming to IS-1489-1976 and/or Ordinary Portland Cement conforming to IS: 269-1976 shall be used. Twenty bags of the cement shall be taken to weigh one tonne i.e. cement shall have unit weight of 1,440 kg/m3. It shall be stored in a dry place and on higher ground on watertight platform and shall be protected from moisture while in store. Cement, which is moist before use, will not be allowed to be used at all.

Test certificates to show that cement is fully complying with the specification shall be submitted to the Architect/Consulting Engineer and not withstanding this, the Architect/Consulting Engineer may at his discretion, order that the cement brought on site and which he may consider damaged or of doubtful quality, for any reason whatsoever, shall be retested in approved testing laboratory and fresh certificates of its soundness shall be produced. Cement ordered for retesting shall not be used for any work, if results of such retests are pending.

Daily record of the cement brought to the site and consumed and balance in the works must be maintained properly.

11. **SCAFFOLDING:**

Scaffolding shall consist of the sal wood bullies and necessary battens and planks. All members before installation shall be checked for their strength and stiffness and tied up properly. Steel scaffolding may be used as directed by Engineer-in Charge. When necessary, during the construction, scaffolding and planks may be supported on/in the wall and these shall be fixed and tied together. In case of finishing work such as plastering, painting and distempering, no part of the scaffolding should touch the structure. Timber members shall be replaced from time to time with new timber as necessary and directed.

12. **FORM WORK:**

All props, planks, plates, braces, ties, bolts, wedges etc. shall be provided and all form work shall be sufficiently strong and sound for the purposes.

Formwork shall be thoroughly cleaned with wire brush etc. after use and oiled (with fresh and clear oil) or greased each time before use.

Wooden formwork shall be replaced from time to time with new timber as necessary and steel plates shall be got repaired from time to time.

For all exposed work, all the forms of fresh and raw steel shall be used as per pattern given by Consulting Engineers/Architects for the various members of the structure.

For wooden formwork, type of the timber as specified in the Bills of Quantities shall be provided.

All the formwork provided by the Contractor shall be approved by Engineer-in-Charge before use and the Contractor shall be allowed to use approved formwork only.

13. **REINFORCING STEEL:**

Mild Steel Reinforcing bars shall comply with the IS 432-1966. The surface of reinforcement bars shall be free from rust, oil, grease, dirt, paint or other deleterious matter. High Strength Corrosion Resistant Steel (CRS) having more elongation than CTD bars manufactured by Tata Steel or Thermo Mechanically Treated (TMT) bars manufactured by SAIL shall be used as specified / approved.

14. **STRUCTURAL STEEL:**

Structural steel shall be mild steel rolled sections and plates conforming to the latest Indian standards IS:.226-1962. The steel shall be free from loose rust, mill scale. fissures etc. The steel with fissures are to be rejected.

15. **TIMBER:**

Timber shall be seasoned and of the best teak available or as specified in the Bills of Quantities and of the best description, perfectly dry, well seasoned, uniform in colour, free from sop wood and wraps, sound, straight, free from large and loose knots, cracks, shakes and other defects and any appearance of rot. It shall not be placed in position covered in the wall or ground unless Architects have approved it.

Timber shall be considered as well seasoned, if its moisture content does not exceed the following limits:

(i) Timber for frames - 14%

(ii) Timber for planking, shutters etc. - 12%

16. **HOLDFASTS:**

Holdfasts for Doors and Windows, with steel or timber frame, shall be of M.S. flats, 6mm thick and 30mm wide, one end fish detailed and other end turned down 75mm with two holes for screws complete with 37 mm. long screws or machine bolts.

17. **NAILS ETC:**

Nails and staples shall be of hard drawn galvanised wire.

18. **BOLTS, NUTS ETC.:**

Bolts, nuts, holdfasts, etc. shall be of mild steel painted with Bitumen based paint, as specified, before fixing. Threads of bolts, nuts and washers shall be truly fitting and shall be painted with zinc chromate before fitting the nuts.

19. **SCREWS:**

Screws shall be of make as approved and specified.

20. **PAINTS:**

Filler, primer, enamels, paints and varnishes and external finishing application to cement plaster shall be of an approved best quality, propriety brand. Distemper shall be either water bound or oil bound as stated in the Bills of Quantities. These shall be in sealed drums or the packages and shall be of approved brand.

21. **GLASS:**

Glass shall be sheet glass or plate glass having uniform refractory index and shall be of best quality. This glass shall be plain clear glass, ground glass figured glass or wired glass of approved make.

Glass shall be free from waviness, bubbles, scratches, etc.

The thickness of the glass shall be as under:

Panel up to 0.84 Smt.	4.0 mm thickness
Panels above 0.84 Smt. to 1.20 Smt.	5.5 mm thickness

Glass to be fixed with -

(i) Teakwood beading of approved shape with screws of approved make and size.
(ii) Aluminium beading of approved shape and size with approved make and size of screws and Neoprene rubber gaskets of approved quality.
(iii) Putty of approved make and with approved wire clips pulley to be provided for full length of glass on all periphery.

The minimum consumption of whiting should be as follows:

Size of rebated sash	10x15mm	10x20mm to 15xl5mm	15x20mm	Beading patty
Consumption in Kg. Per 1O Rmt. of sash bar	1.50	1.53	2.30	0.90

Where no glazing beads are used, 0.013 Kg. of wire clips are required as per 10 Rmt. of rebated sash.

22. **PUTTY:**

Glazier's putty should meet the following requirement. Putty, which does not meet with the following requirement, will be rejected.

(i) It should have sufficient plasticity. A thread rolled from good quality putty will show well pronounced necking before rupture in tension while that of unsound quality putty will break without necking.
(ii) It should be adequately soft so that it can readily be placed on rebates for glass and glazing beads and stick well to glass, wood, metal or concrete. It shall be suitable for filling all spaces between the edges of rebate and the glass.
(iii) It should readily come off when cut with a putty knife. It shall be easy to spread and show a smooth, brilliant surface after it has been shaped with the putty knife.
(iv) It should neither peel off the rebate during application nor crack or crumble after drying. It should retain some elasticity upon drying to allow the glass to move if sash is deformed.
(v) It should offer substantial resistance to water, frost and heat. It should dry within three days.

23. **METAL LATHING:**

Expanded metal Hy-rib weld mesh or similar metal lathing shall be of an approved manufacture and of the quality specified in the Bills of Quantities.

24. **WIRE MESH:**

Wire mesh to vents shall be brass wire or as specified in the Bill of Quantities and have a maximum of 250 meshes to a square inch.

25. **MANHOLE COVERS:**

Manhole cover shall be light or heavy-duty pattern, with double seal as approved and as specified in the Bills of Quantities.

26. **RAIN WATER DOWNTAKE:**

C.I. PIPES:

C.I. Pipes and fittings such as Bends and Tees, "Y" junction (inspection plugs wherever required for cleaning) shall be of approved make and having specified thickness and weight with inside smooth finish and out side painted with black paint of approved make.

The joints to be filled with Omaiseal multi purpose Epoxy Sealing Compound manufactured by

Om Agro Industrial Plastics Pvt. Ltd., Bombay or equivalent approved sealing compound. Wooden spacers should be fixed to keep gap between vertical surface and pipes.

PVC Pipes:

PVC pipes shall be rigid PVC pipes and fittings such as bends, Tees, "Y" etc. manufactured as per IS: 4985 and having wall thickness for specified working pressure as per IS : 4985 and shall be of approved make. PVC pipes to be fixed to vertical surface of building with clamps fabricated from GI 30 mm x 3 mm flat, fixed at centre-to-centre distance not to exceed 24 times the diameter of pipes and G.I. screws. Wooden spacers should be provided (to be fixed) to provide gap between pipe and vertical surface of the building.

PVC pipes shall be UV resistant. The joining of pipes to be done with the solvent cementing method using solvent cement of approved manufacturer.

27. **SPECIAL MATERIALS:**

If materials of a particular brand are specified in the Bills of Quantities these shall be procured accordingly from approved manufactures. These shall include materials like bitumen, bituminous compounds, waterproofing compounds, hardening compounds, special paints, acoustic and insulation boards and other finishing materials. The responsibility for the use of these materials lies with the Contractor and he should avail himself of the necessary guarantees as may be required by the Architect and give the same to the Architect.

SPECIFICATIONS - TRADEWISE

1.0 **EXCAVATOR:**

1.1 **SITE CLEANINQ:**

All vegetables and deleterious soil shall be removed from the entire area to be covered and carted away from site, as directed, for which contractor will not be paid any extra. Site clearance shall be done 5 meters all around the proposed construction, without any extra cost.

However, if in the opinion of the Consultants, growth of grass, wild grass, bushes etc. is heavy and/or if the bushes are of large size and spread over a large area, the decision regarding payment towards removal thereof will be resting with Consultants and will be binding to Contractor and client.

1.2 **EXCAVATION:**

The excavation to be carried-out under these specifications shall consists of furnishing all the tools, plants, labour and materials required in carrying out excavation of different materials. The excavation shall be done to lines and levels defined and to the correct size of foundation concrete. This shall also include, where required, temporary sheet piling or sheathing, bracing and shoring used to maintain excavation, maintenance without interruptions to service lines such as cables, wires, duct lines, water supply, and/or drainage pipes encountered within the area of excavation or within reasonable distance of excavation and also the furnishing, creating and maintaining of substantial barricades around excavation areas, 'Red' lamps (in the night) & notice boards for ensuring safety. The Contractor shall immediately after beginning of excavation, put proper fencing all around the excavated pit as directed by the Engineer-in-Charge at his own expense and shall keep the same till all plinth work is completed. Contractor should get the excavation work inspected and approved by the Engineer-in-charge before any further works in excavation areas commence.

The Contractor must take every precaution to maintain the earth surrounding the site in perfectly safe condition for the excavation. No excavated material or any other heavy load will be allowed to be imposed on the ground adjacent to any excavation. The Contractor should carryout the excavation work to the level spaces and dimensions as shown or figured on the drawings or as required by the Architects/Consulting Engineers to receive the concrete work.

The term excavation as herein used shall include excavations, removal and transportation of the excavated materials to the dump areas, refilling the excavated earth in trenches, in general, when shown on the drawings, specified in detail for particular items or work mentioned herein after or as directed by the Engineer and will cover lead, lift and other items pertaining to and specified for this class of work, It shall also include dumping of excavated materials in regular heaps, bounds, riprap with regular slopes as directed by the Engineer and levelled so as to provide natural drainage. As a rule, all softer materials shall be laid along the centre of the heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Where consolidation is specified, it is intended that the contractor shall use heavy road rollers for consolidating with water sprinkling, as directed.

1.2.1 **EXCAVATION IN ROCK:**

Excavation in hard rock/soft rock either by chiselling or blasting shall be measured by deposits and 40% deduction in the measurements of the deposits will be made, for voids, for the purpose of payment.

1.3 **EARTH FILLING IN PLINTH:**

Filling in plinth should be started after the building is constructed up to plinth. Before starting filling, debris or grass or organic matter is to be removed from plinth area. Filling should be done to the required level in layers not to exceed 200 mm in thickness with watering to Optimum Moisture Content. Each layer should be compacted with mechanical compactors/rollers to ensure 95% to 98% of the Maximum Modified Proctor Density. If the field density tests, which have to be conducted frequently, indicate that the compaction as prescribed is not achieved, the part of the filling should be removed and refilled or compacted further, to get the specified degree of compaction.

1.3.1 **EARTH FILLING WITH EXCAVATED EARTH:**

In this item, the earth which is available from item of excavation and which is approved by Engineer is to be used for filling work. For measurements purpose, ground levels shall be recorded before start of the work and finished levels after completion of the work. Rate of this item includes watering and consolidating and will be paid at the rate quoted against this item per cum. In no case refilling of trenches brick wall/Concrete work will be paid in this item, as this is included in the item of excavation.

1.3.2 **FILLING WITH APPROVED EARTH BROUGHT FROM OUT SIDE:**

In this item, earth to be used for filling is to be brought by the contractor from out side the premises and samples are to be got approved from the Engineer before using the same. Rate of this item includes excavation, loading, transporting, unloading, consolidating, watering, royalty and taxes if any etc.

1.3.3 **SAND FILLING:**

The sand shall be obtained from river or any other approved source and shall be filled in plinth or in zari in 150 mm layers, each layer shall be well watered, rammed, and consolidated before putting the next layer.

1.4 **CLASSIFICATION OF SOILS:**

All materials to be excavated shall be classified by the Engineer into one of the following categories or classes of materials and shall be paid for at the rate tendered for that particular class of materials. No distinction shall be made whether the material is dry or wet.

(a) **SOIL:**

This shall include all soils, soft, medium and hard murrum, soft disintegrated rock, laminated rock, stiff clay, gravel etc. which can be excavated by ordinary pick, shovel, or the phawra, rake, or other ordinary digging implements. These shall also include chalkstone and rock fragments usually rounded or semi rounded having maximum diameter of 80mm to 300mm which can be loosened with application of picks or jumpers or scarifiers to loosen.

(b) **SOFT DISINTEGRATED ROCK:**

Rock or boulders, which do not require blasting but can be quarried or split with crowbars, such as laterite and hard conglomerate

(c) **HARD ROCK:**

This shall include all rocks occurring in large continuous masses which cannot be removed except by blasting for loosening it and where blasting is approved by the Engineer. Hard or varieties of hard rock with or without veins and secondary minerals, which in the opinion of the Engineer require blasting shall be considered as hard rock. Boulder of hard rock larger than 1 meter in any direction laying in over burden and required to be blasted for easy and efficient removal shall also be included in hard rock.

Where levels for different soil strata cannot be clearly marked and defined, the contractor shall stack different soils of various classifications separately for measurement purpose and then disposing off as directed.

1.5 **STRIPPING BLUFFS AND LOOSE ROCK:**

All loose boulders, semi-detached rocks (along with earthy stuff which might move there with) not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of the Engineer, to fall or otherwise endanger the workmen, equipment or the work, etc. shall be stripped off and removed away from the area of the excavation. The method used shall be such as not to shatter or render unstable or unsafe the portion which was originally sound and safe. Any material not requiring removal as contemplated in the work, but which in the opinion of the Engineer is likely, later to become loose OR UNSTABLE SHALL ALSO BE PROMPTLY AND SATISFACTORILY REMOVED as directed by Engineer.

The cost of such stripping will be paid for at the accepted unit rates for the class of material,

1.6 **EXCAVATION IN SURCHARGE SLOPES:**

The side slopes in excavation shall be as steep as will stand safely in overburden, but shall not exceed those shown on the drawing without specific permission from the Engineer. The over burden shall be excavated to the lines and slopes marked of the drawing or as approved or directed by the Engineer, in writing and volume for the payment will be calculated accordingly.

The Contractor may for facility of work or similar other reasons, excavate, and also back fill later, if so directed by the Engineer, at his own cost, outside the line shown or at slope flatter than those marked on the drawings or approved or directed by the Engineer. But at any particular location, if the contractor considers it necessary, in the interest of safety to make the slope flatter, he shall forth with bring the same to the notice of the Engineer and obtain written orders thereof. Such additional excavation shall be paid for at the rates accepted as for excavation for the particular class of material. Every precaution shall be taken to prevent slips. But should a slip occur, the slipped material shall be removed to the modified slope or as directed by the Engineer. Removal of such material shall be paid for at the rate accepted in the quotations, unless it (the slip) is due to negligence of the Contractor.

NOTE: This is to be confirmed in writing, by the Owner/Consultant's, before commencement of the excavation work. Failing this, the measurements as per the correct dimensions of foundation concrete as per the drawings will be considered for payment.

1.7 **EXCAVATION IN OPEN CUTS:**

All the excavation in open cuts shall be made true to line, slopes and grades shown on the drawings. No material shall project within the dimension of the minimum excavation marked. Boulders projecting out from the excavated faces shall be removed, if in the opinion of Engineer, they are likely to be of hindrance to other works, flow of water etc. The hollows left out in the sides as a consequence of the above shall be paid for as excavation for the particular class of material as already classified.

Suitable beams shall be left at appropriate places with necessary approach ramps for installation of dewatering pumps or other purposes, as required and directed by the Engineer. These shall be excavated later and the excavation finished to the lines and grades shown on the drawings and to the satisfaction of the Engineer. No extra payment shall be made for formation of such berms or ramps, etc. except excavation when the same all within the minimum or modified excavation line.

In case of excavation in soil and overburden, where the surface is to be left excavated, or is to be covered by pitching, formation of rain cuts and gullies shall be avoided by provision of proper drainage. Any gullies formed shall be made good, by properly packing with excavated soil (or excavated rock spoil) at contractors cost. All holes left by removing boulders will also be filled in with excavated earth (or excavated rock spoil) at no extra cost.

1.8 **EXCAVATION IN ROCK:**

After removal of the overburden, excavation shall be continued in the rock to the depths shown in the drawings and as directed by the Engineer. At all stages of excavation, precaution shall be taken to preserve the rock below and beyond the lines required for the excavation in the soundest possible condition. The quantity and strength of explosive used, if the Engineer for excavation for foundations in various locations permits blasting, shall be such as will neither damage nor crack the rock outside the limits of excavation and endanger the foundations or the supper structure of the adjoining existing buildings. All precautions, as directed by the Engineer shall be taken during the blasting operation and care shall be taken that no damage is caused to the adjoining buildings or structures. For any damage caused to the foundations or the super structure of the adjoining buildings, due to negligence, the contractor will have to pay the full cost of the same to the Owner.

As the excavation approaches its final lines, the depth of the holes and strength and amount of explosives should be progressively and suitably reduced. All excavation beyond the minimum excavation line in the surface, which has to be covered by the concrete or masonry, shall be filled back with concrete or masonry of the same quality as directed. No payment shall be made for such concrete or masonry.

Specific permission of the Engineer will have to be taken for blasting rock and the Contractor from the authorities concerned shall obtain a valid Blasting License. The quantity of explosives will have to be reduced and blasting controlled as any blasting with large quantity of explosive will

endanger the operating plant and existing adjacent buildings, foundations and structures. If permission for blasting is refused by the Engineer, the rock shall be removed by the wedges, pick, barring, burning and sudden quenching or other approved means and no extra rates will be admissible for such excavation.

1.9 **LINE DRILLING:**

The Engineer may order line drilling for ensuring safety to adjoining structures and to keep the rock beyond LIMITS of excavation in the soundest possible manner.

For this purpose, one line of holes is proposed to be drilled as 'line drilling' where rock has to be blasted, in case of uniform excavation over the entire area.

The maximum spacing of holes shall be 150 mm and diameter of holes 48 mm. This line drilling will be very close to the required excavation lines. In addition to the above, the Engineer may order further line drilling at suitable location to facilitate safe excavation.

In case of uniform excavation over the entire area, layout of the interior blasting holes shall be carefully planned in such a way that no interior hole is closer than 2.5 m. to the line drilled holes. Only light blasting is permitted in the interior holes which are near the line-drilled holes. The Contractor may carry out tests to determine the amount of an explosive required to ensure an even break at the line drilled holes and that no damage occurs to adjoining buildings and rock beyond excavation limits. After the interior holes are blasted, any irregularities in the vertical face which was line drilled shall be removed and trimmed by wedging, spitting, chiselling and barring. Excavation shall proceed from the centre to the outside.

In case the excavation for columns are required to go deeper than general excavation, explosives used shall be in such quantities that, the rock, beyond the limits of excavation and nearby buildings are not damaged. The Contractor, at no cost to the Owner, shall repair any damage to adjoining structure due to blasting of rock.

Only line drilled holes shall be measured and paid for separately. Other drilling for blasting work is deemed to have been included in unit cost quoted for excavation in hard rock.

1.10 **DEPOSITION AND DISPOSAL OF SOIL:**

The unit rate quoted for excavation in different items shall include the cost of deposition and levelling of soil within a lead as specified in Bill of Quantities. Disposal of soil shall be made in a manner which will avoid rehandling or interference, with the progress. Specific instruction regarding disposal of soil should be taken from Engineer before the actual work is starts. Soil suitable for backfill, if so directed by the Engineer, shall be selected as excavation progresses and shall either be back filled or stored at location indicated by the Engineer, and in the manner specified by him. The lead shall be measured by shortest route possible.

1.11 **BAILING OUT OF WATER:**

The contractor shall make all the arrangements of the required pumps, for draining out of sub-soil water as directed during excavation, concreting etc. till the completion of foundations and keep the work free from water.

The rate includes all the necessary pumps, installation, power charges, necessary pipelines, fittings etc.

1.12 **RUBBLE STONE SOLING:**

The rubble stones to be used shall be irregular shaped (natural), but approximately cubical pieces of stones.

(a) **DRY RUBBLE SOILING:**

Ground shall first be levelled up and thoroughly consolidated by means of heavy wooden log hammer or frog rams. Rubble of specified thickness shall then be laid and set with hand. It shall be consolidated by hand roller or wooden log hammer, free use of water being made during consolidation. All hollows and interstices after consolidation shall be filled up with quarry spoils, stone chips etc. and the packing blended with stone grit and watered and consolidated by log hammer.

(b) **RUBBLE SOLING:**

The rubble stone shall be hard, tough, sound, durable with close texture and free from cracks; weathered and disintegrated stones shall be rejected. The stone for soling shall be of height equal to the thickness of the soling with a tolerance of 10 mm. and shall not have a base area of less than 550 sq. cm. nor more than 900 sq. cm. the smallest dimension of any stone shall not be less than half the largest dimension.

1.13 **MEASUREMENTS & PAYMENT:**

Cross section shall be taken normal to the centre line at as close intervals as necessary and practicable, but in any case not more than 5 m. apart prior of starting of excavation. The volume of excavation in soil shall be computed from the cross section taken after deducting the volume of hard rock.

All rock excavated shall be stacked in depots and arranged as not to obstruct development of site or building work or construction of roads. Measurements for rock payment will be by depots at least 1 m. high with 40% deduction for voids.

The contractor should carry out the excavation work to the levels, spaces, and dimensions as shown or figured on the drawing or as required by the Architect/Consulting Engineers to receive the concrete work. Should any of the excavation be taken down below the proper levels, the contractor shall fill in such excavation at his own expense with M-10 concrete well rammed in the position until it is brought up to the proper level.

If the trenches are made broader or longer than directed, the extra breadth and length shall be filled in, after the foundations are built, with earth rammed hard, by the contractor at his own expense and without extra charge. The Contractor shall make provision for all shoring, pumping, dredging or bailing out of water and keep in the trenches free from water while the masonry work is in progress. The contractor shall also, at his own costs, remove such portions of boulders, or rocks as required to make the bottom of the trenches horizontal and levelled,

The rate of this item includes the refilling excavated earth in the sides of the masonry or concrete work to the original surface of the ground in 230 mm. layers with watering and ramming. All surplus earth left over shall be either spread or deposited on the site, within a lead as specified in the Bill of Quantities and as directed by Owner/Consulting Engineers, without any extra charge.

2.0 **CONCRETOR:**

2.1 LIME MORTAR:

Mortar shall be composed of one part of lime and two parts of sand for (1:2) proportion. The materials shall be stacked in alternative layers of 75 mm and 150 mm thickness respectively. A top layer of 75 mm of sand 'being allowed, after at least 4 layers of lime have been laid. The stacked layer shall be watered thoroughly and allowed to stand for 24 hours. The mortar shall be ground in a mortar mill with 200 turns. The mortar shall be kept moist and protected from sun, rain and dust. Mortar more than 3 days old shall not be used. Mortar shall be laid in proper position in layers not exceeding 230mm. thick at a time and shall be thoroughly watered and kept wet,

2.2 BRICK BAT CONCRETE:

The brickbats shall be of new bricks, hard and well burnt and broken to sizes varying from 37 mm to 50 mm Brickbats shall be free from earth and shall be got approved before use. Sand shall be coarse, clean, sharp, dry and free from silt, organic and other impurities.

(a) LIME CONCRETE:

If lime concrete is to be used, brickbat concrete of specified thickness in layers not exceeding 150 mm. thick shall be composed of 2 parts of brickbats broken to regular size of 30 mm. and one part of lime mortar (1:2) proportion or as specified, well mixed together either in mixer or on brick or stone platform as per the instructions of Engineer-in-Charge of work, with sufficient water and rammed hard till consolidated and top surface of the concrete shall be roughened, in order to have proper bond with the new layer.

2.3 CEMENT CONCRETE:

(a) Placing of concrete shall start after the bottom of foundation is well dressed, watered and rammed by means of rammers. After laying and consolidation is completed, watering twice a day for a week from the next day shall be done.

The measurements shall be exact to length, breadth and depth as per drawing.

(b) If cement concrete is to be used, mixing shall be done either in a mixer machine or as required by Engineer-in-Charge of works in grades of M-10 / M-15 / M-20 / M-25 or as specified in the tender item. Concrete shall be laid in layer of maximum 150 mm. thickness with sufficient water and well consolidated with rammer and shall be roughened, in order to have proper bond before the next layer is laid. Placing of concrete, by curing and measurements shall be done as per lime concrete.

(c) DAMP PROOF COURSE:
Damp proof course shall consist of a layer of 50 mm thick cement concrete (M-15/ M-20). Over the layer of cement concrete, a thick coat of mineral asphalt (heated to 350 degree F to 400 degree F) shall be laid. The work shall be measured in square metre of specified thickness. Rate shall include cost of all materials and labour involved in all the above operations.

All sanitary block floors shall be laid over a continuous bitumen damp proof course similar to above and to vertical faces of the wall for a height of 300 mm. and turned horizontally to a length of 150 mm. and shall be properly fused and made water tight around all plumbing work.

2.4 MATERIALS - CEMENT AND AGGREGATES:

2.4.1 CEMENT:

The Cement used shall be only of the following with prior approval of the Engineer-in-Charge.

(a) Ordinary Portland Cement conforming to IS: 269 (For 33 Grade) IS: 8112 (For 43 Grade) and IS: 12269 (For 53 Grade)
(b) Rapid Hardening Portland Cement conforming to IS: 8041.
(c) Portland Pozzolana Cement conforming to IS: 1489.
(d) Portland slag Cement conforming to IS: 455.
(e) Hydrophobic cement conforming to IS: 8043.
(f) Low Heat Portland Cement conforming to IS: 12600
(g) Sulphate Resisting Portland Cement conforming to IS: 12330

The cement shall satisfy the physical requirements given in Table 2.1

2.4.2 AGGREGATE:

Aggregate shall confirm to IS: 383. Aggregate shall consist of naturally occurring sand and gravel or stone, crushed or uncrushed or a combination thereof from source known to produce satisfactory aggregate for concrete and shall be chemically inert, strong, hard, dense, durable against weathering. It shall have limited porosity and shall be free from veins and adhering coatings, iron pyrites, coal, mica, shale or similar laminated material, sea shells, alkali, clay lumps, coal residues, clinkers, slag, organic and other impurities that may cause corrosion of the reinforcements or may impair the strength and/or durability of the concrete. The grading shall be arranged by the contractor that will produce dense concrete of the specified proportions - and consistency that will work readily into position without segregation and without the use of excessive water. The contractor shall submit to the Engineer for approval, a representative sample and sieve analysis of the aggregate at the site. Coarse and fine aggregates shall be delivered at the site separately. The size of the aggregate and sieve analysis furnished below are for the guidance only. The grading of the aggregate shall be based on the mix design and preliminary tests on concrete specified later in this Specification.

TABLE 2.1

PHYSICAL REQUIREMENTS
(TEST TO BE DONE AS PER IS: 4031)

	Ordinary Portland Cement	Low heat Portland Cement	Portland Pozzolana Cement	Hydrophobic Portland Cement
Fineness (Blaine's Air Permeability) Specific Surface cm2/gm	Not less than 2250	Not less than 3200	Not less than 3000	Not less than 3500
Soundness (Le Chatelier method) Expansion)	Not more than 10 mm	Not more than 10 mm	--	Not more than 10 mm
Setting Time (Vicat Apparatus initial Setting Time - Not less than	30 minutes	60 minutes	30 minutes	60 minutes
Final Setting time - Not more than	600 minutes	600 minutes	600 minutes	600 minutes
Compressive Strength (Avg. of 3 Mortar Cubes (Area of Face 50 Sq.cm of 1:3 cement : Sand)	(Not less than)	(Not less than)	(Not less than)	(Not less than)
72 + 1 hour	160 kg / sq.cm.	100 kg / sq.cm.	--	160 kg / sq.cm.
168 + 2 hour	220 kg / sq.cm.	160 kg / sq.cm.	220 kg / sq.cm.	220 kg / sq.cm.
672 + 4 hours	--	350 kg / sq.cm.	310 kg / sq.cm.	310 kg / sq.cm.
Heat Hydration		Not more than		
7 days	--	66 cal/gm	--	--
28 days	--	75 cal/gm	--	--

2.4.3 SAMPLING AND TESTING AGGREGATES:

Samples of the aggregate for mix 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. Records of the tests, which have been made on proposed aggregate and on concrete, made from the source of aggregate, shall be furnished to the Engineer in advance of the work of use in determining aggregate suitability.

2.4.4 CHEMICAL REQUIREMENTS:

The chemical requirement as given in relevant codes shall be satisfied when tested in accordance with IS: 4032.

2.4.5 FINE AGGREGATE:

Fine aggregate shall consist of natural sand and/or manufactured sand. The sand shall be sharp, hard, strong, durable and free from organic materials and other deleterious substances

a) MACHINE MADE SAND:

Machine made sand will be acceptable upon approval by the Engineer, provided that the base rock composition shall be sound, hard, dense, non-organic, uncoated and durable against weathering.

b) SCREENING AND WASHING:

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.

c) FOREIGN MATERIAL LIMITATIONS:

Sand shall be free from all vegetable and injurious substances, dust, clay lumps, soft or elongated or flaky particles, shale, alkali, organic matter, loam mica and other deleterious

substances. The percentages of deleterious substances in sand delivered to the mixer shall not exceed the following.

	Percentage by weight
Material passing IS: 460 - 75 Micron sieve	3
Shale	1
Coal and lignite	1
Clay lumps	1
Total of all above substances	Not to exceed five percent

d) GRADATION:

The sand shall be so graded that concrete of the required quality, workability, density and strength can be produced using the specified water cement ratio. Unless otherwise directed, sand shall be graded as indicated in Table - 2.2.

TABLE -2.2
FINE AGGREGATE

IS Sieve Designation	Percentage			
	Grading Zone-I	Grading Zone-II	Grading Zone-III	Grading Zone-IV
10 mm	100	100	100	100
4.74 mm	90-100	90-100	90-100	95-100
2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-95	75-100	90-100
600 micron	15-34	35-59	60-79	80-100
300 micron	5-20	8-30	12-40	15-50
150 micron	0-10	0-10	0-10	0-10

Note:

(1) For crushed stone sands permissible limit on 150 micron IS Sieve is increased to 20 percent (in addition to 5 percent tolerance allowed).

(2) Where concrete of high strength and good quality is required, fine aggregate conforming to any one of the four grading zones may be used; however the concrete mix should be properly designed. As the fine aggregate grading becomes progressively finer, that is, from grading zones I to IV, the ratio of fine aggregate to coarse aggregate should be progressively reduced. The most suitable fine aggregate to coarse aggregate ratio to be used for any particular mix will, however, depend upon the actual grading, particle shape and surface texture of both fine and coarse aggregates.

(3) It is recommended that the fine aggregates conforming to grading zone IV should not be used in reinforced concrete unless tests have been made to ascertain the suitability of proposed mix proportions. Where the grading falls outside the limits of any particular grading zone of sieves, other than 600 micron I.S. sieve by total amount not exceeding 5 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 on the coarser limit of grading zone I or the finer limit of grading zone-II.

e) FINENESS MODULUS:

The sand shall have fineness modulus of not less than 2.8 nor more than 3.2. The fineness modulus shall be determined by adding cumulative percentages retained on the five IS : 460 sieve designations viz 2 mm, 1 mm, 500 micron, 300 micron and 150 micron and dividing it by 100. The sieve generally adopted are 4.75 mm, 2.36 mm, 1. 18 mm, 600 micron, 300 micron and 150 micron.

f) SPECIFIC GRAVITY:

Sand having specific gravity below 2.60 (saturated surface - dry basis) shall not be used without special permission of the Engineer.

TABLE - 2.3
GRADING LIMITS FOR COARSE AGGREGATES

IS Sieve Designation	Percentage Passing for single sized aggregate of Normal size						Percentage Passing for Graded Aggregate of Nominal Size			
	60 mm	60 mm 40 mm	40 mm 20 mm	20 mm 16 mm	16 mm 12.5 mm	10 mm	40 mm	40 mm 20 mm	15 mm	12.5 mm
80 mm	100	--	--	--	--	--	100	--	--	--
53 mm	85-100	100	--	---	--	--	--	--	--	--
40 mm	0-80	85-100	100	--	--	--	95-100	100	--	--
20 mm	0-5	0-20	85-100	100	--	--	30-70	95-100	100	100
16 mm	--	--	--	85-100	100	--	--	--	90-100	--
12.5 mm	--	--	--	--	85-100	100	--	--	--	90-100
10 mm	--	0-5	0-20	0-30	0-45	85-100	10-35	25-55	30-70	40-85
4.75 mm	--	--	0-5	0-5	0-10	0-20	0-5	0-10	0-10	0-10
2.36 mm	--	--	--	--	--	0-5	--	--	--	--

2.4.6 COARSE AGGREGATE STONE:
This shall consist of broken trap, granite or any suitable rock from a source to be approved by the Engineer. It shall be machine crushed, hard, strong, durable, free from clay films or loamy admixture, vegetable or organic matter.

a) SCREENING & WASHING:
Natural gravel and crushed rock shall be screened and/or washed for the removal of dirt or dust coating, if so demanded by the Engineer.

The pieces shall be regular in shape, shall have granular or crystal like shape. Friable, flaking and laminated pieces, mica, shale shall be present only in such quantities that will not, in the opinion of the Engineer, effect adversely the strength and/or durability of concrete.

The amount of fine particles occuring in the free state or as loose adherent shall not exceed 1% determined by laboratory sedimentation tests, after 24 hours immersion in water. A previously dried sample shall not have gained more than 10% of the weight.

b) GRADING:
The aggregate shall be well graded., he grading limits for coarse aggregates shall be as given in Table-2.3.

c) SPECIFIC GRAVITY:
No coarse aggregate of less than 2.6 specific gravity (saturated surface - dry basis) shall be used without written approval of the Engineer.

d) FOREIGN MATERIAL LIMITATIONS:

The percentage of deleterious substances in the coarse aggregate delivered to the mixer shall not exceed the following:

	Percentage by Weight
Materials passing IS 460-75 Micron sieve	1
Coal and lignite	1
Clay lumps	1
Total of all the above substances	3

2.4.7 ALL - IN -AGGREGATES:

If combined aggregates are available, they need not be separated into fine and coarse, but necessary adjustments may be made in the grading by the addition of single-sized aggregate. The grading of All in Aggregate shall be as given in Table 2.4.

TABLE - 2.4
GRADING OF ALL-IN-AGGREGATE

IS Sieve Designation	Percentage passing for All in Aggregate of	
	40 mm nominal size	20 mm nominal size
80 mm	100	--
40 mm	95-100	100
20 mm	45-75	95-100
4.75 mm	25-75	30-50
600 micron	8-30	10-35
150 micron	0-6	0-6

2.4.8 MECHANICAL PROPERTIES OF AGGREGATES:

The aggregates shall have flooring mechanical properties:

Aggregate Crushing Value - 45 percent for concretes other than for wearing surfaces

- 30 percent for concrete for wearing surface

Aggregate Abrasion Value - 12 percent

Aggregate Impact Value (Alternative to Aggregate Crushing Value) - 45 percent by weight for concretes other than for wearing surfaces

- 30 percent by weight for concrete for wearing surface

2.4.9 COARSE AGGREGATE - SLAG:

Aggregate shall conform to the following in addition to para 2.4.2 to 2.4.8 above, which are applicable in this case also.

Approval for Use	Blast furnace slag as aggregate may be used for concrete work if such use is permitted by the Engineer
Separating and Grading	Slag shall be crushed s required and over Magnetic Separators to remove stray bits of iron and then graded as required
Sulphur Content	Sulphur contents shall be controlled as per laboratory tests and as required by

	the Engineer
Specific Gravity	No aggregate of less than 2.1 specific and Weight gravity shall be used. Weight of dry compact graded material (6-40 mm) shall range between 1300 - 1450 kg. Per cu.m.
Weight of slag Concrete	The weight of concrete made from slag aggregate should be 2170 to 2245 kg. per cum.
Test for approval	In addition to the tests mentioned for coarse aggregate stone, contractor shall perform tests for sulphur and iron contents and any other test required by the Engineer. The Test results shall be approved by the Engineer before the material is used for work

2.5 WATER:

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalies, salts, sugar, organic materials or other substances that may be deleterious to steel or concrete. Potable Water is generally considered satisfactory for mixing concrete. pH value of water shall generally be not less than 6. Mixing or curing of concrete with seawater is not recommended because of presence of harmful salts in seawater. Under unavoidable circumstances, seawater may be used for mixing or curing in plain concrete or such reinforced concrete constructions, which are permanently under seawater.

2.6 ADMIXTURES:

Admixtures 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 of concrete is reduced by more than 10 percent nor are other requisite qualities of concrete and steel impaired by the use of such admixtures. Calcium chloride should not be used. Admixtures, if used shall comply with IS: 9103.

2.7 REINFORCEMENT:

2.7.1 BIS Specifications:

The Reinforcement Steel shall comply with the following Specifications:

a) Ordinary Mild Steel and Medium Tensile Steel Bars/Reinforcement shall comply with IS: 432.

b) High Strength Deformed Steel Bars/Reinforcement shall comply with IS: 1139 or IS: 1786.

2.7.2 FREEDOM FROM DEFECTS:

All finished bars shall be well and clearly rolled to the dimensions and weights specified. Also they should be sound and free from cracks, surface flaws, laminations, rough, jagged and imperfect edges and other defects.

2.7.3 WEIGHTS AND AREAS:

The weight of the bar shall be calculated on the basis that steel weighs 0.785 Kg./meter run/cm of the nominal cross sectional area.

The weights per meter of round bars in kilograms rounded off to three or two decimal places in Kg. and areas of cross section in Sq. Cms should be as given in Table-2.5.

TABLE - 2.5

WEIGHTS AND CROSS SECTION AREAS OF BARS

Bar dia Mm	Weight (Kg/m.)	Area of Cross Section sq.cm.
5	0.154	0.20
6	0.222	0.28
8	0.395	0.50
10	0.617	0.79
12	0.888	1.13
16	1.58	2.01
18	2.00	2.54
20	2.47	3.14
22	2.98	3.80
25	3.85	4.91
26	4.85	4.81
32	6.31	8.04
36	7.99	10.18

2.7.4 QUALITY:

All steel shall be of tested quality. No re-rolled material will be accepted. The Contractor shall submit the manufactures' test certificate for steel to the Engineer. All bars shall be free from grease, oil, dirt, mill scales, loose rust and bituminous material. All bars shall be thoroughly cleaned before being fabricated. Pitted and defective bars shall not be used. All bars shall be placed and shall be rigidly held in position before concreting.

2.7.5 PHYSICAL REQUIREMENTS:

The reinforcement shall satisfy the requirements given in Table 2.6 :

TABLE 2.6

PHYSICAL PROPERTIES OF REINFORCING STEEL

		M.S. Reinforcement		Cold twisted (Plain or Deformed) Bars			
				Fe 415		Fe 500	
		Bar Sizes	Values	Bar Sizes	Values	Bar Sizes	Values
1.	Ultimate Tensile Stress kg / sq.cm.	All sizes	4200	Under 10mm	5650	All sizes	5000
				10 mm & over	4950		
2.	Yield Stress or 0.2% Proof stress kg/sq.cm.	Upto and including 20mm	2600	Under 10mm	4950	All sizes	5000
		Over 20 mm	2400	10 mm & over	4250		
3.	Percent Elongation	Under 10mm	20	All sizes	14.5	All sizes	12.0
		10mm and over	23				
4.	Bend Test		Around a Mandrel of 3d, through 180 ^{0}			Around a Mandrel of 4d, through 180 degree	
5.	Rebend Test		Around a mandrel of 6d, through 45^0 and average bend through 23^0 , around a mandrel of 6d			Around a mandrel of 7, through 45^0 and average bend through 23^0 , around a mandrel of 6d	

NOTES ON MANUFACTURE:

- All M.S. reinforcement bars shall have chemical composition in accordance with IS: 226 - OR IS: 2062. These bars if deformed shall be deformed in accordance with IS: 1139.

- All twisting shall be carried out in cold. The bars shall not be subjected to any heat treatment at any stage during the process of manufacture.

- The amount of twisting given to a bar shall be such that the pitch of one complete twist through 360^0 is 'N' times the nominal size of bar where N is as follows:

Type of Bar	N
Plain Twisted Bar	2 to 14
Deformed Twisted Bar	8 to 30

- Fe 415 grade steel is made from basically soft mild steel (IS: 226) with maximum 0.25% carbon and is weldable.

- Fe 500 grade steel is made from selected prime quality Steel with maximum 0.3% carbon and is also weldable.

2.7.6 TOLERANCE:

The rolling tolerance shall be as given below:

	Nominal Size	Tolerance
Bars in Straight Lengths (M.S.)	Up to and including 25 mm. bars	+ 0.5 mm.
	Above 25 mm bars.	+ 0.75 mm.
Coiled Round (M.S.)	Up to and including 12 mm bars.	+ 0.5 mm.
Weights (M.S. & C.T.bars)	Up to and including 8 mm. bars.	+ 4.0 percent
	Above 8 mm bars	+ 2.5 percent

The cutting tolerance on length shall be as given below:

When specified length is not stated to be either a maximurn or a minimum.	- 25 mm + 75 mm
When a minimum length is specified	± 75 mm
When a maximum length is specified	- 50 mm

2.7.7 BENDING OF REINFORCEMENT BARS:

All the bars should be bent according to the sizes and shapes shown in the detailed working drawings. They shall be bent gradually by machine or other approved means. They shall be bent cold except bars of over 25 mm. in diameter, which may be bent hot, if approved by the Engineer. Bars bent shall not be heated beyond red colour and after bending shall be allowed to cool slowly without quenching. Bars incorrectly bent shall be used only if the means used for straightening and rendering be such as shall not, in the opinion of the Engineer, effect properties of the reinforcement. No reinforcement shall be bent when in position in the work without approval, whether or not it is partially embedded in hardened concrete. Stipulations laid down in IS: 2502 for bending and fixing shall be followed unless otherwise specified herein.

Where reinforcement bars are bent aside at construction joints and afterwards bent back into original position, care should taken to ensure that at no time is the radius of the bend less than 4 bar diameter for plain mild steel or 6 bar diameters for deformed bars. Care shall also be taken when bending back the bars, to ensure that the concrete around the bar is not damaged.

2.7.8 FIXING REINFORCEMENT:

Reinforcement shall be accurately fixed and by approved means maintained in the position shown in the drawings. Bars intended to be in contact at crossing points shall be securely bound together at all such points with No. 16 gauge or 18 gauge annealed soft iron wire, The cover or concrete

over the reinforcement shall be as shown on the drawings and shall be provided and maintained by means of cement mortar briquettes or other approved means.

The vertical distances required between successive layers of bars in beams or similar members shall be, maintained by the provision of mild steel spacer bars at such intervals that the main bars do not perceptibly sag between adjacent spacer bars.

Reinforcement shall be placed within the following tolerances:

a) For effective depth 200 mm or less ..... + 10 mm

b) For effective depth more than 200 mm ..... + 15 mm

The cover, shall in no case be reduced by more than one third of specified cover or 5 mm., whichever is less.

2.7.8.1 SPACING OF REINFORCEMENT:

Minimum distance between two parallel main reinforcement bars shall usually be not less than the greatest of the following:

Horizontal distance		(i)	bar diameter (of larger bar if unequal diameters are used)
		(ii)	5 mm more than nominal size of coarse aggregate
Vertical distance			(i) Two thirds the nominal size of coarse aggregate
		(ii)	Maximum bar (size
	or	(iii)	15 mm.

In locations where reinforcement is congested, grouping of bars by touching one another may be permitted provided the requirements of minimum horizontal distance as specified above are complied with and provided further that development length is adequately increased.

2.7.8.2 COVER:

Reinforcement shall have cover and the thickness of such cover (exclusive of plaster or other decorative finish) shall be as follows or as per instruction of Engineer-in-Charge.

a) At each end of reinforcement bar, not less than 2.5 mm. nor less than twice the diameter of such rod or bar.

b) For a longitudinal reinforcing bar in a column, not less than 40 mm. or less than the diameter of such rod or bar. In the case of columns of minimum dimension of 200 mm. or under, whose reinforcing bars do not exceed 12 mm. in dia.; the cover of 25 mm. may be used.

c) For longitudinal reinforcing bar in a beam, not less than 25 mm. nor less than the diameter of such rod or bar.

d) For tensile, compressive, shear, or other reinforcement in a slab, not less than the diameter of such reinforcement; and

e) For any other reinforcement, not less than 13 mm nor less than the diameter of such reinforcement.

For concrete members in contact with earth, the above provisions for cover shall be increased by 15 mm.

Increased cover thickness may be provided when surfaces of concrete members are exposed to the action of harmful chemicals (as in case of concrete in contact with earth faces contaminated with such chemicals), acid, vapour, saline atmosphere, sulphurous smoke (as in case of steam operated railways) etc. and such increase of cover may be between 15 mm and 40 mm beyond the figures given above as may be specified by the Engineer-in-Charge.

For reinforced concrete members, totally or periodically immersed in sea water or subject so sea spray, the cover of concrete shall be 50 mm. more than that specified above.

Contractor shall prepare concrete cover blocks of different and necessary sizes and shall use as and when required for providing the adequate and specified cover to the reinforcement. Such cover blocks shall be made so in advance and properly cured to take the load of reinforcement. Cement mortar blocks in C.M. (1:1) shall be used for making cover blocks.

2.7.8.3 WELDING:

Welding by gas or electricity may be permitted under suitable conditions and with suitable safeguards. For guidance on welding, relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction may be referred.

In case of tack welding used for fixing reinforcement in their position, no specifically precaution in regard to stress need be taken.

Butt-welding between the ends of a rod in line, where stress is transferred across the section, is recommended to be allowed for mild steel bars only. In the case of rods of mild steel which have their strength increase by cold working the stress at the weld should be limited to the strength of mild steel, before cold working and the additional strength obtained by cold working should be ignored at and near the welded joints or mechanical connections in reinforcement may be used but in all cases of important connections, tests shall be made to prove that the joints are of the full strength of bars connected.

2.7.8.4 LAPS OF REINFORCEMENT:

Where laps and joints are provided in the reinforcing bars, they shall be staggered and the following requirements should generally be satisfied:

(a) No splices of reinforcement shall be made except as shown on the design drawings or as specified by the Engineer-in-Charge. Lap length to be adopted for all reinforcing bars (for both mild steel and CTD bars) shall be for mix up to M20, 60x diameter of bars, unless otherwise specified.

(b) Lapped splices in tension shall not be used for bars of sizes larger than 25 mm diameter; such splices shall preferably be welded.

For contact splices, spaced laterally closer than 12 times bar diameters or located closer than 150mm. or 6 times bar diameters from the outside edge, the lap shall be increased by 20 percent or stirrups or closely spaced spirals shall enclose the splice for its full length.

Where more than one times half of the bars are spliced within a length of 40 times bars diameter or where splices are made at points of maximum stress, special precautions shall be taken such as increasing the length of lap and/or using spirals or closely spaced stirrups around and for the length of the splice.

(c) Splices in compression reinforcement:

Where lapped splices are used, the lap lengths shall be 40 times of diameter of the bars. Welded splices or other positive connections may be used instead of lapped splices. Where bar size exceeds 25 mm diameter, welded splices or other positive connections shall preferably be used in bars required for compression only, the compressive stress may be transmitted by bearing of square cut ends held in concentric contact by a suitable welded sleeve or mechanical device.

In columns where longitudinal bars are off set at a splice, the slope of the inclined portion of the bar with the axis of the column shall not exceed 1 in 6, and the portions of the bar above and below the off set shall be parallel to the axis of the column. Off set bars shall be bent before they are placed in the forms. Where column faces are off set 75mm. or more, splices of vertical bars adjacent to the off set face shall be made with separate dowels overlapped as specified above.

(d) Approved welded splice and positive connection:

An approved welded splice Is one in which the bars are butted and welded so that it will develop in tension at least 125 percent of the specified yield strength of the reinforcing

bar. Approved positive connections for bars designed to carry critical tensions or compression shall be equivalent in strength to an approved welded splice.

2.7.9 PAYMENT FOR REINFORCEMENT WORK:

For purpose of payment, all the steel provided in accordance with the drawings shall be measured and paid for including hooks, laps, separations, cranks etc. However, no payment shall be made for binding wires. Chairs when shown on drawings and/or when specifically instructed at site to provide shall be paid for as per actual weight in the reinforcement item. The dowels shown on the drawings or instructed to be provided by the Engineer shall also be measured and paid for at the unit rate quoted. The rate quoted shall include applying two coats of Bitumastic paint on dowels and wrapping them with burlap. The unit rate shall be irrespective of the level or the height at which work is done. Steel reinforcement shall be measured in Kg. based on total computed weight for the size and length of bars as shown on drawings or as instructed by Engineer. The weight of bars will be computed from theoretical weight for the respective sizes as shown in para 2.7.3 above.

The laps will be given as under:

i) at the places shown in the drawing
ii) at the places where lap is provided as per the instruction of Engineer.
iii) at the places where the length of bar is more than 9 mtrs.
iv) in case of columns at each floor height. Where floor height is more than 5.0 m, lap to be provided as per instruction of the Consultant.

2.8 STORAGE OF MATERIALS:

2.8.1 CEMENT:

Cement shall be stored in weather-tight buildings, bins, or silos, which exclude moisture and contaminants. Storage of cement at site shall be at contractor's expense and risk. In the event of any damage occuring to cement due to faulty storage in contractor's shed or on account of negligence on his part, such damages shall be the liability of Contractor.

In case cement is stored and stacked in bags, storing shall be done in weather tight and properly ventilated structures to prevent absorption of moisture. The bags shall be stacked at least 100 - 200 mm clear above the floor. A space of 600 mm all around shall be kept between exterior walls and stacks.

Cement bags shall be placed close together in the stack to reduce circulation of air as much as possible. Cement bags should not be stacked more than 10 bags high to avoid lumping under pressure.

If the stack is more than 7 bags high, arrange the bags in header and stretcher fashion, that is, alternatively length-wise and crosswise so as to tie them together and lessen the danger to toppling over. For extra safety during the monsoon or when it is expected to store the cement for an unusually long period, enclose the stack completely in polythene sheets or any other suitable water proofing materials (covering). The flap will close on the top of stack. Care should be taken that the polythene sheet is not damaged any time during use. When removing bags from storage some bags should be removed from two or three tiers back rather than all from one tier. If the rows are thus stepped back, there is less chance of over turning. When removing cement bags for use, apply "first in, first out" rule, that is, take the oldest cement out first. Each consignment of cement shall be stacked separately to permit easy access for inspection and to facilitate removal.

2.8.2 AGGREGATES:

The aggregate shall be stored in such a way as to prevent mixing of and with foreign materials. The heaps of fine and coarse aggregates shall be kept separately. When different sizes of fine or coarse aggregate are procured separately, they shall be stored in separate stockpiles sufficiently away from each other to prevent the material at the edges of the piles from getting intermixed.

2.8.3 STEEL & REINFORCEMENT:

The steel shall not be kept in direct contact with the ground but shall be stacked on top of an arrangement of timber sleepers. It is good practice to coat reinforcement with cement wash before staking to prevent scale and rust.

2.8.4 All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the presentation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer-in-Charge, shall not be used for the concrete.

2.9 TESTS:

Appropriate tests, which are required by the different Indian Standards to ascertain that the materials used in construction conform to the respective standards and specifications, are to be carried out by the contractor at his own cost. Whenever there is a change of the source of supply of the materials, change in size or change in proportions of materials, such test should be carried out. For materials, such as cement which deteriorates due to passage of time such tests as are required should be carried out at suitable intervals and all costs for testing shall be borne by the contractors. Contractor as suggested by the Architects shall keep all records. All the costs for testing of all other materials shall be borne by the contractor

2.10 WORKMANSHIP - CONCRETE:

2.10.1 GRADES OF CONCRETE:

The concrete shall be in grades designated as M10, M15, M20, M25, M30, M35, M40, M45, M50, M60, M65, M70, M75 and M80.

Note:

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. cube at 28 days expressed in N/mm^2. IS: 516 and IS: 1199 shall be followed for sample sizes, sampling and testing of all samples.

2.10.2 STRENGTH REQUIREMENTS OF CONCRETE:

Where Ordinary and Low Heat Portland Cement conforming to IS: 269, Portland Pozzolana Cement conforming to IS: 1489 or Portland Blast Furnace Slag Cement conforming to IS: 455 is used, the compressive strength requirements for various grades of concrete shall be as given in Table 2.7. Where Rapid Hardening Portland Cement (IS: 8041) is used, the 28 days compressive strength requirements specified in Table 2.7 shall be met at 7 days.

The strength requirements specified in Table 2.7 shall apply to both Controlled Concrete i.e. Design Mix Concrete and Ordinary Concrete i.e. Nominal Mix Concrete.

In order to get a relatively quicker idea of the quality of concrete, optional works tests on beams for modulus of rupture at 72 + 2 hours or 7 days or compressive strength at 7 days may be carried out in addition to 28 days compressive strength test. The Engineer-in-Charge may suitably relax the frequency of 28 days compressive strength test specified in Table 2.7 of IS: 456 - 2000 provided the expected strength values at the specified early age are consistently met. For this purpose, the values given in Table 2.8 may be taken for general guidance in the case of concrete made with Ordinary Portland Cement.

Where the strength of a concrete mix, as indicated by tests lies in between the strength for any two grades specified in Table 2.7, such concrete shall be classified for all purposes as a concrete belonging to the lower of the two grades between which its strength lies.

TABLE - 2.7

STRENGTH REQUIREMENTS OF CONCRETE

Group	Grade of Concrete	Compressive Strength of 150mm cubes at 28 days after mixing, conducted in accordance with IS:516 N/sq.mm
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

Note:

(a) Preliminary test - A test conducted in a laboratory on the trial mix of concrete produced in the laboratory with object of:
   (i) Designing a concrete mix before the actual concreting operation starts.
   (ii) Determining the adjustments required in the designed mix when there is a change in the materials used during the execution of works or,
   (iii) Verifying the strength of concrete mix.

(b) Works Tests:
A test conducted either in the field or in laboratory, on the specimens made on the works, out of the concrete being used on works.

2.10.3 PROPORTIONING & WORKS CONTROL:

The mix proportions shall be selected to ensure that the workability of the fresh concrete suitable for the condition of handling and placing, so that after compaction it surrounds all reinforcement and completely fills the form work. When concrete is hardened, it shall have the required strength durability and surface finish. The determination of the proportions of cement, aggregate and water to attain the required strength shall as follows:

(a) By designing the concrete mix; such concrete shall be called "Design Mix Concrete" or "Controlled Concrete
(b) By adopting nominal mix, such concrete shall be called. "Nominal Mix Concrete".

TABLE - 2.8

OPTIONAL WORK TEST REQUIREMENTS OF CONCRETE (All values in N/mm^2)

(All tests conducted in accordance with IS : 516)

Grade of Concrete	Compressive Strength of 150mm cubes. min at 7 days	Moulds of Rupture by Beams Test Min.	
		at 72 + 2 hrs.	at 7 days
M-10	7	1.2	1.7
M-15	10	1.5	2.1
M-20	13.5	1.7	2.4
M-25	17	1.9	2.7
M-30	20	2.1	3.0
M-35	23.5	2.3	3.2
M-40	27	2.5	3.4

The concrete mix shall be designed to have an average strength corresponding to the values specified for preliminary tests in Table - 2.7. The proportions chosen should be such that the concrete is of adequate workability for the conditions prevailing on the work in question, and can be properly compacted with the means available. The maximum total quantity of aggregate by weight per 50 kg. of cement shall not exceed 450 kg. Except where otherwise specially permitted by the Engineer-in-Charge.

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 should be controlled by obtaining the coarse aggregate in different sizes and blending them in the right portions when required, the different sizes being stocked in separate stock pites . The material should be stock piled for several hours preferably a day before use. The grading of coarse and fine aggregate should be checked as frequently as possible, the frequency for a given job being determined by the Engineer-in-Charge to ensure that the suppliers are maintaining the grading uniform with that of the samples used in the preliminary test.

In proportioning concrete, the quantity of both cement and aggregate should be determined by weight, where the weight of cement is determined by accepting the maker's weight per bag. A reasonable number of bags should be weighted separately to check the net weight. Where the cement is weighed on the site and not in bags, it should be either measured by volume in calibrated tanks or weighed. All measuring equipment should be maintained in clean serviceable conditions, and their accuracy periodically checked.

It is most important to maintain the water cement ratio constant at its correct value. To this end, determination of moisture contents in both fine and coarse aggregates should be made as frequently as possible, the frequency for a given job being determined by the Engineer-in-Charge according to weather conditions. The amount of the added water shall be justified to compensate for any observed variations in the moisture contents. For the determination of moisture content in the aggregate for concrete: Part-III specific gravity, density, voids, absorption and bulking may be referred to. To allow for the variation in weight of aggregate due to variation in their moisture content, suitable adjustments in the weights of aggregate should also be made.

No substitutions in materials used on the work or alterations In the established proportions, except as permitted in the above para shall be made without additional tests to show that the quality and strength of concrete are satisfactory.

2.10.4 WORKABILITY OF CONCRETE:

The concrete mix proportions chosen should be such that concrete is of adequate workability for the placing conditions of the concrete and can properly be compacted with the means available. The definitions of the ranges of "workability" of concrete as measured by either the slump or V-B tests (IS: 1199) and the range to be adopted for different kinds of work unless specified otherwise is given in Table - 2.9.

TABLE - 2.9

WORKABILITY OF CONCRETE

Placing conditions	Degree of Workability	Slump (mm)	Values of Workability	
			Vee-Bee	Compacting Factor
Blinding concrete; Shallow Sections' pavements using pavers	Very Low	--	20-10 secs.	0.75-0.80
Mass concrete; Lightly reinforced sections in slabs, beams, walls, columns, Floors, Hand placed, pavements, Canal ling, Strip footings	Low	25 - 75	10 - 5 secs.	0.80 - 0.85
Heavily reinforced sections in slabs, beams, walls, columns, Slip form works, Pumped concrete.	Medium	50-100 75-100	5-2 secs.	0.85- 0.92*
Trench fill, in-situ pilling Termite concrete	High Very High	100- 150 Workability to be decided by determination of flow (IS-9103)	--	Above 0.92** Above 0.92**

Note: For most of the placing conditions, internal vibrators (needle vibrators) are suitable. The diameter of the needle shall be determined based on the density and spacing of reinforcement bars and thickness of sections. For tremie concrete, vibrators are not required to be used.

A competent person should be employed whose duty will be to supervise all stages in the preparation and placing of the concrete. All works test specimens should be prepared and site tests carried out under his direct supervision.

2.10.5 NOMINAL MIX CONCRETE:

Nominal mix concrete may be used for concretes of grades M-5, M-7.5, M-10, M-15, M-20. The proportions of materials for nominal mix concrete shall be as specified in Table 2.10.

TABLE - 2.10

PROPORTIONS OF NOMINAL MIX CONCRETE

Grades of Concrete	Total quantity of Dry Aggregate by Mass per 50 Kg. of Cement, Sum of Masses of Fine and Coarse Aggregates	Proportion of fine Aggregate to Coarse Aggregate (by Mas)	Quantity of Water for 50 Kg. of Cement (Max.) Lit.
M-5	800 Kg. 635 Kg.	Generally 1.2 but subject to upper limit of 1:1.5 and a lower limit of 1:2.5	60 45
M-10	480 Kg.	Adjust from upper to lower limit as grading fine aggregates becomes	34
M-15	350 Kg.		32

M-20	250 Kg.	finer and maximum sizes of coarse aggregate become larges.	30

The maximum water cement ratio shall be maintained as per Table 2.12

NOTE:
The Contractor will be required to prepare his own mix design and establish from preliminary tests as per Indian Standards that the mix design is according to that specified for each concrete. The same shall be adopted only after the Consulting Engineer/Architect approves it.

Workability of the concrete should be controlled by direct measurement of water content, making allowance for any surface water in the fine and coarse aggregates. The slump test in accordance with IS: 1199 may be used as a guide. Allowances should be made for surface water present in the aggregate when computing water content. Surface water shall be determined by one of the field methods described in IS: 2386 (Part III). In the absence of exact data, the amount of surface water may be estimated from the values given in Table - 2.11.

TABLE - 2.11
SURFACE WATER CARRIED BY AGGREGATE

Aggregate	Percent by Mass	Approximate Qty. of Surface Water Lt/Cum
Water wet sand	7.5	120
Moderately wet sand	5.0	80
Moist sand	2.5	40
Moist gravel or crushed rock	1.25 - 2.5	20 to 40

2.10.6 REQUIREMENT FOR DURABILITY:
Minimum cement content required in cement concrete to ensure durability under specified conditions of exposure should be as given in Table 2.12 unless otherwise specified. The general environment to which the concrete will be exposed during its working life is classified into five levels of severity, that is, mild, moderate, severe, very severe and extreme as described in Table 2.13.

TABLE - 2.12
Minimum Cement Content, Maximum Water Cement Ratio And Minimum Grade Of Concrete For Different Exposures With Norma Weight Aggregates Of 20mm Nominal Maximum Size.

Sr. No.	Exposure	Plain Concrete			Reinforced Concrete		
		Minimum Cement Content Kg/Cu.m.	Maximum Free Water Cement Ratio	Minimum Grade of Concrete	Minimum Cement Content Kg/Cu.m.	Maximum Free Water Cement Ratio	Minimum Grade of Concrete
1.	Mild	220	0.60	--	300	0.55	M-20
2.	Moderate	240	0.60	M-15	300	0.50	M-25
3.	Severe	250	0.50	M-20	320	0.45	M-30
4.	Very Severe	260	0.45	M-20	340	0.45	M-36
5.	Extreme	280	0.40	M-25	360	0.40	M-40

The general environment to which the concrete will be exposed during its working life is classified into five levels of severity, that is, mild moderate, severe, very severe and extreme as described in Table 2.13.

TABLE 2.13

ENVIRONMENTAL EXPOSURE CONDITIONS

Sr.	Environment	Exposure Conditions
1.	Mild	Concrete surfaces protected against weather or aggressive conditions, except those situated in coastal area.
2.	Moderate	Concrete surfaces sheltered from severe rain or freezing whilst wet. Concrete exposed to condensation and rain Concrete continuously under water Concrete in contact or buried under non-aggressive soil/ground water Concrete surfaces sheltered from saturated salt air in coastal area
3.	Severe	Concrete surfaces exposed to severe rain, alternate wetting and drying or occasional freezing whilst wet or severe condensation. Concrete completely immersed in seawater Concrete exposed to coastal environment
4.	Very Severe	Concrete surfaces exposed to seawater spray, corrosive fumes or severe freezing conditions whilst wet. Concrete in contact with or buried under aggressive sub-soil/ground water
5.	Extreme	Surface of members in tidal zone Members in direct contact with liquid/solid aggressive chemicals

2.10.7 MIX DESIGN AND SAMPLING AND TESTING FOR CONCRETE:

Facilities required for sampling materials, shall be provided when required by the Engineer. The methods used in sampling, laying curing and testing the concrete samples, either in the field or in the laboratory, shall be in accordance with the appropriate Indian Standards. This is to investigate the grading of aggregate, water cement ratio, workability and the quantity of cement required to give works cubes of the minimum strength specified.

The mix shall be designed to produce the grade of concrete having required workability and desired characteristic strength. As long as the quality of the materials does not change, a mix design done earlier may be considered adequate for later work. As already stated under "proportioning" the proportion of the mix shall be by weight. In case uniformity in the materials used for concrete making has been established over a period of time, the proportioning may be done by volume batching, by the use of bulk densities, provided periodic checks are made on mass/volume relationships of materials. Where weigh batching is not practicable, the quantities of fine and coarse aggregate (not cement) may be determined by volume. If aggregate is moist and volume batching is adopted, allowance shall be made for bulging in accordance with IS: 2386 (Part-III). Mix proportioning shall be carried out according to the ACI Standard ACI 631 or "Design of Concrete Mixes" Road Research Note No.4 of Department of Scientific and Industrial Research, U.K.

Whenever there is either a change in strength of concrete required, water cement ratio, workability or the source of aggregates and cement, preliminary tests shall be conducted again to determine the revised proportions of the mix to suit the later conditions. While designing mix proportions, over wet mixes should always be avoided.

2.10.8 PRELIMINARY TESTS:

The materials and proportion used in main preliminary tests shall be similar in all respects to hose to be actually employed in the works as the object of this test is to determine proportion of cement, aggregates and water necessary to produce the concrete of consistency required to give the strength specified. It will be the contractor's sole responsibility to carry out these tests and he shall therefore furnish to the Engineer, statement of proportions proposed to be used for concrete mix. For preliminary tests, the following procedure shall be followed. Materials shall be brought to the room temperature and all materials shall be in a dry condition. The quantities of water, cement and aggregate for each batch shall be determined by weight to an accuracy of 1 Part in 1000.

(a) Mixing:

Concrete shall be mixed in a mechanical mixer. The mixer should comply with IS: 1791. The cement and fine aggregate shall first be mixed dry until the mixture is in uniform colour. The coarse aggregate shall then be added, mixed and water added and mixed thoroughly for a period of not less than two minutes after all the materials are in the drum

and until the resulting concrete is uniform in appearance. If there is segregation after unloading from the mixer, the concrete should be remixed.

(b) The consistency of each batch of concrete shall be measured immediately after mixing, by the slump test in accordance with IS: 1999. In the slump test, care shall be taken to ensure that no water is lost; the material used for slump test may be remixed with the remainder of concrete for making the test specimen. The period of remixing shall be as short as possible yet sufficient to produce a homogeneous mass.

Note : In exceptional circumstances such as mechanical breakdown of mixer, work in the remote areas or when the quantity of concrete work is very small, hand mixing may be permitted, subject to adding 10% extra cement at his (contractors) cost. When hand mixing Is permitted, It shall be carried out on a watertight platform and care shall be taken to ensure that mixing is continued until the concrete is uniform in colour and consistency.

2.10.9 CONCRETE CUBES:

(a) Size of test specimen & moulds:
Test specimens cubical in shape shall be 150 x 150 x 150 mm. If the largest nominal size of the aggregate does not exceed 200mm, 100 mm cubes may be used as an alternative.

A cube mould should be of metal and stout enough to prevent distortion. It shall be constructed in such a manner as to facilitate the removal of the moulded specimen without damage, and shall be so machined that, when it is assembled ready for use, the dimensions and internal faces shall be accurate within the following limits:

Height of mould and distance between opposite faces: Specified size + 0.2 mm.
Angle between adjacent faces: 90 + 0.5 degree

Each mould shall have a plane face metal base plate of such size as to support the mould during the filling without leakage and shall be attached to the moulds; when assembled shall be positively and rigidly held together and suitable methods of ensuring this, both during filling and on subsequent handling of the filled mould, shall be provided. In assembling the mould for use, the joints between the sections of mould shall be thinly coated with mould oil and a similar coating of mould oil shall be applied between the contact surfaces-of the bottom of the mould and the base plate in order to ensure that no water escapes during filling. The interior surfaces of the assembled mould shall be thinly coated with mould oil to prevent adhesion of the concrete. The tamping bar shall be a steel bar 16 mm. in diameter, 0.6 m. long and bullet pointed at the lower end.

(b) Compacting:The test specimens shall be made as soon as practicable after mixing and in such a way as to produce full compaction of the concrete with neither segregation nor excessive laitance. The concrete shall be filled into the mould in layers approximately 50 mm deep. In placing each scoopful of concrete, the scoop shall be moved around the top edge of the mould as the concrete slides from it, in order to ensure a symmetrical distribution of the concrete within the mould. Each layer shall be compacted as described below. After the top layer has been compacted, the surface of the concrete shall be finished level with the top of the mould using a trowel, and covered with a glass or metal plate to prevent evaporation.

For compacting, standard tamping bar shall be used and the strokes of the bar shall be distributed in a uniform manner over the cross section of the mould. The number of strokes per layer required to produce specified conditions will vary according to the type of concrete but in no cases shall be less than 35 strokes per layer for 150 mm cubes or 25 strokes per layer for 100 mm cubes. The strokes shall penetrate into the underlying layer and the bottom layer shall be rodded throughout its depth. Where the tamping bar leaves voids, the sides of the mould shall be tapped to close the voids.

(c) Curing: The test specimen shall be stored on the site at a place free from vibration under damp-matting, sacks or other similar material for 24 hours + 0.5 hour from the time of adding water to the other ingredients at a temperature range of 22^0 C to 32^0 C After 24

hours, they shall be marked for later identification, removed from the moulds and stored in clean water at a temperature of 24^0 C to 30^0 C. They shall be sent to the testing laboratory well packed in damp sand, sacks or other suitable material so as to arrive there in a damp condition not less than 24 hours before the time of test. On arrival at the testing laboratory, the specimen shall be stored in water at 27^0 C $+21^0$ C temperature until the time of test. Records of the daily maximum and minimum temperature shall be kept both during the period the specimens remain on the site and in the laboratory.

(d) Tests for Cube Specimen:

The concrete cubes shall be tested in standard testing machines by skilled personnel. Tests shall be made at recognized ages of the test specimen, the most usual being 7 and 28 days. Tests may be made at 24 hours + 1/2 hour and 72 hours + 2 hours if early strengths are needed. The age shall be calculated from the time of the addition of water to the dry ingredients.

At least three specimens, preferably from different batches shall be made for testing at each selected age.

Specimens stored in water shall be tested immediately on removal from the water and while they are still in the wet condition. Surface water and grit shall be wiped off the specimens and any projecting fins removed.

The bearing surface of the testing machine shall be wiped clean and any loose sand or other material removed from the surfaces of the specimen, which are to be in contact with the compression platens. The specimen shall be so placed in the machine that the load shall be applied to the opposite sides of the cubes as cast, that is, not to the top and bottom. The axis of the specimen shall be carefully aligned
with the centre of thrust of the spherically seated platen. No packing plates shall be used between specimen and platens of the machine. Once the uniform seating is obtained, load shall be applied without shock and increased continuously at a rate of approximately 14.0 N / mm^2 /Min. until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained. The maximum load applied to the specimen shall be recorded and the appearance of the concrete and any unusual features in the type of failure shall be noted.

The measured compressive strength of the specimen shall be the maximum load applied to the specimen divided by the cross sectional area of the specimen and shall be expressed to the nearest N. per sq. mm. Average of the values shall be taken as the representative of the batch provided the individual variation is not more than + 15 percent of the average. Otherwise repeat tests shall be made. Cube crushing strength shall conform to the values given in Tables 2. 7 and 2.8.

(c) Frequency of Sampling of Concrete Cubes:

A random sampling procedure should be adopted to ensure that each concrete batch shall have a reasonable chance of being tested; that is, the sampling should be spread over the entire period of concreting covering all mixing units. The minimum frequency of sampling of concrete of each grade shall be as follows:

Quantity of concrete in the work cu.m.	No.of samples
1 - 5	1
6 - 15	2
16 - 30	3
31 - 50	4
51 and above	5 plus one additional sample for each additional 50m or part thereof.

The test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for determining strength of concrete at 7 days. The test strength of

the sample shall be the average strength of three specimens. The individual variation should not be more than 15 percent of the average.

Concrete shall be assessed daily for compliance. The contractor shall keep a record at site of all such tests identifying them with the proportion of the work to which they relate. The Architects will check this record from time to time. The said record shall give the following details and shall be initiated by the Engineer-in-Charge.

(i) Reference to specific structural member receiving the batch of concrete from which the cubes were cast.

(ii) Mark on cubes.

(iii) Mix of concrete.

(iv) Data and time of casting.

(v) Water cement ratio by weight and slump.

(vi) Crushing strength as obtained at the end of 7 days for 3 cubes out of a set of 6 cubes and the end of 28 days for the remaining 3 cubes.

(vii) Laboratory in which tested and reference to test certificates.

(viii) The quantity of concrete, incorporated in work, that is represented by the quantity of concrete of the set of the cubes.

(ix) Any other information required by Architects.

(f) Consistency:

The consistency of each sample of concrete shall be measured immediately after remixing by the slump test. The slump shall be as directed by the Engineer, which would be based on the preliminary test result keeping in view, the workability of the concrete. The approved slump shall be maintained through the field operations unless otherwise directed by the Engineer. In order to ensure the maintenance of uniform consistency, slump tests shall be carried out as often as demanded by the Engineer and invariably with the batch of concrete from which test cubes are made.

(g) Record of Temperature:

A record of maximum and minimum temperature at the places of storage of the cube shall be maintained, during the period they remain at site, by the Contractor.

2.10.10 OPTIONAL TESTS:

The Engineer, if he so desires, may order tests to be carried out on cement, sand, coarse aggregate in accordance with the Indian Code of Practice or any other approved code.

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 Tensile Strength,

(vi) Test for Heat of Hydration (by experiment and by calculations) in accordance with BIS or any other approved standard for cements.

Test on sand shall include:

(i) Sieve Test

(ii) Test for Organic Impurities

(iii) Decantation Test for Determining Clay

(iv) Specific Gravity Test

(v) Test for Sieve Analysis and Fineness Modulus.

Tests on coarse aggregate shall include:

(i) Sieve Analysis

(ii) Specific Gravity and Unit Weight of Dry Loose and Rodded Aggregate (Bulk Density Test)

(iii) Determination of Yield of a Dry Mixture

(iv) Petrographic Examination of Deleterious Minerals in Aggregates.

(v) Test for Aggregate Crushing Value and 10% Fine Value Test.

(vi) Aggregate Impact Value

(vii) Toughness Test

(viii) Soundness Test

(ix) Hardness Test

(x) Alkali Aggregate Reaction

(xi) Deleterious Material

Any or all these test would normally be ordered to be carried out, if the specified concrete strengths are not obtained, at the Contractor's cost. If the works cubes do not give the stipulated results, the Engineer reserves the right to ask the Contractor to dismantle such portions of the work, which in his opinion are unacceptable and redo the work to the standard stipulated at his (Contractors) cost. It shall be very clearly understood by the Contractor that no extra claims shall be entertained by the Owner for excess use of cement over the minimum quantity stipulated to give the works cubes of required strength. The unit rate for design and test cubes, works cubes, testing them as per specifications, optional tests etc.

Unless otherwise stipulated, the concreting, testing, etc. shall be carried out as directed by the Engineer and to the appropriate BIS Specifications.

In the event of any work being suspected of faulty materials or workmanship or both, the Engineer before requiring its removal and reconstruction, may order, or the contractor may request, that it should be load tested in accordance with the following provisions.

2.10.11 LOAD TEST ON MEMBERS OR ANY OTHER TEST:

The test load shall be 125 percent of the specified super imposed load for which the structure was designed in addition to the full dead load (self weight of structure members plus weight of finishes and walls or partitions, if any as considered in the design). Such test load shall not be applied before 28 days after the time of placing of concrete.

During the tests, struts strong enough to take the whole load shall be placed in position leaving a gap under the members. The test load shall be kept for 24 hours before removal.

If within 24 hours of the removal of the load, the structure does not show a recovery of at least 75 percent of the maximum deflection shown during the 24 hours under load, the test loading shall be repeated after a lapse of at least 72 hours. The structure shall be considered to have failed to pass the test if the recovery after the second test is not at least 80 percent of the maximum deflection shown during the second test.

If during the test, or upon removal of the load, the structure shows signs of weakness, undue deflection or faulty construction it shall be reconstructed or strengthened as necessary.

Any other test, e.g. taking out concrete cores, examination and test on such cores removed from such parts of the members in an approved manner and as directed by the Engineer shall be carried out by the Contractor at his own cost, if so directed.

2.10.12 TESTING CONCRETE OF TANKS FOR LEAKAGE:

In addition to the structural test given in clause above, structures (tanks, chests, pits, etc.) to be used for storage of liquids shall also be tested for water tightness at full storage level as described below:

(a) In case of structure whose external faces are exposed such as elevated tanks, the requirements of the test shall be deemed to be satisfied if the external faces show no sign of leakage or sweating and remain completely dry over the period of observation of seven days after allowing a seven days period for absorption after filling with water.

(b) In case of structure whose external faces are backfilled and are not accessible for inspection, such as underground tanks, the tanks shall be filled with water and after the expiry of seven days after the filling, the level of the surface of the water shall be recorded. The level of water shall be recorded again at subsequent intervals of 24 hours over a period of 7 days. The total drop in surface level over a period of seven days shall be taken as an indication of the water tightness of the tank. The Engineer shall decide on the actual permissible rate of this drop in the surface level, taking into consideration whether the tanks are open or closed and the corresponding effect it has on evaporation losses. Backfilling shall be withheld till the tanks are tested if directed by the Engineer.

Costs of Tests:

The entire cost of tests as specified, in clause above shall be borne by the Contractor.

Unsatisfactory Test**:**

If the results of any test prove unsatisfactory, the Contractor shall remove and rebuild the member or members involved or carry out such other remedial measures as may be required by the Engineer or his representative. The Contractor shall bear the cost of so doing, unless the failure of the member or members to fulfill the test condition is solely due to faulty design.

2.10.13 PLACING:

The procedure for placing of concrete shall be as follows:

(a) Preparation before placing of concrete shall be as given below.

(i) Engineer's Approval of Equipment & Method:
Before any concrete is placed, the entire placing programme, consisting of equipment, layout, proposed procedure and methods shall be submitted to the Engineer for approval if so demanded by the Engineer and no concrete shall be placed until the Engineers approval has been received.

(ii) Hardened concrete and foreign materials should be removed from the inner surface of the conveying equipments.

(iii) Form work shall have been completed; snow, ice and water shall have been removed. Reinforcement shall have been secured in place, expansion joint material, anchors and other embedded items shall have been positioned and the entire preparation shall have been approved.

(iv) No concrete shall be placed on watered surface.

(v) Rain or Wash Water:
No concrete shall be placed in wet weather and 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 mixtures. To guard against damage which may be caused by heavy rains, the works shall be covered with gunny bags immediately after the concrete has been placed in position on the surface of the newly placed concrete and shall be removed by approved means and no further concrete shall be placed thereon.

(b) Time interval between mixing and placing:

Concrete shall be placed in the forms within 30 (thirty) minutes as rapidly as practicable, after addition of water to cement and aggregate, unless otherwise authorised by the Engineer.

(c) Concrete placing by manual labour:

Except when otherwise approved by the Engineer, concrete shall be placed in the shuttering by shovels or other approved Implements and shall not be dropped from a height or handled in a manner, which will cause segregation. Accumulation of set concrete shall be avoided. Concrete shall be placed directly in its permanent position and shall not be worked along the shuttering to that position.

(d) Avoiding segregation:

Concrete shall, in all cases, be deposited as nearly as practicable directly in its final position, and shall not be caused to flow in a manner, which will cause segregation, loss of materials and impair its strength. For locations where direct placement is not possible, and in narrow forms, the Contractor shall provide suitable drop chutes and "Elephant Trunks" to confine the concrete in movement.

(e) Concrete placing by Mechanical Equipment:

The following specification shall apply where placing of concrete by use of mechanical equipment is specifically called for while inviting bids or is warranted considering the nature of the work involved.

The control of placing shall begin at the mixer discharge. Concrete shall be discharged by the vertical drop into the middle of the bucket or hopper and this principle of a vertical discharge of concrete shall be adhered to throughout all stages of delivery until the concrete comes to rest in the structures.

(f) Type of Buckets:

Central bottom dump buckets of a type that provides for positive regulation of the amount and rate of deposit of concrete in all dumping positions shall be employed.

(g) Operation of Bucket:

In placing concrete in large open areas, the bucket shall be spotted directly over the position designated and then lowered for dumping. The open bucket shall just clear the concrete already in place and the height of drop shall not exceed 1.00 M. The bucket shall be opened slowly to avoid high vertical bounce, Dumping of buckets on the swing, or in any manner which results in segregation of ingredients or disturbances of previously placed concrete will not be permitted.

(h) Placement in Restricted Forms:

Concrete placed in restricted forms by borrows, buggies, cars, short chutes or hand shovelling shall be subject to the requirement for vertical delivery of limited height to avoid segregation and shall be deposited as nearly as practicable in its final position to avoid segregation due to rehandling or falling.

(i) Chuting:

Where it is necessary to use transfer chutes between mixer, containers or hoppers, and point of deposit in the forms, specific approval of the Engineer must be obtained as regards the type, length, slopes, baffles and vertical terminals. Concrete shall not be permitted to fall from the end of the chutes or tube more than 1.00 M. Chutes, when approved for use shall have slope not flatter than 1 to3 and not steeper than 1 to 2.

(j) Placing by Pumping:

Concrete may be conveyed and placed by mechanically operated pressure equipment only with the written permission of the Engineer. Water cement ratio may not be increased above that for the same class of concrete placed by bucket and the slump shall be held to the minimum necessary for conveying concrete by this method.

(k) Bonding Mortar:

Immediately before concrete placement begins, prepared surfaces except formwork, which will be in contact with the concrete to be placed, shall be covered with a bonding mortar as specified.

(l) Thickness of Layers:

Concrete shall be placed in successive horizontal layers ranging in thickness from 15 to 90 mm. as directed by the Engineer the bucket loads, or other units of deposit shall be potted 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 shovelling. Any

tendency to segregation shall be corrected by shovelling stones into mortar then mortar on the stones. Such a condition shall be corrected by redesign of mix or other means, as directed by the Engineer.

(m) Bedding of layers:

Bedding planes shall be approximately horizontal unless otherwise instructed.

(n) Compaction:

Concrete shall be compacted with approved mechanical vibrating equipment until the concrete has been consolidated to the maximum practicable density, and is free of pockets of coarse aggregate, and fits tightly against all form surfaces and embedded materials.

2.10.14 TYPE OF VIBRATORS:

(a) Vibrators shall be the internal or immersion high frequency type, with speed of not less than 6000 revolutions per minute when immersed in the concrete. Vibrators shall be used in sufficient number of units and power of each unit shall be adequate to properly consolidate the concrete**.**

(b) Use of Vibrators:

Vibrators shall be inserted in a vertical position at intervals of about 600 mm depending upon the mix, the equipment used, and continued experience on the job. Vibrators shall be withdrawn slowly. In no case shall vibrators be used to transport concrete inside the forms.

(c) Successive Batches:

In placing concrete in layers, which are advancing horizontally as the work progresses, great care shall be exercised to ensure adequate vibration, blending of the concrete between the succeeding batches.

(d) Vibrator Penetration of under layer:

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

(e) Vibrating Against Reinforcement:

Care shall be taken to prevent contact of vibrators against reinforcement steel, Vibrators shall not be allowed to come in contact with reinforcement steel after start of initial set. Vibrators shall not be allowed to come in contact with forms of finished surface.

(f) Use of form attached Vibrators:

The use of form attached Vibrators shall be used only with specific authorization of the Engineer.

(g) Use of Surface Vibrators:

The use of surface vibrators will not be permitted under ordinary conditions. However, for thin slabs, such as highways, runways, and similar construction surface vibration by specially designed vibrators may be permitted, upon the approval of the Engineer.

(h) Stone pockets and Mortar Pondages:

The formation of stone pockets and mortar pondage in corners and against form face shall not be permitted. If these occur, they shall be dug out, reformed and refilled to sufficient depth and shape for the rough blending, as directed by Engineer.

2.10.15 CONSTRUCTION JOINTS AND KEYS:

Concrete shall be placed continuously unless otherwise specified.

If stopping of concreting becomes unavoidable anywhere, the construction joint shall be made, where the work is stopped, 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. Horizontal and vertical

construction joints and bonding keys shall be located and shall conform in details to the requirements of the plans unless and otherwise directed by the Engineer. Where not described, the joint shall be in accordance with the following:

(a) Column joint:In a column, the joint shall be formed 75 mm. below he lowest soffit of the beams joining to it.

(b) Beam and Slab Joint :

Concrete in a beam shall be placed throughout without a joint but, if the provision of a joint is unavoidable, the joint shall be vertical and at the middle of the span. A joint in a slab shall be vertical and parallel to the principal reinforcement. Where it is unavoidable, the joint at right angles to the principal reinforcement, shall be vertical and at the middle of the span.

2.10.16 CURING, PROTECTING, REPAIRING AND FINISHING:

All concrete shall be cured by keeping it damp for the period of time required for complete hydration and hardening to take place.

Certain types of finish, or preparation for overlaying, concreting must be done at certain stages of the process and special treatment may be required for specific concrete surface finish.

(a) Curing with water:

Fresh concrete shall be kept continuously wet for a minimum period of at least 21 days since lapse of 24 hours after laying concrete. Quantity of water supplied shall be controlled so as to prevent the erosion of freshly placed concrete.

(b) Continuous Spraying:

Curing shall be assured by use of an ample water supply under pressure in pipes, with all necessary appliances of hose (sprinklers to be used), unless otherwise specified or approved by the Engineer.

(c) Alternate Curing Methods:

Whenever, in the judgment of the Engineer, it may be necessary, the continuous spray method may be omitted and a covering of sand, or other approved mulching such as wet gunny bags, which will prevent loss of moisture from the concrete, may be used. No type of covering will be approved which should strain or damage the concrete during or after curing period. Covering shall be kept continuously wet during the curing period.

(d) Curing compounds:

Surface coating type-curing compounds shall be used only by special permission of and under the direction of the Engineer. Curing compounds shall be colourless / pigmented, liquid type, conforming to approved specifications. No curing compound shall be used on surfaces where future blending with concrete or painting is specified,

(e) Ponding:

For curing of concrete in pavement, sidewalks, 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. Special attention shall be given to edges and corners of the slabs to ensure proper protection to these areas. The ponded areas shall be kept continuously filled with water.

(f) Curing Equipments:

All equipment and materials required for curing shall be on hand and ready for the use before concrete is placed.

(g) Protection of Fresh Concrete:

Fresh concrete shall be protected by leaving forms in place for an ample period as specified later in this specification. Newly placed concrete shall be protected by approved means from rain, sun and winds. Steps as approved by the Engineer shall also be taken

to protect immature concrete from damage by debris, excessive loading, vibration, abrasion or other materials etc. that may impair the strength and/or durability of the concrete. Workmen shall be warned against and prevented from disturbing green concrete during its setting period. If it is necessary that workmen enter the area of freshly placed concrete, the Engineer may require that bridges be placed over the area.

(h) Repair and Replacement of Unsatisfactory Concrete:

Immediately after the shuttering is removed, the surface of concrete shall be very carefully one over and holes noticed shall be filled up and made good with mortar composed of one part of cement to one part of sand after removing any loose stones adhering to the concrete. Concrete surfaces shall be finished as described under the particular items of work. Superficial honeycombed surfaces shall be made good immediately after removal of shuttering, in presence of Architect's representative and superficial water and air holes shall be filled in. Unless otherwise instructed by the Engineer, the surface of the exposed concrete placed against shuttering shall be rubbed down immediately on removal of shuttering to remove fins or other irregularities.

Unsatisfactory concrete shall be cut out and replaced with new concrete, as soon as practicable after removal of forms. Anchors, tees, or dovetail slots shall be provided wherever necessary to attach the new material securely in place. Surface of prepared voids shall be wetted for 24 hours immediately before the patching material is placed.

Use of an epoxy for blending fresh concrete used for repairs will be permitted upon written approval of the Engineer. Epoxies shall be applied in strict accordance with the instructions of the manufacturer.

2.10.17 FINISHING -GENERAL:

The specification is intended to cover the treatment of concrete surfaces of all structures. Area requiring special finish not covered by this specification may be clearly indicated on the drawings and specifications will be furnished.

(a) Finish for Formed Surfaces:

The type of finish for formed concrete surfaces shall be as follows, unless otherwise specified by the Engineer:

(i) Cement plaster finish:

The concrete shall be properly roughened immediately after the shuttering is removed, taking care to remove the laitance completely without disturbing concrete. The roughening shall be done by hacking. Before the surface is plastered, it shall be cleaned and wetted so as to give good bond between concrete and plaster.

(ii) For surface against which backfill or concrete is to be placed. 'no' treatment is required except tie holes & repair of defective areas shall be patched with cement mortar.

(iii) For surfaces below grade, which will receive waterproofing treatment, the concrete shall be free of surface irregularities, which would interfere with proper application of the waterproofing material, which may be specified for use.

(iv) Surfaces which will be exposed when the structure is in service shall receive no special finish except repair of damaged or defective concrete, removal of fins and abrupt irregularities, filling of holes left by form ties and rods, and clean up of loose or adhering debris.

(b) Finishing:

Finishing of exposed concrete surface shall conform to the following.

Smooth form finish:

The form facing material shall produce a smooth, hard, uniform texture on the concrete, it may be plywood or other approved material capable of producing the desired finish. All

ties, burns and fins are to be removed. Mix one part of Portland cement and one part fine sand with sufficient water to produce a stiff mortar. The mortar after drying shall match the rest of the surface in colour. Before application of mortar, concrete surface is to be dampened. Mortar is to be applied by firm rubber float or trowel, filling all surface voids. Compressing mortar into voids by using carborundurn stone shall be continued till uniform colour and texture is produced. If the mortar surface dries too rapidly to permit proper compaction and finishing, apply a small amount of water with a sprayer. Quoted rate of exposed shuttering shall be inclusive of this treatment.

(c) Finish for Unformed Surfaces:

Surfaces which will be exposed to the weather and which would normally be a specified level, a horizontal surface or shows the slope required, the tops of narrow surfaces, such as stair treads, walls, curbs and parapets shall be sloped approximately 10mm in 300mm width, broader surfaces such as walkways, roads, parking areas and platforms shall be sloped about 1 in 50. Surfaces that will be covered by backfill or concrete, sub-floors to be covered with concrete topping, terrazzo or quarry tile, and similar surfaces shall be smooth screened and levelled to produce even surfaces. Surfaces which will not be covered by backfill, concrete or tile toppings such as outside desks, floors of galleries and sumps, parapet, gutters, sidewalks and slabs shall be consolidated, screened and flattened. Flattening may be done with hand and started as soon as the screened has attained a stiffness to permit finishing operations, and shall be the minimum required to produce surface uniform in texture and free from screened marks or other imperfections. Joints and edges shall be tooled as called for on the drawings or as directed by the Engineer.

(d) Protection:

All concrete shall be protected against damage until final acceptance by the Architect or his representative.

2.10.18 CONCRETING IN HOT WEATHER:

Concreting in extreme hot weather shall be avoided. Special care shall be exercised and measure undertaken when temperature on site exceeds 105^0 F or 40^0 C. Such measures shall include:

(i) Provision of a shade for coarse aggregate so that the same do not absorb heat from the directly indenting rays of sun.

(ii) Continuously wetting coarse aggregates to keep their temperature down, fog sprays.

(iii) Providing a shade for the mixing machine.

(iv) Depositing the concrete from the machine as quickly as possible.

(v) Adjusting water proportions throughout the day to account for water in the wet aggregate, giving desired strength and workability.

(vi) Covering the deposited concrete by a membrane as soon after the placing as possible without damaging the fresh concrete.

(vii) Wet gunny bags shall be laid immediately after two hours of concreting on the top surfaces of slab and shall be kept wet for curing period.

(viii) Use of retarder (2% of Calcium Chloride).

(ix) Use of Zero Heat Portland Cement or even the Portland Pozzolana Cement.

(x) Use of higher water cement ratios.

(xi) Keep moist, the formwork continuously for the period of 2 hours at least.

On such days of hot weather, concreting records shall be kept of the atmospheric temperature and corresponding temperatures of concrete discharged from the mixing machine.

2.11 CURING OF DIFFERENT ITEMS:

For all the time during construction, curing shall be carried out especially from 7.00 AM to 7.00 PM even on holidays with proper manpower, necessary pumps and pipe lines, connections, etc.

2.11.1 Exposed surfaces of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacking, canvas, hessian or similar material and kept constantly wet for at least seven days from the date of placing concrete in case of OPC and at least 10 days where

mineral admixtures or blended cements are used. The period of curing shall not be less than 10 days for concrete exposed to dry and hot weather conditions. In the case of concrete where mineral admixtures or blended cements are used it is recommended that above minimum periods may be extended to 14 days. For the concretes containing PPC or Portland Slag Cements, period of curing may be increased.

2.11.2 For other items the curing shall be done as follows or as directed by the Engineer-in-Charge.

(a)	Brick work	At least for 10 days.
(b)	Plaster work	At least for 7 days.
(c)	Sand faced plaster	At least for 15 days.
(d)	Tiles or stone flooring and dado	At least for 10 days.

2,12 FORM WORK:

2.12.1 General:

The form work shall conform to the shape, lines and dimensions as shown on the drawings and be so constructed as to remain sufficiently rigid during the placing and compacting of the concrete and shall be sufficiently tight to prevent loss of slurry.

(a) All forms shall be checked frequently during the concreting operations and until removed so that they may be driven up if any settlement occurs.

The design, fabrication and erection of formwork are solely the responsibility of the Contractor. The formwork should be safe and stable to withstand dead load of concrete, men etc. Further, the form should yield security to the structure or its members.

(b) Materials:

The selection of materials suitable for formwork shall be based on economy and consistency with safety and quality required for the finished work. Formwork shall be of timber, plywood, steel or any other materials as approved by Architect/Engineer-in-Charge whose decision in this respect shall be final. Props and shores shall be of steel, timber posts, bullies or any other material as approved by Architects.

(c) Chamfer strips shall be placed in corner of forms to produce bevelled edges on permanent exposed surface, if specified.

(d) Temporary openings shall be provided at the base of column forms and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed.

(e) Mould Oil:

Care should be taken to see that the formwork is perfectly cleaned and two coats of mould oil or any other approved material is applied before placing the concrete. Such coating shall be insoluble in water, non-staining and non-injuries to the concrete. It shall not become flaky or be removed by rain or wash water. Block boards or equivalent shall be used for shuttering columns, beams, etc. and steel sheets for slab shuttering will be allowed.

(f) Chamfers and fillets:

All concrete and angles exposed in the finished structure shall be formed with mouldings to form chamfers of fillets on the finished concrete. The standard dimensions of chamfers and fillets, unless otherwise specified, shall be 20 mm. Care should be exercised to ensure accurate mouldings. The diagonal face of the moulding shall be placed or surfaced to the same textures as the forms to which it is attached.

(g) Vertical construction joint chamfers:

Vertical construction joints on faces, which will be exposed at the completion of the project, shall be charnfered as above except where not permitted by the Engineer for structural or other reasons.

(h) Reuse of Forms:

Before reuse, all forms shall be thoroughly scraped, cleaned, joints examined and when necessary, repaired and the inside retreated to prevent adhesion, to the satisfaction of the Engineer. The Contractor shall equip himself with enough shuttering to complete the job in the stipulated time.

(i) The contractor shall record on the drawing 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 in removed there from. Striking of forms in the case of sides of beams, columns and slabs can be carried out after 24 hours of concreting. The striking of forms shall be done as para 2.12.4. Striking shall be done with utmost care without shock or vibration by gently easing the wedges. If, after removing the formwork, it is found that the timber is embedded in the concrete, it has to be cut out and made good with fine concrete. Due care shall be given to the provision of correct form work for holes and openings in the slabs, inserts, grounding cables, conduits and pipe sleeves, foundation or anchor bolts etc. as per approved drawings or as directed by the Engineer.

2.12.2 CLEANING AND TREATMENT OF FORMS:

The forms shall be carefully examined to see that they are vertical and horizontal and the joints are properly closed. If forms are to be reused, they should be carefully examined before such, reuse, properly aligned and open joints shall be repaired and coated with crude oil. The centering planks for columns shall be joined together and provided with threaded bolts and nuts.

The centering and props for the various members shall be fixed in a workman like manner to be approved by the Engineer-in-charge. They shall be of such size as the Engineer-in-Charge thinks fit and proper. The centering shall be removed only after the permission has been obtained from the Engineer-in-Charge. Props shall be supported on wedges placed on planks and the planks shall be 25 mm thick.

All rubbish, particularly chippings, shavings and saw dust shall be removed from the interior of the forms before the concrete is placed and the form work in contact with the concrete shall be cleaned and thoroughly wetted or treated with an approved composition. Care shall be taken that such approved composition is kept out of contact with the reinforcement.

(a) In columns of any forms where access to the interior is not available otherwise, a sufficient area of one side shall be left loose so that it may be removed for cleaning out all chips, dirt, sawdust and other extra materials.

(b) Where the shoring bores on the ground, the Contractor shall spread the load from shores by suitable brick platforms in order to prevent settlement.

2.12.3 ARCHITECTURAL EXPOSED REINFORCED CEMENT CONCRETE:

(a) General:

Generally specification for reinforced cement concrete work shall also apply to this type of work and additional specification setforth below.

(b) Materials:

(i) Cement used for such work shall be of a uniform colour and obtained from one source of manufacture.

(ii) Aggregate:

a) Fine Aggregates:

Colour being an important consideration for exposed concrete, colour of sand used shall also be uniform through out the entire construction.

Preferably total quantity required for the work shall be collected and well mixed together to a uniform shade.

b) Coarse Aggregate:

The colour of the aggregate shall be maintained the same through out. Unless otherwise specified, exposed concrete in walls, fences and parapets which are nonload bearing and are less than 120 mm. in thickness the maximum size of coarse aggregate shall be limited to 12 mm for which nothing extra shall be admissible. Flat and flaky pieces shall not be allowed.

(iii) Reinforcement & Cover of the Concrete:

Correct placing of the reinforcement with proper cover is important in all exposed work to avoid discolouration by rusting. The minimum cover specified in the Specification shall be maintained throughout.

Concrete blacks or spacers shall be sparingly used at exposed surfaces. When used, such blocks shall preferably be cast on vibrating tables or in some other similar manner so that it may match the concrete surface in texture and colour. Cover blocks of materials other than precast blocks shall not be allowed to be used.

(c) Construction of shuttering:

All centring and framework shall be rigid and of robust construction. All vertical props shall be cut square at ends and shall rest on double wedges, placed on continuous horizontal runners on firm natural soil. Resting of props or runners on made up soil shall not be permitted on any account. All members of the formwork shall be closely fixed without any gap between them so as to safeguard against any settlement or displacement of shuttering at the time of concreting.

(i) Timber Shuttering:

Formwork for exposed work shall be of seasoned wrought hard wood timber planks free from loose knots. The planks shall be 50 mm thick, 100 to 125 mm wide with tongue and groove joints, assembled to a pattern approved by the Architect. The formwork shall be so constructed, braced, and stayed as to remain absolutely rigid and true during and after concreting. The boards shall be planed to a suitable thickness in order that the surface against the concrete shall not be broken at joints between boards. Chamfers, grooves, drips mouldings, bevelled edges etc. shall be made in the form itself to the size, profiles and details called for on the drawings.

(ii) Plywood Shuttering:

The contractor shall provide shuttering quality plywood not less than 12 mm thickness as per IS.4990 (type-I) of approved make or equivalent approved by the Architect in place of timber plank shuttering mentioned above for such location as called for by the Architects. The joints in plywood shuttering shall be located as directed by the Architects. Shuttering, centering and form work for all exposed concrete work like exposed columns, beams, ribs, slabs, chajjas, facias, walls etc. shall be of such finish and rigidity as to produce all faces fair and smooth, true to line level and plumb. No rendering or touching shall be permitted on these faces.

(iii) Steel shuttering:

Steel shuttering for exposed concrete work shall be made of shuttering plates of standard sizes and to suit the pattern of exposed concrete indicated in Architect's drawings. The shutter plates used will be made of steel sheets strengthened at the edges and in middle to prevent sagging or any deflection and concrete deformity or dents and should fit with each other properly without any space or groove being left between adjacent plates to avoid and leakage of concrete slurry. If any concrete projects out between plates this will be neatly cut away.

The contractor shall be required to produce details of working showing the general construction of formwork and panels with details such as nail position and holes for supports that may be required; nail heads shall be positioned as instructed by the Architects. Grooves and chamfers shall be formed as shown on the drawings without any extra cost.

Any holes for the supports, which the contractor may need, shall be permitted only if approved by the Architects. All such holes shall be subsequently filled in carefully as to match with the other surface. Walls, columns etc. shall generally be cast to the full height in one operation and the formwork shall be provided accordingly. If permitted by the Architects, these may be completed in two or more heights when the formwork shall be carefully and correctly raised for further height so as to ensure a neat joint without disturbing the pattern. Any groove desired by the Architect at the joint shall be provided by the Contractor at no extra cost.

(d) Coating for shuttering:

Shuttering oil, colourless and emulsifiable in water shall be used for oiling the woodwork, when only a thin film shall be neatly applied avoiding collection at one place. Any mark left by the shuttering oil shall be washed clean.

(e) Measurements and proportioning of concrete materials:

This shall be as laid down generally for R.C.C. work. In no case extra dust or sand or additional water shall be allowed with the intention of getting better finish, which shall only be obtained by erecting centering as specified above and proper vibrating of the mix after placing. In no case, the slump limit, specified in the Specification shall be exceeded.

(f) Preparation for placing concrete:

Special care is essential to see that all saw dust, chips, nails or any foreign material is washed out or otherwise removed from the shuttering.

(g) Mechanical vibration:

All concrete for exposed concrete work shall be vibrated, using needle vibrators -30/32 mm. Surface or trough vibrators may be permitted to be used for thin slabs. External vibrators for walls may be allowed but this shall be done carefully to safeguard the displacement of the shuttering. Vibrators shall only be operated by skilled labour; over or under vibration shall not be permitted. Any spillage, or leakage, which is unavoidable and which flows down the exposed concrete surfaces, shall be immediately washed away with clean water and brush.

Exposed concrete members shall be finished to desired surface while the concrete is still green.

(h) Curing and protection of concrete:

Curing will be done with clean water, so as not to discolour the concrete. All expose d concrete work shall be properly protected by Alkathene film, gunny bags, wooden boards etc. so the surfaces and edges are not damaged or discoloured till the entire construction is handed over, at no extra cost. All such damages shall be set right or replaced by the contractor at his own cost; the contractor is deemed to have considered this in quoting his rate.

(i) Removal of shuttering:

Striking and removing of formwork for exposed concrete shall be done very carefully without damaging the surface or edges. All such damages shall be set right or replaced by the contractor as his own cost.

(j) Finishing:

Finishing of exposed concrete surface shall be as specified.

Exposed concrete surface shall on no account be permitted to any sort of repairs or patching after striking the formwork. In the event of any portion not coming up to standard, this shall be taken down by the contractor at no extra cost. Decision of the Architects as to the rejection of such work shall be final and binding on the contractor.

2.12.4 STRIPPING TIME:

In normal circumstances (generally where temperatures are above 20^0 C) and where Ordinary Portland Cement is used, forms may generally be removed after expiry of following periods:

Type of Form work		Minimum Period before striking Form work
(a)	Vertical formwork to columns, walls, beams.	16-24 h
(b)	Soffit formwork to slabs (Props to be refixed immediately after removal of form work	3 days
(c)	Soffit form work to beams (props to be refixed immediately after removal of form work	7 days
(d)	Props to slabs (a) Spanning up to 4.5 m. (b) Spanning over 4.5 m.	 7 days 14 days
(e)	Props to beams and arches (a) Spanning up to 6 m. (b) Spanning over 6 m.	 14 days 21 days

The number of props left under, their sizes, load and disposition shall be such as to be able to safely carry the full dead of the slab, beam or arch as the case may be together with live load likely to occur during curing or further construction.

However, this period may be increased or decreased at the discretion of Architects. In case when the cube strengths at seven days are found to be low or in the cases when other cements are used, the curing period and stripping time for forms and removal of props may have to be extended. This shall be decided by the Architect and the contractor shall not claim any extra costs for such increased periods of curing and stripping of forms etc. Special care shall be taken while removing the centering of cantilever slab, canopies, portal frames, folded plates construction etc. Stripping time for such special structure as shell roofs etc. shall be determined from tests of stripping cubes taken specially for the purpose. These cubes shall give strength of 75% of the 28 days strength.

For rapid hardening cement 3/7 of the above period will be sufficient in all cases except vertical sides of slabs, beams and columns, which should be retained for 24 hours.

Note:

The props left under shall mean that the form work for slabs and beams soffits at 3 days and 7 days respectively can be removed only if the same can be done without disturbing the props which are required to support the slab or beam completely. In normal cases this will mean that period for removal of formwork for slabs and beam soffits will be 7 days and 14 days respectively.

2.12.5 PROCEDURE WHEN REMOVING THE FORMWORK:

All formwork shall be removed without such shock or vibration as would damage the reinforced concrete. Before the soffit and struts are removed, the concrete surface shall be exposed, where necessary, in order to ascertain that the concrete has sufficiently hardened. Proper precautions shall be taken to allow for the decrease in the rate of hardening that occurs with all cements in the cold weather.

2.12.6 CAMBER:It is generally desirable to give forms an upward camber to ensure that the beams do not have a sag when they have taken up their deflection, but this should not be done unless allowed for in the design calculation of the beams.

2,12.7 TOLERANCES: The Contractor shall, before putting any concrete in any unit, check all dimensions according to the drawing governing the accuracy of the dimension of all the units and the necessary formwork shall be approved by the Engineer-in-charge and if any error is found in dimensions, the Engineer-in-charge will not allow in any case more than the tolerances specified as below and any unit which does not comply will be liable to rejection at the discretion the Engineer-in-charge.

The formwork shall be designed and constructed to the shapes, lines and dimensions shown on the drawings within the tolerances as given below. The tolerances in footings apply to concrete dimensions only and no to positioning of vertical reinforcing steel or dowels.

(a)	Deviation from specified dimensions of cross sections of columns and beams	-6 mm + 12 mm
(b)	Deviation from dimensions of footings	
i)	Dimensions in Plan	- 12 mm
ii)	Eccentricity	0.2 times the width of the footing in the direction of deviation but not more than 50mm.
iii)	Thickness	+ 0.05 times the specified thickness.

2.13 FOUNDATION BEDDING, BONDING AND JOINING:

All surfaces upon or against which concrete will be placed shall be suitably prepared by thoroughly cleaning, washing and dewatering as may be indicated in the drawing, or as the Engineer may direct to meet various situations encountered in the work.

2.13.1 SPACE OF CROSS SECTION:

No line on the cross section of unit shall deviate from its correct position by an angle exceeding one degree. Contractor shall not make any change in the cross section of the units in any case.

2.13.2 PREPARATION OF ROCK FOUNDATION:

The prescribed methods of rock excavation will be shown on the drawings or given in the general specification for excavation and foundation preparation for a particular job and not in this specification. The exact foundation configuration cannot always be predicted and the subsequent treatment thereof cannot always be shown or indicated on drawings prepared before the excavation is done. However, the following general requirements shall be observed:

(a) Concrete shall not be deposited on large sloping rock surfaces. Where required by the Engineer or as indicated on the drawings, the rock shall be cut to form rough steps or benches, to provide roughness or a more suitable bearing surface.

(b) Rock foundation shall be prepared by picking, barring, wedging and similar methods which will leave the rock in an entirely sound and unsheltered condition.

(c) Shortly before concrete is placed, the rock surface shall be cleaned with the high-pressure water and air jet. even though it may have been previously cleaned in that manner.

(d) Prior to placing concrete, the rock foundation shall be kept wet for a period of 2 to 4 hours unless otherwise directed by the Engineer.

(e) Before placing concrete on rock foundations, all water shall be removed from depressions to permit thorough inspection and proper bonding of the concrete to the rock.

2.13.3 PREPARATION OF EARTH FOUNDATION:

All earth surfaces upon which or against which concrete is to be placed shall be well compacted and free from standing water, mud or debris. Soft yielding soil shall be removed and replaced. Where specified, lean concrete shall be provided on earth for receiving the concrete. The surface

of absorbing types of soils against which concrete is to be placed shall be moistened thoroughly so that no moisture will be drawn from the freshly placed concrete.

2.13.4 PREPARATION OF CONCRETE SURFACES:

The preparation of concrete surfaces upon which additional concrete is to be placed 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 of the surface with picks and stiff brooms and by use of an approved combination of air and water jet, as directed by the Engineer. Great care shall be taken in performing this work to avoid removal of too much of mortar and 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.

2.13.5 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 content as the concrete, which will be placed on it. The water-cement ratio shall be determined by conditions and as approved by the Engineer.

Bonding mortar shall be placed in sufficient quantity to completely cover the surface about 12.5 mm thick for rock 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 the Engineer.

Mortar shall be placed at a rate that it can be brushed over the foundation 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 take place. The amount of mortar that will be permitted to be placed at any one time, or the area which it is to cover, shall be in accordance with the Engineer's direction.

2.13.6 CLEANING AND BONDING FORMED CONSTRUCTION JOINTS:

Vertical construction joints shall be cleaned as specified above or by other methods approved by the Engineer. In placing concrete against formed construction joints, the surface 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 pudding and spacing with aid of suitable tools.

2.13.7 When reshoring is permitted or required, the operation shall be planned in advance and shall be subject to approval of Architect. When reshoring is underway, no live load shall be permitted on the construction.

(i) In no case during reshoring shall concrete in beam, slab, column or any other structural member be subjected to combined dead and construction loads in excess of the loads permitted by Architect/Engineer for the concrete strength developed at the time of reshoring. Reshore shall be tightened to carry their required load without overstressing the construction.

(ij) Floors supporting shores under newly placed concrete shall have their original supporting shores left in places or shall be reshored. The reshoring system shall have capacity

sufficient to resist the anticipated loads and in all cases shall have a capacity equal to at least one half of the capacity of the shoring system above.

The reshores shall be located directly under a shore position above unless other location is permitted.

(iii) In multi-storey building the reshoring shall extend over a sufficient number of storeyes to distribute the weight of newly placed concrete forms and construction live loads in such a manner that the design superimposed loads of the floors supporting shores are not exceeded.

2,13.8 EXPANSION AND CONSTRUCTION:

Provision will be made for expansion joints and construction joints in concrete by use of special types of joints located as shown on the drawings, Construction joint surfaces are to be treated as shown on the drawings or as directed by the Engineer.

2~14 ADVERSE WEATHER CONDITIONS:

When concrete is to be placed under adverse weather conditions special provisions shall be made in the handling and placing methods and in protection during the curing period to ensure that concrete of full strength and free from damage will be obtained.

2.14.1 PLACING CONCRETE UNDER WATER:

Under all ordinary conditions, all foundations shall be completed unwatered and concrete placed in the dry. However, when concrete placement under water is necessary, the procedure shall be as follows:

(a) Concrete shall be deposited underwater by means of tremies, or cotton-dump covered buckets of approved type. As per IS: 456, clause 14.2.4 under water concreting can be done by:

- Tremie
- Direct Placement With Pumps
- Drop Bottom Bucket
- Bags
- Grouting

(b) All work requiring placement of concrete under water shall be designed, directed and inspected with the due regard to local circumstances and purposes. All underwater concrete shall be placed according to the drawings or Specifications and as directed and approved by the Engineer.

2.14.2 Calcium chloride shall not be used for accelerating setting of the cement for any concrete containing reinforcement, or embedded steel parts. The use of calcium chloride in mass concrete of footings and similar occasions will be permitted only upon written approval of the Engineer. When calcium chloride is used, it shall be liquefied and added to the mixing water in an amount not exceeding 2 % of the weight of the cement in each batch of concrete. If calcium chloride added is:

(a) 1 % of weight of cement, it serves the purpose of acceleration. But if the quantity exceeds 2% it causes delay in the initial setting time; it acts as retarder.

(b) 8% of weight of cement, it causes slash-set. Calcium Chloride should not be used in the prestressed concrete works at all and more amount of it reduces the resistance of the cement to the sulphur attacks.

2.15 OPENINGS, INSERTS ETC.

Slots, openings or holes, pockets, etc. shall be provided in the concrete work in the positions indicated in the drawings or as directed by the Engineer. Any deviation from the approved drawings shall be made good by the contractor without darnaging any other work. Sleeves, bolts, inserts etc. shall also be provided in concrete work, where so specified.

2.16 RATES ALL INCLUSIVE:

2.16.1 The unit rate for concrete work under various categories shall be inclusive of and no claims for extra payment on account of such items as leaving holes, pockets, embedding inserts etc. shall be entertained. No extra claim shall also be entertained due to change in the number, position and/or dimensions of holes, slots or openings, sleeves, inserts or on account of any increased lift or scaffolding etc. All these factors should be taken into consideration while quoting the unit rates. The rates shall also include fixing inserts in all concrete work, whenever required.

2. 16.2 PAYMENT FOR CONCRETE WORK:

Payments for concrete will be made on the unit rates quoted for the respective items in the Bills of Quantities. No deduction in the concrete quantity would be made for reinforcements, inserts, etc. and opening less than one twentieth of the square meter and 1/150 Cmt. where concrete is measured in cubic meters. It shall be very clearly understood that payment for "concrete work formwork" is inclusive formwork, shuttering shoring, propping, scaffolding, etc.

Rate for all concrete work shall be based on 20 mm maximum size aggregate. Contractor shall also quote the reduction offered for using 40 mm maximum size aggregate, if permitted by the Engineer.

2.17 PRECAST CONCRETE:

2.17.1 Precast concrete shall comply generally with the requirements given below.
All precast units shall be cast on a suitable bed or platform with firm foundation and free from wind, the contractor shall be responsible for the accuracy of the level or shape of the bed or platform, a suitable serial number and the date of casting shall be impressed or painted on each unit.

All precast concrete units shall be prepared and fixed as shown in the drawings and as specified in the detailed specification. Concrete mix shall be as specified or as shown in the drawings with machine mixed, machine vibrated and prepared by weigh batching with Contractor's own mix design which shall be approved by Consulting Engineers. IS: 456 Code Practice for Plain and Reinforced Concrete shall be followed as relevant Indian Standard Specification.

(a) Striking Forms:

Side shutters shall not be struck in less than 48 hours after deposition of concrete and no precast units shall be !ifted in less tiian 21 days after the date of casting or built into position in less than 28 days.

(b) Hoisting Precast Units:

The lifting and removal of precast units shall be undertaken without causing shcck, vibration or undue bending stresses to or in the units. Before lifting and removal take place, the contractor shall satisfy the Engineer or his representative that the methods he proposes to adopt for these operations will not over stress or otherwise affect seriously the strength of the precast units.

(c) Curing:

All precast work shall be protected from the direct rays of the sun for at least 21 days after casting and during that period each unit shall be kept constantly watered or preferably be completely immersed in water.

The surface i.e. the underside or upper side, which is reinforced, shall be distinctly marked.

2.17.2 MOULDS:

Moulds shall be constructed of well-seasoned timber of stout scantling, steel or concrete. They shall be constructed so as to prevent leakage of cement slurry, remain true to shape at all times during use and give a smooth finish to the unit. Moulds shall be coated with an approved nonstaining liquid prepared before each unit is cast. Precast concrete beams, purlins and similar units shall be cambered where shown on the drawings or directed by the Engineer-in-charge,

2.17.3 UNITS CAST ON FLOORS:

When units are cast directly into a concrete floor slab, the contractor shall ensure that the parts of the surface on which the units rest are sufficiently smooth and level or are made so by laying temporary screeds which must be removable without damage to the floor surface. In all cases, a membrane of a waxed paper or other approved material shall be carefully laid on the floor beneath the moulds to prevent the deposited concrete adhering to the floor.

2.17.4 DEMOULDING UNITS:

No units shall be demoulded sooner than 12 hours after casting unless cured by steam or hot water. The time of demoulding shall be related to the temperature of the ambient air.

Freshly demoulded units shall be handled with the greatest care so as to avoid cracking and damage to the surface.

2.17.5 HOLES FOR FIXING SERVICES ETC.

Holes shall be formed in the positions shown on the drawings or as directed by the Engineer-in-Charge with steel or wooden cores, cardboard tubes or other approved forms fixed in position prior to concreting.

Holes for the fixing of precast units shall be cored accurately in the positions shown on the drawings and at right angles to the surface from which they are cored unless otherwise shown Former-pins shall be well greased before concreting.

Holes which are to receive fixing bolts which bear on the surfaces of the holes shall be permanently cored with galvanized steel tube, the ends of which must be finished flush with the surface of the unit and be galvanised or dipped in approved zinc rich paint, 12 hours before fixing in the mould.

Holes must not be cut in hardened concrete without the permission of the Engineer-in-Charge.

2.17.6 CAST-IN-ITEMS:

Fittings and items of equipment which are set in position before the surrounding concrete is deposited shall be protected by painting or otherwise, as agreed with the Engineer-in-Charge against the effect of the water in chemical action of the concrete. Particular care shall be taken to ensure that concrete completely surrounds and is in intimate contact with all cast-in items and is properly compared thereabout.

2.17.7 DIMENSIONS OF PRECAST UNITS:

Accuracy of Dimensions:

The contractor shall, before commencing manufacture of present units, check all dimensions on the detailed drawings governing accuracy of fit and assembly in accordance with the general arrangement and assembly drawings. Any errors or omissions shall be reported to the Engineer-in-Charge who may agree on the adjustments to be made to the drawings and to the contract sum if extra material and/or labour are necessitated.

The dimensions of precast units must not vary from those specified by more than the tolerance given and any units which do not comply with, will be liable to rejection at the discretion of the Engineer-in-Charge.

2.17.8 TOLERANCE:

Forms for precast members shall be true to size and dimensions shown on drawings and should be constructed and protected from warping so that finished product will be within limits given below:

(a)	Overall dimensions of members	+ I mm per meter.
(b)	Cross sectional dimensions: Section less than 150 mm	± 3 mm

	Section 150 mm to 450 mm	± 5 mm
	Section 450 mm to 900 mm	± 6 mm
	Section over 900 mm	± 10 mrn
(c)	Deviation from straight line in long sections not more than 1 mm per meter	
(d)	Deviation from specified chamber	+ 0.5 mm per 1 m. of span
(e)	Maximum differential between adjacent units In erected position	6 mm.

2.17.9 ERECTION OF PRECAST UNITS:

Erection Programme:

Prior to be erection of precast reinforced concrete structural units, the contractor shall submit to the Engineer-in-Charge for his approval, detailed erection programme giving full descriptions of the methods and plant to be employed for lifting, assembling and fixing the units, and safeguarding the structure during erection. No erection shall be carried out until the Engineer-in-Charge has approved the methods to be used.

Handling, lifting, transporting. All units shall be handled, lifted and transported in a manner which does not cause damage or cracking, when units are lifted by tackle or crane, the weight shall be taken up gradually without snatch. When units are being lowered, they shall not be dropped but shall be let down gently into position without impact.

Pre cast members are not to be transferred from the manufacturing yard to the site before they are 21 days old. Lifting shall be done only at points provided for this purpose. Under no circumstances shall precast members be reversed while handling or be lifted at midspan.

The position of slings, lifting holes, or lifting eyebolts, shall be decided by the contractor with the consultation of the Consulting Engineer, and the same shall not be departed from without the permission of Consulting Engineer.

The contractor shall not introduce any holes, cavities, lifting loops, lifting eyebolts or other features for his own convenience without the permission of the Engineer-in-charge.

The Contractor is responsible for the safety of the structure and operations at all stages during the erection of precast concrete units and shall provide all necessary frames, guys, wedges and other temporary supports.

2.17.10 Storage of Units on site:

All precast units shall be stored on site in a manner and In the position, which will prevent damage or cracking of any kind and permit erection with a minimum of preliminary handling and, transporting.

In cold weather, boltholes, recesses, cable duct, and other cavities shall be plugged to prevent entry of rain or other water unless such water can freely drain away.

2.17.11 Fixing:

The Contractor is responsible for accurate setting out of the work and for ensuring that all precast concrete frame work units come together without strain and in their correct relative positions as shown on the working drawing. If due to inaccuracies in the position or level or in the dimensions of units without straining them into position, no such straining shall be done without the permission of the Engineer-in-Charge and when directed, the contractor shall dismantle the work and re-erect and make good to the satisfaction of the Engineer-in-Charge.

2.17.12 TESTS AND INSPECTIONS:

Rejection of work:

The Engineer-in-Charge reserves the right to condemn any work, which appears unsatisfactory or does not comply with the specifications or working drawings. The contractor shall at his own expense cut out the condemned work and replace it with new work to the satisfaction of the Engineer-in-Charge.

Pre-cast Facto[y Made Units:

Cube Tests: Cube tests shall be carried out as and when required to satisfy the Engineer-in-charge that the concrete is of the specified quality and strength.

Test cubes shall be made concrete prepared for the work and tested in accordance with the procedure laid down in relevant codes.

Inspection at Works:

Immediately after receiving the order, the manufacturer shall draw up a casting programme and submit this to the Engineer-in-Charge in order that inspections may be made to examine the moulds, reinforcement and the units during and after manufacture.

The Engineer-in-Charge shall at all reasonable times have free access to the place where the units are being manufactured or stored for the purpose of examining the materials, the method of manufacture and the finished products, and for testing and marking of units. For this purpose, the manufacturer shall stack the units with passages, between the stacks, of sufficient width for inspection of each unit to be properly and easily made.

The manufacturer shall, free of charge, provide or make arrangements for the provision of very facility and all labour required for such examination, testing and marking and if so required shall load on to a lorry at the works free of cost for dispatching to a testing laboratory, the samples as described hereafter.

Testing of Units:

The selected units shall be tested In the manner laid down by the Engineer-in-Charge, The manufacturer shall be entitled to charge at the contract rates for all units, which pass the prescribed tests but shall not be paid for units that do not pass the tests.

Should one or more test samples fail to comply with the requirement of the prescribed tests, the Engineer-in-Charge shall be entitled to take further samples for the tests and if these also prove to be unsatisfactory, the Engineer-in-Charge shall at his own discretion, reject any or all of the units of the type being tested.

Marking:

Units, which withstand the test load without damage, may themselves be passed for delivery. All units passed for delivery shall be suitably marked in the presence of the Engineer-in-Charge if so required, in which case no units not so marked shall be loaded for the delivery by the manufacturer. The Engineer-in-Charge shall be entitled to remove the mark from any units previously marked as approved, if it is subsequently found to be defective before leaving the approved works. Any unit, which has been marked as approved, but which is later damaged in the works or loading, shall not be dispatched.

Inspection and Tests on Site:

The Contractor shall provide all necessary labour and facilities for the inspection of units after delivery the site and after erection. If any unit is found to be defective by the inspection or testing, then notwithstanding any prior approval of the units before delivery, it shall be removed from the site and replaced at the Contractors expenses.

2.18 LOADING TESTS:

If required by the Engineer-in-Charge, the Contractor shall carry out a loading test on the finished structure or any part thereof as directed. If the test shows that the work is in accordance with this specification, the contractor will be reimbursed for the cost thereof but if any work is found to be not in accordance with this specification, it shall, at the discretion of the Engineer-in-Charge, be cut and replaced at the contractor's expense, and the contractor shall also bear the cost of the test.

Load tests should be carried out as soon as possible after expiry of 28 days from the time of placing of concrete, The structure should be subjected to a load equal to full dead load of the structure plus 1.25 times the imposed load for a period of 24 hours and then the imposed load shall be removed.

Note:
Dead loads include self-weight of the structural members plus weight of finishes and walls or partitions, if any, as considered in the design,

The deflection due to imposed load shall be recorded. If within 24 hours of removal of the imposed load the structure does not recover at least 75 percent of the deflection under superimposed load, the test may be repeated after a lapse of 72 hours. If the recovery is less than 80 percent, the structure shall be deemed to be unacceptable.

If the maximum deflection in mm, shown during 24 hours under load is less than 40 %, where L is effective span in meters and D, the overall depth of the section in mm, it is not necessary for the recovery to be measured and the recovery provision given above not apply.

Other Non Destructive Test methods may be adopted in which case the acceptance criteria shall be agreed upon by the Engineer-in-Charge and the tests shall be done under expert guidance.

2.19 REINFORCED CONCRETE FLOORS (WITH FLOOR HARDENER)

2.19.1 LEVELLING OF SUB-BASE:

The P.C.C. floor bedding should be in required level/slope with top surface even to get a uniform thickness of R.C.C. floor within variation of 3% to 5%,

2.19.2 CLEANING THE SUB-BASE:

Any debris/mortar/concrete above the P.C.C. floor bedding to be cleaned before fixing of side forms for laying concrete floor.

2.19.3 FORM WORK FOR PANELS:

Side forms for panels should be 15 to 20 mm less than the specified thickness of floor.

- The side form will be of IS MC or fabricated with two ISA and MS flats of required length to get required height. The side form should be in perfect alignment, slots in IS MC to be provided for passing the dowel bars to be provided at the longitudinal joints, The top level of formwork to be perfectly checked before starting concreting for floor.

- 10 mm thick expanded polyethylene foam to be fixed at junction of floor and wall and around all rigid structures such as columns and machine foundation walls for Isolation of floor from rigid structures.

2.19.4 JOINTS LOCATION AND DESIGN FOR NON-STRUCTURAL FLOOR:

(a) Isolation Joints: (From rigid Structures)

The floor must be separated structurally from other building elements to accommodate differential horizontal and vertical movement. 10 mm wide isolation joints must be provided at junctions of wall, columns, machine foundations etc. using 10 mm thick Expanded Polyethylene having height equal to thickness of floor.

(b) Control Joints: (For Controlling Shrinkage Cracks)

Differential movement in the floor is caused due to drying shrinkage, thermal changes and carbonation shrinkage. The first is usually the most important.

Some shrinkage is expected and can be tolerated. This amount will depend on the design and exposure of the particular structural elements. However when this amount approaches to un-tolerable limit, proportioning, mixing and selection of material deserves careful evaluation and alteration. In floor, shrinkage occurs more rapidly at the exposed surface and causes upward curling at the edges. If the floor is restrained from curling,

cracking will occur wherever restrained portion develops stress greater than the tensile strength of RCC floor.

Differential movement must be accommodated by control joints spaced at 4.5 M to 7.50 M intervals in both directions; shorter intervals can also be used. Whenever there is reason to expect shrinkage to be high, temperature steel may be used to restrict crack width.

For transverse joints 6 mm Plain Asbestos Cement Sheet or PVC sheets having depth up to 2/3 of floor thickness to be fixed before laying concrete for floor. These are fixed simultaneously along with the fixing of from work on the previous day so that it will not be disturbed during concreting. This will help to avoid cracks due to thermal expansion / contraction and also due to drying shrinkage. After the curing work is completed these joints are to be filled with Polysulphide Epoxy mortar having proportion of one part Poly-sulphide Epoxy and two parts silica quartz.

2.19.5 TRANSPORTING AND PLACING OF CONCRETE:

The concrete shall be mixed in quantities required for immediate use and shall be deposited on the subgrade/sub-base to the required depth and width of the pavement section in successive batches and in continuous operation without the use of intermediate form between the joints. Care shall be taken to see that no segregation of materials results whilst the concrete is being transported from the mixer to the place where it is to be deposited. The spreading shall be as uniform as possible to avoid re-handling of concrete. Where, however a certain amount of redistribution is necessary, it shall be done with shovels and not with the rakes.

While being placed the concrete should be rodded with suitable tools so that formation of voids or honeycomb pockets is prevented. The concrete shall be well placed and tamped against the forms and along all joints.

2,19.6 COMPACTION OF FLOOR CONCRETE:

The concrete at the side of the forms and between the reinforcements at joints and at corners to be compacted with internal vibrator (needle vibrators) to avoid honeycombing and to get perfect compaction at these locations.

The vibrating screed shall rest on side forms and it shall be lowered vertically on the concrete surface, (evenly spread to an appropriate level above the base) to provide the required surcharge for compaction; allowed to remain in position for few seconds until compaction is completed, then lifted vertically and lowered on to the adjacent strip of un-compacted concrete. The amplitude of vibration of the screed shall not be less than 1.5 min and speed of travel not more than 0.60 m per minute. The screed shall again be taken slowly over the surface, sliding with its axis slightly fitted away from the direction of sliding and operation repeated until the required dense, close knit textured finish surface Is obtained.

Notes: Precautionary measures to be taken before starting concrete floor.

(a) The working of vibrators shall be regularly checked and standbys shall always be maintained for emergency use.

(b) The segregated particles of coarse aggregates which collect in front of the tamper or screed shall be thrown outside the forms. Under no circumstances shall such segregated particles be carried forward and pushed on to the base in front of the mass.

2.19.7 CONCRETE FLOOR FINISHING:

Immediately after completing the compaction by screed vibrator and excess water has disappeared but while the concrete is still plastic, the floor top surface shall be tested for true-ness with a 3.65 M long straight edge (Aluminium Box Section).

The straight edge shall be held in successive positions parallel to the guide channels in contact with top surface of floor laid and the whole area gone over from the one side of the floor to the other. Advance along the floor shall be in successive stages of not more than one half length of straight edge. Any area of the depressions found shall be scooped to a depth of 40 to 50 mrn filled immediately with freshly mixed concrete, struck, compacted and refinished. High areas shall

be cut down and refinished. The straight edging and re-floating shall continue until the entire surface is found to be free from observable departures from straight edge and top surface has the required levelled surface.

The floor top surface shall be re-tested for trueness before the concrete begins to set with the 3.60 M long master straight edge (Aluminium Box Patti). Any irregularity in surface to be rectified,

2.19.8 PREPARATION OF SURFACE AND USE OF FLOOR HARDNER (FIRST DRY SHAKE):

Following types of floor hardeners are used for increasing strength of concrete floors.

- Ironite basod
- Silica / Quartz based
- Carboranclum based

The quantity of floor hardener shall be used as specified by the Consultants (or as per manufacturers specification) and according to light / medium / heavy-duty floor as specified.

Scrap the concrete deposited, if any, on the top of side form during concreting. As soon as concrete is firm enough to support the weight of workmen and their equipment and no water Is observed on surface; apply first shake of hardener evenly using 2/3 of total mix e.g. 2/3 of 7.5 Kg./Smt. Treat areas adjacent to walls and columns first, spread the materials evenly by sprinkling at right angles in two passes close to floor level. Do not broadcast (spread) the hardener from a station position but use a wooden scraper to spread the hardener. Alternatively, a mechanical spreader can be used for better application.

2.19.9 FLOATING: (With Finishing Machine Having DISC)

Power float the shake application promptly, work near wall, columns and door area first. Avoid excessive floating but ensure that the shake application is completely wetted and incorporated in to the base slab.

2.19.10 USE OF FLOOR HARDENER - SECOND DRY SHAKE:

Start immediately after first floating, spreading of balance material (1/3 quantity) of hardener and follow it up immediately with second power floating.

Third power floating if required to be carried out for getting required compaction. Do not add additional water during finishing with floating machine,

2,19.11 TROWELLING: (With Finishing Machine Having BLADES)

For the first trowelling, the trowel blade must be kept as flat against the surface as possible. If trowel blade is tilted or pitched at an angle, it is objectionable. The smoothness of the surface can be improved by timely additional trowelling. There should be laps of time between successive trowellings to permit concrete to become hardener. The purpose of additional trowelling is to increase the compaction of fines at the surface. This gives greater density and wear resistance.

2.19.12 CURING COVERING:

After completion of the finishing operations, the surface of floor shall be entirely covered with wet hessian cloth, barlap or jute mats. The coverings used shall be of such length (or width) that when laid will extend at least 500 mm beyond the edges of the floor slab and shall be so placed that entire surface and both the edges of the slab are completely covered. They shall be maintained fully wet and in position for 24 hours' after the concrete has been placed or until the concrete is sufficiently hard, to walk on without damaging the floor. To maintain the covering wet, water shall be gently sprayed so as to avoid damage to the fresh concrete. If it becomes necessary to remove the coverings for any reason, the concrete slab shall not be kept exposed for a period of more than half an hour. Final curing shall be done by preparing water on floor by preparing earthen bunds for 14 days.

2.19.13 REMOVAL OF FORMS:

Forms shall not be removed from freshly placed concrete until it has set or at least 12 hours whichever is later. They shall be carefully removed in such a manner that no damage is done to

the edges of floor. Ensure that the dowels provided in floor panel are not disturbed while removing the floor channel.

3.0 **BRICK LAYER:**

3.1 ORDINARY BRICK WORK:

3.1.1 BRICKS:

Bricks shall conform to IS: 3102 (latest revision).

(i) The bricks shall be local best quality and of regular & uniform size, shape & colour, uniformly well burnt through out but not over burnt. They shall have plain rectangular parallel sides & sharp, straight & right angled edges. They shall be free from cracks or other flaws. They shall have a frog of 10 mm. depth on one of the flat faces. They shall give a ringing sound when struck with each other.

(ii) The bricks shall show a fine grained, uniform, homogeneous & dense texture on fracture and shall be free from lumps of lime, laminations, cracks, air holes, soluble salts causing efflorescence or other defects which may in any way impair their strength, durability, appearance or usefulness for the purpose intended. They shall not break when thrown, on the ground on their flat face in a saturated condition from a height of 600mm.

(iii) The size of brick shall be 230 x 115 x 76 mrn (or locally available sizes) only bricks of one standard size shall be used on one work unless specially permitted by the Architects.

(iv) After 24 hours immersion in water, absorption by weight shall not exceed 20 percent of the dry weight of the bricks, when tested according to IS: 1077 - 1976.

(v) Unless otherwise specified, crushing strength of brick shall not be less than 50 Kg./Sq.cm.

(vi) Bricks rejected by. the Engineer shall be removed from the site of work within 24 hours.

3.1.2 MORTAR:

The mortar, which Is used, shall be mixed in proper proportion as specified in tender item. li shall be thoroughly mixed on an impervious platform by being turned over at least twice dry and twice wet; water in required quantity shall be added gradually. Mortar shall not be ground. Cement mortar shall be prepared in required quantity and not with more than one bag of cement at a time and this quantity shall be consumed within half of an hour after mixing.

3.1.3 CONSTRUCTION DETAILS:

(i) SOAKING:

All bricks shall be immersed in water for two hours before being put into works so that they will be saturated and will not absorb water from the mortar. Alternatively the bricks shall be well socked with watering so that they will not absorb water from the mortar.

(ii) BATS:

No bats or cut bricks shall be used in the work unless absolutely necessary around irregular openings or for adjusting the dimensions of different courses and for closer in which case, full bricks shall be laid at corners, the bats being placed in the middle of courses.

(iii) LAYING:

The bricks shall be laid in mortar to line, level and shapes shown on the plans slightly pressed and thoroughly bedded in mortar and all joints shall be properly flushed and packed with mortar so that they will be completely filled with mortar and no hollows are

left anywhere. Bricks shall be handled carefully so as not to damage their edge. They should not be thrown from any height to the ground; these should be put down gently.

Bricks shall be laid with frogs up and every 4th course shall be grouted. Seven courses should not exceed 600 mm. in height and in no case brick work shall be raised more than 14 courses per day.

All courses shall be laid truly horizontal and all vertical joints made truly vertical. Vertical joints in one course and the course below shall not come over one another and shall not normally be nearer than quarter of a brick length. For battered faces, bedding shall be at right angles to the face, care shall be taken during construction to see that edges of bricks at quoin, sills head etc. are not damaged. The verticality of the wall and horizontality of the courses shall be checked very often with plumb and spirit level respectively.

All uneven, irregular and bad brickwork shall be demolished, if deemed necessary by Engineer-in-charge and rebuilt at contractor's expenses.

Pipes or fitting shall be fixed during the progress of brick work or all chases or holes shall be neatly cut in the brick work later or shall be formed as the work proceeds and shall be filled with (1:2:4) P.C.C. and made good after pipes or fittings have been fixed.

Wherever possible bricks shall be bedded in sand instead of cutting and this method is to be used particularly for the fixing of lugs and holdfasts to doors and windows and to rakes of staircases. The bricks shall then be removed only when the fixings are to be made.

(iv) BOND:

Brick work shall be done In English bond unless directed otherwise by the Engineer-In-Charge.

(v) JOINT:

Joints shall not exceed 12mm in thickness and this shall be uniform through out. The joints shall be racked out not less than 12 mm deep when the mortar is green where pointing is to be done.

When the brick surface is to be plastered, the joints shall be racked to a depth of 6 mm. when the mortar is still green, so as to provicie key to plaster.

(vi) SCAFFOLDING:

Scaffolding will be double or single as warranted for the particular work and as approved by the Engineer-in-Charge. Holes shall be made good by bricks to match the work when scaffolding is removed.

(vii) CURING:

All brickwork shall be kept well watered for at least 10 days.

3.2 EXPOSED BRICK WORK:

Where exposed brick work is specified, the usual specification for 'Exposed' Brick shall be applicable and in addition, selected brick shall be used for facing, ensuring regular and clean faces or uniform colour. No bricks, which are broken, chipped, wrinkled, or which have irregular edges or corners, shall be used. Depending on the quality of bricks and if instructed by Engineer-in-Charge, the exposed face of every brick shall be rubbed before laying without any extra charge. Wooden fillets 12 mm thick and 12 mm. wide shall be placed at the edge of joints so that no mortar come on the surface of the bricks and a regular thickness of joint is maintained. The surface shall be rubbed down with brushes or bricks if necessary, and thoroughly washed. No mortar shall be allowed to stick to the surface, which shall be left clean with all joints even and true to straight line. Double scaffolding shall be used in exposed brickwork.

As specified in the tender, pointing (1:1) shall be done to brick joints. Before pointing, the joints shall be racked out to a depth 15 mm. and the surface of the wall shall be cleaned, washed and well watered at least for two days.

The mortar shall be prepared by mixing cement and sand in proportions as specified in Bills of Quantities. The material shall be thoroughly mixed in dry condition before water Is added to them. The mixing shall be done on a water tight platform and mortar of one cement bag only shall be prepared at a time which shall be consumed within 30 minutes after adding water. The mortar shall be placed in the joints in the best workman like manner. The extra mortar shall be removed so that the edges of bricks shall be clearly defined. The finished work shall be kept well watered at least for 10 days.

3.3 PARTITION WALLS:

Specifications shall be as per brickwork. Cement mortar proportion shall be (1:4) i.e. 1 part of cement and 4 parts of sand, by volume.

Partition brick wall shall be provided with reinforcement consisting of 2 numbers of 6 mm. diameter M.S. bars embedded in mortar 15 mm. thick at every fourth course and shall be anchored at ends. The cost of laying M.S. Bars will be included in rate for partition walls in case of Free Issue of reinforcement by Owner.

3.4 BRICK FACIA:

Bricks shall be of uniform size 16mm x 64mm x 25mm (5/8"x2.5"xl") and shall be free from cracks and shall have sharp and square edges. Brick shall be from MORVI or other place as shall be approved by Engineer-in-Charge.

Before laying brick facing, the surface shall be well watered and bricks shall be soaked well in water or shall be well watered to avoid absorption of water from the mortar.

The bedding mortar shall be prepared by mixing 1 part of cement and 3 parts of sand by volume. The cement mortar shall be prepared in required quantity of not more than one bag of cement at a time. This quantity shall be consumed with in 30 minutes after adding water.

The bedding mortar shall be spread to required thickness and cement slurry then be spread, in the portion specified for facia bricks. The facia bricks shall then be laid in position and required pattern, tapped with a wooden mallet till the brick is properly bedded in line an level. The wooden fillet of required size shall be placed if necessary.

The extra mortar and slurry shall be removed from brick facia. Double scaffolding shall be used in brick facia work.

The finished surface shall be cured for seven days.

3.5 RATES TO INCLUDE:

3.5.1 ORDINARY BRICK WORK

The rate shall include the cost of materials, labour required for all the operations described above. This shall include the following:

(i) All raking or false cutting and wastage.
(ii) Chamfering all external angles if instructed.
(iii) Extra cuffing and wastage for forming rebated, reveals or squint or birds mouth angles.
(iv) Cutting and fitting brick work to steel.
(v) Wedging and pinning up brick work to ceiling.
(vi) Bedding and pointing to wood frames,
(vii) Cuffing and pinning ends of timbers, lintels, steps etc.
(viii) Leaving small holes as necessary for pipes, conduits etc.
(ix) Scaffolding double or single for the brick wall, as directed.

(x) Necessary tools, plant etc. required for this work.

(xi) Leaving teeth or steps for proper bond with future masonry work.

(Xii) Soaking of bricks in water and curing of work done.

3.5.2 EXPOSED BRICK WORK:

Rate includes the following, in addition to those included for ordinary brick work and all the cost of materials, labour required for all the operations described above.

(i) Rubbing the bricks with bricks or on girder.

(ii) Pointing the exposed brick work.

(iii) Raking out the bricks up to 15 mm.

3.5.3 BRICK PARTITION WALL:

In addition of above items (described under the heading of 'RATE') the rate shall also include the cost of placing reinforcement as specialised.

3.5.4 BRICK FACIA WORK:

Rate includes the cleaning of mortar from the bricks in addition to those included for ordinary brickwork and all the cost of materials, labour required for all the operation above.

3.6 MEASUREMENTS:

3.6.1 ORDINARY BRICK WORK:

Unless otherwise specified, all work shall be measured in metric units, as fixed in its proper position. Any extra work done by the contractor, over the specified dimensions shall be ignored. Dimensions shall be measured correct to one cm. Cubic contents shall be worked out in cum. correct to two places of decimal.

No deduction shall be made nor any extra payment made for the following:

(i) Ends of dis-similar materials (i.e. joists, beams, posts, girders, rafters, purlins, trusses, steps etc., up to 0.1 Smt. in section.

(ii) Opening, each up to 0.1 sq. m. in calculating the area of the opening any separate lintels or sills shall be included along with the size of the openings but the end portion of the lintels shall be excluded and the extra width of the rebated reveals, if any, shall be excluded.

The work shall be measured separately under the following general categories; the mode of measurements however shall be as per levels/heights mentioned in Bills of Quantities.

(a) From foundation to floor (1st level - Plinth level)

(b) From floor (1st level) to floor (2nd level)

(c) From floor (2nd level) to floor (3rd level) and so on.

(d) Brick wall in parapet walls shall be measured along with the corresponding masonry in the walls of the storey just below it.

(e) Brick masonry below A.C. Sheet (i.e. galabid) shall be measured in Rmt. and paid in their respective item. In this case only single side measurement shall be paid to cover the work for both the sides and 300mm height shall be deducted from brick masonry measurement.

(f) Brick masonry above A.C. She~t (i.e. load wall) shall be measured in Rmt., and paid in their respective item. The quoted rate shall include the cost of cement finish plaster/sand face plaster, concrete water, water proofing paint etc. as specified.

3.6.2 EXPOSED BRICK WORK:

The length and height of the wall shall be measured correct to one cm. The area shall be calculated in sq. m.

3.6.3 BRICK PARTITION WORK:

The length and height of the wall shall be measured correct to one cm. The area shall be calculated in sq. m. Where half brick wall is joined to the main walls of one brick or greater thickness the measurements for half wall shall be taken for its clear length from the face of the thicker wall.

3.6.4 BRICK FACIA:

The length and height of the wall shall be mealred correct to 1 cm. The area shall be calculated in sq. m.

3.7 STONE MASONRY - (UNCOURSED RUBBLE MASONRY):

Stone for this work shall be of the best quality from an approved quarry. It shall be hard, sound, closer fine grained, free from decay, weathering and effects like cavities, flaws, sand holes, patches of soft or loose materials etc. The stone shall be laid in mortar as specified in the item. The stones shall be well wetted before laying in position.

All stone masonry work shall be hammer dressed well bonded, faced with hammer dressed stones, with squared quoins at joints and corners.

No stones shall tail into the wall, either with a point up to a length less than 1.5 times its height. The thickness of the bed and vertical joints shall not exceed 25 mm.'

Spalls and pinnings shall not be allowed, to show on the face of the wall. Two bond stones for every square meter of wall face shall be provided. There shall be through stones in walls 600 mm. thick and under. In walls thicker than 600 mm., the length of the bond stones shall be 2/3 times the thickness of the wall. The face beds of quoins shall be squatted back to at least 10 mm. Stones for hearting of the wall shall not be less than 150 mm. in any direction. Chips and spalls shall be wedged in, to avoid thick mortar, and bad stone joints. The wall faces, corners and joints of openings shall be truly vertical. All joints of masonry shall be raked out as specified, and shall be cement pointed by using cement mortar in specified proportion to all exposed surfaces.

The masonry in a structure shall be carried out regularly in layers. Where the masonry of one part has to be delayed, the work shall be raked back at an angle not steeper than 45 degrees. All masonry work shall be well watered for a period of seven days.

The unit of measurement shall be cubic meters. Actual quantity of masonry shall be calculated from the dimension shown on the drawings or as executed, less the openings. If pointing is done, it shall be paid separately.

3.8 SPECIFICATION FOR PRE-CAST CONCRETE BLOCK MASONRY WORK

A pre-cast hollow concrete block is defined as a block having one or more large holes or cavities which pass through the block and has solid material between 50 and 75 percent of the total volume of block, calculated from overall dimensions.

The mix proportions for preparing concrete block is related to their method of manufacture.

	Method of Manufacture	Mix Proportion by volume
(i)	For manually operated moulds	1, part of cement +5 part of coarse graded sand
(ii)	For power operated machine (including	1 part of cement +6 parts of graded aggregates sand) (maximum size of aggregate limited to 12mm)

Table showing gradation of aggregates

B. S. Sieve	Cumulative percentage retained	Remarks
3/16 inch	25	(i) Fifteen percent retained on each of No.7/14/25/52
No.7	40	sieves
No.14	55	(ii) Fineness modulus equals 3.7
No.25	70	
No.52	85	
No.100	95	

Note: Pre-cast concrete *blocks (solid)* shall be prepared in concrete mix (1:3 :6)

IS Specification for Pre-cast Concrete Blocks	IS 2185 Part I & 11 (Grade B 5.0)	
Compressive Strength	60 kg / cm^2 and above	or as specified
Water absorption	8% max.)	
Moisture Movement	0.08%	
Drying shrinkage	0.60%	

The concrete blocks are to be made In a fully mechanized high tech plant using a process which involves compaction by high pressure and vibration. The blocks to be cured for 21 days in a water pond.

Masonry work will be done using Hollow Blocks of the sizes as specified in the drawings; wherever required solid concrete block shall be used without any extra cost. Special recessed web blocks shall be used for concealed wiring as and where required; without any extra cost.

The concrete block masonry shall be done in cement mortar 1:6.

Before starting the block work, mark the courses on columns and try to adjust the first course in a way so as to avoid any gap at the beam bottom.

The thickness of mortar joint shall be 10 mm to 15 mm and shall be uniform through out the masonry work.

Blocks are to be made with necessary holes, grooves etc. as required and/or as per detailed drawings or as instructed by engineer-in-charge.

Provide hexagonal wire mesh or a single leg 6 mm stirrup at corners and inter section of the walls as per details. This shall be repeated at every 3rd layer. The masonry rate shall include the cost of this work.

The block shall be solid or hollow as required and shall be of size as specified by engineer-in-charge/consultants.

(i)	400mm x 2OOmm x 2OOmm	}	
(ii)	400mm x 200mm x 100mm	}	or as specified
(iii)	400mm x 2OOmm x 3OOmm	}	
(iv)	400mm x 200mm x 150mm	}	

All blocks shall be sound, free from cracks, broken edges, honey combing and other defects that would interfere with the proper placing of blocks, or impair the strength or performance of construction.

Detailed specifications of masonry work shall be followed for concrete block masonry work also.

The shell thickness of hollow blocks in load bearing walls should be at least one eight of the height of each block or 25 mm whichever is greater, Out of every 10,000 blocks or less, 10 blocks

shall be tested for quality parameters. The decision of engineer-in-charge for testing the blocks from each new lot will be final.

The hollow blocks should be stacked in narrow stock piles and spaced apart with the cores of hollow blocks vertical. Blocks are not normally wetted before or when laying them.

Concrete blocks adequately dried and delivered should be protected from weather until they are built into the wall.

The bottom courses of stacks, should be raised a steel platform or planks free from contact with the ground. If ordinary concrete blocks with a moisture content above 30 percent of their total absorption are built into a wall, their subsequent drying shrinkage is likely to cause cracking. Blocks should be tested for dryness before use and if their moisture content. is found to be unduly high, it may be necessary to introduce effective drying facilities.

Hollow concrete blocks are laid with a shell bedding that is kept off the cross webs, while solid blocks are given a full bedding of mortar. Before laying the first course, blocks should be aligned temporarily in position so as to check their selection for the work. A full bedding of mortar is then spread and troweled with a trowel, so as to ensure plenty of mortar along the bottom edges of the blocks. In no case concrete block masonry work shall be raised more than 1200 mm per day.

The unit of measurement shall be in cubic meters. Actual quantity of masonry shall be calculated from the dimensions shown on the drawings or as executed, less the openings.

4.0 **CARPENTER AND JOINTER:**

4.1 TIMBER:

All timber shall be as per relevant specification mentioned in the section of materials.

The timber for frames and shutters for doors, windows, ventilators shall be of first class, sound, well seasoned, Bulsar teak wood / C.P. teak wood or other specified and approved quality wood and shall be free from knots, shakes, fissures, flaws, sun cracks and other defects.

All timber for carpentry and joinery in contact with masonry or concrete shall be coal tarred before fixing. All exposed faces of timber shall receive a primer coat before erection. The rate shall be inclusive of one coat of primer and three coats of approved quality and shade of flat enamel paint.

Unless otherwise specified all doorframes shall have six M.S. flat holdfasts and window frames shall have four holdfasts. Holdfast shall be provided to the ventilators, if directed. When door/window frames are to be fixed to R.C.C. column or R.C.C. wall, holdfast shall be substituted by suitable arrangements such as coach screws, rowl bolts etc. to secure frames to R.C.C. column or R.C.C. wall, as directed by Architects.

Frames and shutters shall not be painted or erected before being approved by Architect.

4.1.1 CARPENTRY WORK:

The timber shall be properly planned and wrought in a workman like manner. Joints shall be true and properly fit, assembled accurately and clamped together so as to make square, flat, and close joints. No timber shall be painted, tarred without the previous permission of the Architects/Engineer-in-Charge, No glue or wedges shall be allowed to be used and all woodwork before being erected shall be passed by Architects/Engineer-in-Charge.

In wrought timber, tolerance of 1.5 mm will be allowed for each wrought face of size specified except where described as "finished" in which case they shall have to be the full dimensions. The rate, for wood work, shall include the cost of all sawing, planning, framing, labour and materials and fixing and supply of all traps, bolts, nails, spikes, keys, wedges, pins, screws, glues, etc. necessary for the framing and fixing joints, Portions inserted in the masonry/floor shall not be allowed for the measurements.

4.1,2 JOINERY:

Doorframe shall be of such dimensions as directed by the Architects/ Consulting Engineers. They shall be properly framed and mortised and tennoned together and set in masonry by means of M.S. / wrought iron holdfasts. The parts hidden in the masonry shall be well tarred or coated with soligumum-paint. The frame shall be rebated by 13 mm up to the face thickness of shutters on one side if the shutter is on one side and to be moulded as per design. The other side of the frame shall be rebated if there are shutters on both the sides.

4.1.3 T.W. DOOR OR WINDOW FRAME:

T.W. shall be of good quality as specified above. Frame size shall be of 150 x 63 mm or 127 x 76 mm as specified in Bills of Quantities. Rebate and grooves shall be made for receiving shutters, grills, plaster etc. as per drawing.

4.1.4 WOODEN FLUSH DOOR SHUTTERS (SOLID CORE TYPE):

Solid core flush shutters shall be of commercial or teak veneered type as specified in the item, of approved quality and manufactured by approved manufacturers. The finished thickness of the shutter shall be as mentioned in the tender items, Face veneer shall be of the pattern and colour approved by Architects and as per approved sample, which shall be deposited in the office of Architects for reference, The shutters will be provided with T.W. lipping.

The framework shall be measured in Smt. from outside to outside of frame and shall be priced per unit of Smt. The rate shall include fixtures and fastening as required and specified in Table -4.1.

4.1.5 PANELLED SHUTTERS:

The exact shape for frame shall be as per Architects/Consulting Engineer's details. The styles-rails and panels shall be 37 mm thick and 25 mm thick respectively. Wood panels shall be of pattern and size as specified. The panel shall be joined continuous with 40 x 6 mm thick ply, inserted into grooves and glued together. The grains of solid Panel shall run along the longer dimension of the panel and Panel shall be framed into groove to the full depth of the groove leaving an air gap, and the faces shall be closely filled to the sides of groove. The type and number of fixtures shall be as mentioned in the Table-4.1 given below. The fixtures and fastening shall be fixed rigidly to the shutter If they get loosened within defect liability period, the contractor shall have to replace the shutters with better ones at his cost.

The rate is inclusive of providing and fixing. The measurement shall be in sq. meter and dimensions measured out to out of the frame. The rate is inclusive one coat of primer and three coats of approved quality and shade of enamel paint.

4.1.6 TEAK GLAZED SHUTTERS:

These shall be similar to panelled shutter except that such parts as are directed shall be glazed with plain or ground sheet glass or plate glass or frosted glass as specified. Styles and rail in the glazed shutters shall be rebated 13 mm to receive glass. Such bars shall be mounted and rebated and mitered on side to receive the glass. Glass panels shall be fixed by means of teak beads painted with approved paint. The prices shall include supply and fixing of glazing and teak beads with screws, painting, polishing except where otherwise stated in the Bills of Quantities.

TABLE - 4.1
SCHEDULE FOR HARDWARE FITTINGS FOR WOODEN SHUTTERS

Sr. No.	Type of Shutters	S.S. Hinges		Tower Bolts Aluminium		Handles Aluminium		Wind Hook & Eye / Adjusters		Cleats		Aldrops Aluminium		Latches (For Toilet Doors)	
		No.	Size	No.	Size	No.	Size	No.	Size	No.	Size	No.	Size	No.	Size
1.	Glazed or Partly Glazed or Fully Panelled Double shutters size														
i)	1.20 m x 2.10 m x 40mm thick	6	10 cms.	3	25 cms	3	15 cms.	--	10 cms	--	15 cms	1	30 cms	--	--
ii)	(szie exceeding 1.20 M x 2.10 M x 1.50 M x 2.45 M)	6	13 cms	2	45 cms	3	15 cms	-	15 cms	2	20 cms	1	30 cms	--	--
iii)	(Size exceeding 1.50 M x 2.50 M)	6	15 cms	2	60 cms	3	15 cms	--	20 cms	2	30 cms	1	45 cms	--	--
2.	Glazed or Partly Glazed or Fully Panelled Double shutter size														
i)	upto size 0.90 M x 2.0 M	3	13 cms	2	25 cms	2	15 cms	--	10 cms	1	15 cms	--	--	1	30 cms
ii)	Size exceeding 0.50 M x 2.0 M	3	15 cms	1	30 cms	2	15 cms	--	15 cms	1	20 cms	1	30 cms	--	--
3.	Doors with wire guage panels														
i)	Double shutters all sizes	4	13 cms	3	25 cms	3	20 cms	--	15 cms	1	15 cms	1	30 cms	--	--
		2	Single action sping hinges												
ii)	Single shutter of all sizes	2	13 cms	2	25 cms	2	20 cms	--	15 cms	1	15 cms	1	30 cms	--	--
4.	Windows Glaze / partly glazed & Fully panelled	4	10 cms	3	15 cms	3	15 cms	2	15 cms	2	15 cms	--	--	--	--
i)	Double shutter upto 11.50 mt. height														
ii)	-do- single shutter	2	10 cms	1	10 cms	1	15 cms	1	15 cms	1	15 cms	--	--	--	--
5.	Fan light & ventilator	2	7.5 cms	--	--	--	--	1	Spring hinges	--					

		2	Pivot Hinges												

Notes :

1. The top of tower bolt in closed position should be within a reach of 1.90 M.
2. Eye and hooks in places of hinged door stopper are to be used in case of window shutters when the operation cannot be done due to fixing of grills, wire mesh or expanded metal or wire netting on one side of opening.
3. For shutters exceeding 40mm thickness heavy type SS butt hinges of 125 mm x 90 mm x 40 mm shall be used.
4. Hardware of timber doors, windows etc. shall be as above, if not specified otherwise, and shall be of quality as approved by the Architect / Consulting Engineer.

4.1.7 TEAKWOOD LOUVERED SHUTTERS:

The specification shall be as per paneled shutter except that such part as are directed shall be louvered. In louvered shutter, the style shall have groove of 25 mm width and 15 mm depth, to receive teak wood louvers of 25 mm thickness. The louver shall be fixed at an angle as per drawing. The louver's width shall be 10 mm less that the slant groove width to finish with beading. The beading size shall be 15 mm x 15 mm and shall be fixed, as specified, with screw.

The work shall be measured in sq.meters inclusive of frames both ways. The rate includes providing and fixing, louvers, beading, fixtures and fastenings as required and specified in the Table – 4.1 or as directed.

4.1.8 FIXING GLASS LOUVERS:

Louvers shall be 6 mm thick of wired glass or frosted glass with ground/polished edges as specified and of approved quality. The work shall be measured in sq.meter inclusive of frames and shall be measured outside of frames both ways according to drawing. The rate includes providing & fixing glass, beading, paints or polishing etc.

4.2 STEEL WINDOWS:

Steel windows shall conform to IS: 1038 and shall have brass oxidized fittings. They may be of composite sizes and assembled and fixed as per the manufacturers specifications using special mastic and putty for steel windows. The size of section shall be such as to be adequate for the specific type shown on the drawing. They shall have necessary accessories such as handles, stays, lugs, etc. The members shall be assembled with electric flush butt-welded joints/welded smooth joints as directed. These items include all types of windows such as fixed partially fixed, partially hinged, side hung, bottom hung, top hung, centre hung, etc. This item also includes windows of curved shapes and all other windows as specified and detailed by the Architects/consulting Engineers. The necessary accessories such as handles, stays, stoppers, etc. shall be brass oxidized and shall be included in this item. The rate also includes glazing panels with plain or ground glass with aluminium/teak wood beads of the required size and mastic putty of the same colour, which shall be applied for full length and not at intervals. The contractor shall provide windows with threaded holes for fixing aluminium/wodden beading, with screws, required for fixing of thickness specified.

The windows shall have glazing fixed as shown in the drawing and the glass shall be float glass sheet glass of the best quality and approved by the Architect/Consulting Engineer. It shall be transparent or translucent as required by the Architect/Consulting Engineers. It shall be free from flaws, specks, and bubbles.

Thickness of glass shall be as under (costs included in this item).

(i) 24 Oz glazing for glass size not exceeding area 600 mm x 600 mm subject to any dimension not exceeding 1.0 meter.
(ii) 26 Oz glazing for glass size not exceeding area 750 mm x 750 mm but any dimension not exceeding 1.20 meter.
(iii) 32 Oz glazing for glass size not exceeding area 75 mm x 750 mm and 900 mm x 900 mm but any dimension not exceeding 1.20 meter.
(iv) 6 mm thick plate glass for glass size more than 900 mm x 900 mm and any dimension not exceeding 1.00 meter.

4.2.1 Typical approved samples of the glazing unit shall be kept in the office of the Architect till the satisfactory completion of work. The decision of the Architect whether a unit compares well with the approved sample shall be binding as final on the concerned parties.

The rate also includes a coat of primer (yellow zinc chromate) before erection and after erection, 3 coats of approved enamel paint of required shade to the windows. Fixed and openable window shall be paid separately. The measurement shall be square meter of over all size of the frame as per drawing.

4.2.2 HARDWARE:

Rates of doors and window include fixing of all hardwares of specified and approved quality and material.

4.2.3 SCHEDULE OF HARDWARE (UNLESS OTHERWISE SPECIFIED):

(a)	Steel windows (each shutter):		
	150 mm handle.	-	1 No.
	300 mm peg stay	-	1 No.
	Project of friction hinges	-	2 Nos.
(b)	Top or bottom hung ventilators:		
	300 mm peg stay arm	-	1 No.
	Projection or friction hinges.	-	2 Nos.
(c)	Steel doors:		
	Brass mortise lock with a pair of chromium handles.	-	1 No.
	300 mm tower bolt (per leaf)	-	1 No.
	Friction Hinges (per leaf)	-	3 Nos.

Measurement:

Width and height shall be measured outside to outside of frame and measurement shall be in Smt.

4.2.4 COLLAPSIBLE STEEL DOORS AND GATES:

Approved manufacturers shall fabricate these, from mild steel sections. The gates shall be double or single collapsible gates depending upon the size of the opening. These shall consist of vertical double channels 20 x 10 x 2 mm at 100 mm centers braced with flat iron diagonals 20 x 5 mm and with top and bottom rails of Tee section of size 40 x 40 x 6 mm with 38 mm dia pulleys or ball bearings in every 4th double channels, unless otherwise specified. Where collapsible gate is not provided within the opening and is fixed along the outer surface, Tee section at the top may be replaced by flat 40 x 10 mm. the collapsible gate shall be provided with necessary bolts and nuts, locking arrangements, stoppers and handles. Any special fittings like springs, catches and locks shall be provided as described in the Bills of quantities.

Rates include for making zari in floors and walls, holes in masonry of R.C.C and restoring the same including applying one coat of rust remover, one coat of zinc chromate and three coats of approved make and shade of flat/enamel paint or aluminium paint.

Measurement:

The gate shall be measured in sq.meters. The breadth and height shall be measured correct to a cm. The height shall be measured as the length of double channels and breadth from out side to out side of the end fixed double channels in open position of the gate.

4.3 ROLLING SHUTTERS:

Rolling shutters shall consist of 75 mm wide 18 gauge M.S. laths machine rolled and straightened with an effective bridge depth of 16 mm. The laths shall be interlocked through their entire length and jointed together at the end with end locks. These shall be mounted on specially designed pipe shaft. Each lath section shall be a continuous single strip piece without any joint. The spring shall be prepared from unbreakable high tensile spring steel wire or strip of adequate strength to balance the shutter in all positions. The spring assembly shall be supported on strong mild steel or malleable cast iron bracket shaped to fit the lintels. The shutter shall be complete with door suspension shafts, guides, locking arrangements, brackets, pulleys with ball bearings, pushing hooks, handles, top covers etc. Fixing shall be done accurately in a workman like manner such that the operation of the shutter is easy and smooth.

Rate includes applying one coat of rust remover, one coat of yellow zinc chromate primer and three coats of approved make and shade of flat/enamel paint etc.

Rolling shutters shall be measured in square meters of the clear opening to which they are fixed and in no case top drum with cover and channels shall be paid extra or shall be calculated in area.

4.4 ALUMINIUM DOORS, WINDOWS, VENTILATORS ETC:

These shall be obtained from approved and established manufacturers and shall be of aluminium alloy conforming to IS: 733 and sections shall generally conform to IS: 1948. These shall be fabricated as per the drawings.

4.4.1 GENERAL:

(I) The unit assemblies shall be as per drawing or as directed by the Architects.

(II) The unit assemblies shall be anodized finished. Anodising shall be minimum 20 to 25 microns thick, of matt non-directional and non-specular. Anodized surface shall be suitably protected during transportation, storage and erection.

(III) Sub units shall be together by concealed screws, Jamb member shall be self mullioning type obtaining use of separate mullions, thus increasing clear height of each unit.

(IV) Joints shall either be mitred or coped. All joints shall be neat, hair line, and sealed with epoxy to make them water proof.

(V) Openable shutters shall have a single row continuous neoprene or PVC weather strip to prevent air infilteration. Weather strips shall not be interrupted by any fittings.

(VI) All windows shall be glazed from inside with PVC rubber or approved “Shalimar” putty. Glazing beads shall snap fit and shall be fitted without use of screws. No screws other than those on some of the hardware shall be visible.

(VII) Glazing shall be approved and specially selected quality glass of thickness as specified in the Bills of Quantities.

(VIII) The rate shall include supplying and fixing with fittings and fixtures including approved locking arrangements.

(IX) Before handing over, the aluminium work shall be washed with mild solution of non-alkali soap and water.

4.4.2 The glazing units, doors, windows and ventilators shall not be built into the walls but shall be fixed in the prepared opening with lugs in masonry or with screws and jute expansion plugs in holes carefully drilled in RCC work. Mastic compound shall be provided all around the frame of the glazing unit at the junction of the frame and opening to make the junction watertight.

Composite glazing units shall be supplied loose with necessary coupling transoms or mullions with machine screws and mastic compound and shall be coupled with box mullions. The mullions shall be embedded in mastic to make the joint watertight.

Measurement shall be in Smt. of net are fixed at site.

5.0 **PLASTERER:**

5.1 PREPARATION OF SURFACE:

Before plastering, masonry joints are to be raked out. Mortar powder and dust shall be brushed out from joints, and the surface shall be washed with clean water and shall be watered well. Cement slurry shall be applied to R.C.C. surface before plastering. The minimum thickness or mortar to be applied shall be as specified. To ensure proper thickness, gauged patches shall be made at 1.5 to 2 m. apart. Plastering shall be started from top and worked to bottom.

5.2 PREPARATION OF MORTARS:

The mortar shall be prepared in required proportion as specified in Tender. The mortar shall be thoroughly mixed on an impervious platform by turning over at least twice dry and twice wet. Water shall then be added gradually in required quantity. Mortar shall not be ground. Cement

mortar shall be prepared in required quantity and not with more than one bag of cement at a time. This quantity shall be consumed within 30 minutes after adding water and mixing.

5.3 SCAFFOLDING:

Scaffolding will be double or single stage as warranted for the particular work and as approved by the Engineer-in-Charge. Holes shall be made good by bricks to match the work when scaffolding is removed.

5.4 PLASTERING:

5.4.1 CEMENT FINISH CEMENT PLASTER:

Before plastering the surface, gauge marks with cement mortar should be carried out in line level and plants at distances less than the gauge patti. These gauge marks should be prepared one day prior to commencement of plastering work. Mortar shall be uniformly applied all over the surface to a thickness of 13 mm and finished true to level, line and plumb taking special care to finish jambs of windows, doors, junction etc. A thin layer of cement paste with 5% slake lime slurry for easy application shall then be applied initially with wooden gutka and then with MS mala / trowel to avoid air bubbles and rubbed into the surface and finished by means of trowel until the surface is even and smooth. Before applying cement paste, care shall be taken that previous coat of mortar shall not be dried. All corner, angles and junctions shall be truly vertical or horizontal and finished. Any cracks which appear in the surface and portions which found hollow when tapped or found soft or otherwise defective shall be cut and redone. Curing shall be started after 24 hours and surface kept wet for seven days.

5.4.2 NEEROO FINISH CEMENT PLASTER:

General specifications shall be as per cement finish plaster, except applying a thin layer of neeroo paste instead of cement paste. In neeroo paste some quantity of cement paste, shall be added. A thin layer of neeroo paste shall then be applied to the under coat and rubbed into the surface and finished by means of trowel until the surface is even and smooth. Surface shall be cure for seven days, after a lap of 24 hours.

5.4.3 WATER PROOFING PLASTER:

Specifications are same as cement finish cement plaster; except that waterproofing compound shall be added in dry with cement and sand, or as per manufacturers specification. Mortar shall be mixed dry thoroughly water shall then be added gradually in required quantity. Mortar shall be uniformly applied all over surface and then thin layer of cement paste shall be finished as specified in cement finish cement plaster.

5.4.4 SAND FACE PLASTER / OR WRINKLE FINISH (GUTKA) PLASTER:

(a) Under Coat:

The surface shall be prepared as above. The coat of cement mortar in proportion (1:4) or as specified, shall be applied uniformly all over surface to a thickness of 15 to 20 mm. and finished true to level, line and plumb. The surface shall be brought to a true line, level by working a wooden straight edge reaching across the gauges. Finally the surface shall be finished true with a trowel. The surface shall then be left rough and furrowed 1.5 mm deep with a scratching tool diagonally both ways to form a key for the topcoat. The scratches shall be not more than 5 mm apart. The surface shall be kept wet till the topcoat is applied.

(b) Top Coat :

The topcoat shall be applied, after the under coat has sufficiently set but not dried at any time, within 48 hours. The proportion of mortar for finishing coat shall be one part of cement and two parts of selected, well graded and washed sand; it shall be applied in a uniform thickness of 5 mm. the surface shall be tapped to uniform grained texture by

using sponge/cork sheet/wooden float as directed. Curing shall start after 24 hours and the surface kept wet for seven days.

(c) 20 to 25 mm. thick sand face plaster using white cement:

All specifications shall be as per sand face plasters except in second coat, white cement shall be added to the required proportion specified in Bills of Quantities.

5.4.5 MALA FINISH PLASTER:

Specification are same as sand face plaster, except in second coat, mortar shall be mixed in proportion as specified in Bills of Quantities and surface shall be finished with Mala only, as directed by Engineer-in-Charge.

5.4.6. ROUGH CAST PLASTER:

Under coat shall be prepared as in sand face plaster.

Finishing coat mortar shall be in proportion one part of cement and one part of specially selected and graded sand and one part of gravel of 3 to 6 mm size. It will be flung upon the first coat with large trowel to form and even and decorative cost. The thickness of the coat shall be about 12 mm. It shall be cured for seven days.

5.4.7 ROUGH PLASTER WITH COLOUR FINISH:

This finish shall be similar to 'Rough cast plaster' above except a high grade mineral pigment of approved quality shall be mixed with white cement instead of ordinary grey cement while preparing the mortar.

Note:

The rate shall also include providing the grooves as per the pattern given or suggested by of Architect.

5.4.8 ZIKI PLASTER:

Specifications for under coat shall be as per sand face plaster. The top coat shall be applied after under coat has sufficiently set. The proportion of mortar for finishing coat shall be 1 part of white Portland cement (or as specified in Bills of Quantities) and 1 part of marble powder. This shall be mixed dry, thoroughly on neat and clean surface, water shall then be added gradually in the required quantity.

Apply prepared mortar to the first coat (under coat) in uniform thickness of 5 mm and rub the surface and finish by means of trowel on surface to get mirror like finish. Curing shall be started after 24 hours and surface kept wet for seven days.

5.4.9 SILVICRETE PLASTER:

Specifications for first coat (under coat) shall be as per sand face plaster.

The second coat (top coat) shall be of about 7mm thickness. The proportion of mortar shall be of (1:2:4) i.e one part of cement (having proportion of (1:2) white and grey cement), two parts of selected sand and four parts of Chhota Udaipur white marble chips of approved size. The above material shall be thoroughly mixed dry and then water shall be added gradually in the required quantity.

Apply prepared mortar to the first coat in uniform average thickness of 7 mm in given pattern. Finishing shall have appearance of artificial malad stone or as directed by Engineer – in - Charge. Curing shall be started to the finished surface after 24 hours and surface kept wet for seven days.

The rate shall include providing grooves as per pattern. If required the contractor shall have to use coloured approved pigments for which extra payment shall not be made.

5.4.10 EXPOSED AGGREGATE PLASTER:

Under coat shall be prepared as per sand face plaster. The second coat shall be of 1:2 proportion, i.e one part of cement and two parts of selected stone chips of approved size and colour by volume. It will be flung upon the first coat and pressed, leveled and finished with wooden float. Trowelling should be kept to a minimum as excessive trowelling may cause hair cracks and crazing. Floating shall be carried out only after the final rendering has slightly dried out. The thickness of the coat shall be about 12 mm to 15 mm.

The rate also includes providing the grooves as per pattern given or suggested by Architect/Consulting Engineer to the required length and width. The Contractor shall have to prepare a sample for this and get the same approved by the Architect.

5.4.11 WATER PROOF PLASTER USING BONDEX AND METAL CRETE:

The surface to be treated shall be prepared as mentioned above.

Operation No.1 (Slush Coat):

Mix in shallow pan, two parts of Metalcrete no.2 or its equivalent, one part of fresh Portland Cement and gauge with a solution made of 1 part of Bondex Liquid or its equivalent and 8 parts of water to the consistency of thick paint and apply it with a steel bristle brush, beginning at the top and working down vigorously, mixing the same each time when brush is dipped into it. Cure the surface with water continuously for 24 hours after the above has set hard to ensure proper chemical action.

In place where the surface is likely to encounter heavy water pressure, it is recommended that the operation No. 1 is repeated before starting operation No. 2.

Where only seepage or dampness is found on the interior or exterior side of wall, 2 or 3 coats of slush coat only (operation No.1) will prevent the dampness.

Operation No.2 (Mortar for Plastering):

Composition of waterproof plaster:

(i) One part of Portland Cement

(ii) Two parts of clean coarse sand

(iii) 5 kg. of Metalcrete No.2 or its equivalent per bag of cement.

Mix the above material in given proportion in dry condition to a uniform colour and add Bondex or its equivalent solution (1 part of Bondex or its equivalent added in 8 parts of water) to make mortar.

Prepared mortar shall be laid uniformly all over surface to thickness of 20 mm and finished true to level, line and plumb.

Where the plastering cannot be completed in a day, the above process shall be started from the bottom, so that it could be cured while the work is in progress.

5.4.12 RATE TO INCLUDE (All Plasters).

The rate shall include the cost of materials and labour required for all the operations, described above. This shall include the following :

(i) Raking out joints of brickwork, stonework or raking concrete for key.

(ii) Work done overhead or in confined spaces and in narrow widths.

(iii) Thoroughly watering surfaces before the plastering.

(iv) Protection of plaster until handing over.

(v) Forming coves at Junction.

(vi) Forming 10 mm to 30 mm and 12 mm deep grooves vertically or horizontally as required at junction of ceiling and wall, skirting, dado floors and at joints of concrete and masonry work.

(vii) Forming drip and weathering where necessary and directed.

(viii) Scaffolding single or double stage, as warranted for the particular work and as approved by the Architects.

(ix) Making sample for respective item for approval if instructed by Engineer-in-Charge, without any extra charges.

(x) Watering the brick surface and applying cement slurry to R.C.C. surface before plastering.

(xi) Curing of work executed.

(xii) Necessary patta as required.

5.4.13 MEASUREMENTS: (All Plasters):

All types of plaster works shall be measure in sq. meters, and shall be paid in their respective item as mentioned in Bills of Quantities.

Quoted rate for outside and inside plaster shall be average rate for all floors/heights. The chicken mesh shall be measured separately and paid in Smt. as per applicable / respective tender item.

5.4.14 DEDUCTIONS:

For jambs, soffits, sills, etc. for openings not exceeding 0.5 smt each in are, for ends of joists, beams, posts, girders, steps, etc. not exceeding 0.5 smt each in area, and for openings exceeding 0.5 smt but not exceeding 3 smt in each area, deductions and additions shall be made in the following manner:

(a) No deduction shall be made for ends of joists, beams, posts, etc. and openings not exceeding 0.5 smt each and no addition shall be made for reveals, jambs, soffits, sills, etc. of these openings nor for finish to plaster around ends of joists, beams, posts, etc.

(b) Deduction for openings exceeding 0.5 smt but not exceeding 3 smt each shall be made as follows and no addition shall be made for reveals, jambs, soffits, sills, etc. of these openings.

(i) When both faces of wall are plastered with same plaster, deduction shall be made for one face only.

(ii) When both faces of wall are plastered with different type of plaster or if one face is plastered and the other pointed, deduction shall be made from the plaster or pointing on the side on which width of reveals is less than that on the other side but no deduction shall be made on other side. Where widths of reveals on both faces of wall are equal, deduction of 50 percent of area of opening on each face shall be made from areas of plaster and / or pointing as the case may be.

(iii) When only one face is plastered and the other face is not, full deduction shall be made from plaster, if width of reveal on plastered side is less than that on unplastered side. However, if widths of reveal on both sides are equal or width of reveal on plastered side is more, no deduction shall be made.

(iv) When width of doorframe is equal to thickness of wall or is projecting beyond thickness of wall, full deduction for opening shall be made from each plastered face of wall.

In case of openings of area above 3 Smt. each, deduction shall be made for opening on each face but jambs, soffits and sills shall be measured.

5.5 POINTING:

5.5.1 PREPERATION OF SURFACE:

Before pointing, all the mortar joints on the face are to be raked out by a special tool to a depth of 20 mm in order to give adequate key for the fresh mortar used for pointing. All the loose mortar and dust should then be brushed out of the joints, and the joints and wall surface well washed, wetted with clean water and kept wet for few hours. After the joints are thus prepared, they should be carefully filled with cement mortar, with small trowel and mortar well pressed into the joints with trowel in order to obtain solid contact with the internal old mortar joints.

All excess mortar sticking to the sides should be carefully scraped away. The finished pointing should be kept wet for seven days.

5.5.2 FLUSH POINTING:

In flush pointing the joints shall be filled up flush (with mortar) with the face of wall and the edges shall be neatly trimmed with a trowel and straight edge.

5.5.3 RULED POINTING:

In ruled pointing, joint shall first be filled flush with mortar and then bent end of a small iron tool, called pointer or naila shall be pressed and rubbed in the middle of the joints until a uniform semi-circular notch is formed.

5.5.4 RAISED POINTING:

Joints shall be of raised band of mortar.

5.5.5. RATES TO INCLUDE (For pointing):

The rate shall include the cost of materials and labour required for all the operations, described above. This shall include the following:

(i) Raking out the joints of brickwork to a depth of 20 mm.

(ii) Scaffolding, single or double stage as warranted for the particular work.

(iii) Making sample for approval if instructed by Engineer.

(iv) Watering the brick surface, before pointing.

(v) Curing of work executed.

5.5.6 MEASUREMENT (For pointing):

Length and breadth shall be measure to a cm. and its area shall be calculated in square metres up to two places of decimals.

The various types of pointing, for example, Flush, Ruled, Raised etc. shall each be measured separately and paid in their respective tender item.

DEDUCTIONS:

It shall be made as described above in the item of plaster.

6.0 **IRON MONGER AND METAL WORKER:**

6.1 GENERAL

In addition to these, other specifications shall be as per structural steel work.

6.2 HARDWARE:

Rates of Iron mongery or steel and metal works shall be inclusive of all the hardwares, screws, as specified in the bill of Quantities or specified as under :

All iron mongery and hardwares shall be secured in position with M.S. screws and each screw hole shall be properly bradawled before inserting the screw. No screw shall be driven by hammer or similar tool (all cuttings with the work shall be in required sizes and no over cutting shall be allowed).

All the fixtures and fastenings shall be obtained of the make, approved by the Consulting Engineer/Architects and shall be of the best quality.

6.3 WROUGHT IRON AND STEEL WORK:

All wrought iron and steel work shall comply with BIS specifications and designs. Consulting Engineers/ Architects shall approve the name of the manufacturer.

The grillwork and grill gates shall be as per Consulting Engineers/Architects detailed drawing.

All the steel work mentioned in this sections shall receive a primer coat of yellow zinc chromate paint before erection on site. All the work shall be measured in units as mentioned in Bills of Quantities. The weight of weld metal shall be allowed for the weight when any steel work is to be paid per unit Kg. The rate shall be inclusive of cutting, welding, bolting fixing, etc. applying rust remover, one coat of approved primer and three coats of best quality approved enamel paint as directed by Consulting Engineer / architects with finishing coat of approved synthetic enamel or flat paint.

7.0 **PAVIOR AND TILER:**

NOTE: FOR RCC FLOORS REFER PARA 2.19

7.1 KOTAH STONE PAVING AND FLOORING:

7.1.1 MACHINE CUT AND MACHINE POLISHED KOTAH STONE PAVING AND FLOORING:

The stone pavement slabs shall be machine cut and machine polished shall be of specified thickness, shall be free from cracks and flakes, shall be of uniform colours, shall have and even surface and shall be of approved quality. The stones shall be cut to required size with its edges dressed fine, true straight and at right angles to each other. The stones shall be or required sizes as specified by the Consulting Engineers/Architects and laid in the level or to slopes as directed and with very fine (almost invisible) joints. The paving shall be firmly bedded flush in lime mortar (1:2) (average 40 mm thick with no hollows in between) and cement floated. The pavement shall be washed out and cleaned after paving. The work shall be carried out as per instruction of Engineer –in – Charge. Joints shall be cement pointed using white cement in required proportion to get the shade matching the colour of stone.

The work shall be calculated/considered in square meter, correct to two decimal places. Length and breadth shall be measured from wall to wall as actually laid.

7.1.2 ROUGH KOTAH STONE PAVING & FLOORING:

The stone pavement slabs shall be rough kotah stone of green colour, of specified thickness, of approve quality and shall be free from cracks and flakes, shall be of uniform colour and shall have even surface. The stones shall be cut to required sizes with edges dressed fine true straight and at right angles to each other. The edges shall be sufficiently rubbed in sand and water with M.S girder or channel to make the edges smooth and straight. The stones shall be of required sizes as specified by the Consulting Engineer/Architects and laid in level or to slopes as directed and with very fine (almost invisible) joints. Other specification are same as those for polished stone paving.

The work shall be calculated/considered in square meter, correct to two decimal places. Length and breadth shall be measure from wall to wall as those for actually laid.

7.2 POLISHED KOTAH STONE SKIRTING AND DADOS:

7.2.1 Specification is same as that for kotah stone flooring except that these shall be embedded in cement mortar 1:3 (1 cement 3 coarse sand) of sufficient thickness with invisible joints. After laying, the work shall be polished as directed to the satisfaction of the Architect/Consulting Engineer.

7.2.2 Measurement shall be from inside of skirting to inside of skirting and height measured at right angle to the floor from top of floor to finished level.

This shall be calculated/considered in square meter correct to two decimal places. Length and breadth shall be measured from wall to wall as actually laid.

7.3 MARBLE STGONE FLOORING:

7.3.1 Marble stone slabs shall be of kind specified in Bills of Quantities. The Marble slabs shall be of selected quality shall be hard, sound, dense and homogeneous in texture, shall be free from cracks, decay, weathering and flaw and shall be as approved by Architects. The slabs of required thickness shall be machine cut to required dimensions. All angles and edges of slabs shall be true, square and free from chipping and the surfaces shall be true and plane.

7.3.2 This shall be calculated/considered in square meter correct to two decimal places. Length and breadth shall be measured from wall to wall as actually laid.

7.3.3 LAYING

Sub grade concrete or R.C.C. slab on which marble is to be laid shall be cleaned, wetted and mopped. The bedding for the marble shall be lime mortar 1:2 (1 lime: 2 coarse sand) or cement mortar 1:4 (1 cement : 4 coarse sand) as mentioned in the Bills of Quantity.

The bedding mortar shall be spread to required thickness and allowed to harden a bit, cement slurry at 4.4. Kg of cement per sq. meter shall then be spread. The marble slabs shall then be placed in position and tapped with a wooden mallet till the slab is properly bedded in line and level. The joints between slabs shall be fine as directed. The pattern shall be as shown in drawing/directed by Engineer-in-Charge. The flooring shall be cured for seven days.

7.3.4 POLISHING & FINISHING:

Slight unevenness at the meeting edges of slabs shall first be removed (if necessary by removing and replacing the stones). The surface, then, shall be ground evenly with machine fitted with coarse grade grit blocks No. 60. The second grinding shall be done by a machine fitted with fine grade grit blocks No. 120. The final grinding with a machine fitted with finest grade grit block No. 320 shall be carried out on the day after the 2^{nd} grinding is done. Oxalic acid shall then be dusted over the surface at 33 gm. Per sq. meter sprinkled with water and rubbed hard with pad of woolen rags. The floor shall be wiped with moist rag and dried with a soft cloth and finished clean on the following day.

7.4 MARBLE STONE IN RISERS AND SKIRTING:

7.4.1 MARBLE STONE SLABS:

Marble Stone Slabs shall be the same as per marble flooring of thickness as specified in the Bills of Quantities.

7.4.2 PREPERATION OF SURFACE:

Where required, the wall shall be cut uniformly to requisite depth so that the skirting face shall have uniform projection from the finished face of wall as per drawings or as directed by the Architects. The concrete wall shall be hacked and roughened with wire brushes. Masonry walls shall have joints racked at least 15 mm deep. The surface shall be thoroughly cleaned, washed, and kept wet.

7.4.3 LAYING

The risers or steps and skirting shall be set, in grey and white cement with an admixture to match the shade of stones, and with the line of slab at an average distance of 12 mm from the wall but not less than 10 mm. If necessary, the slabs shall be held in position, by temporary M.S. hooks at suitable intervals. The rear of the skirting or riser slab shall be packed with cement mortar 1:3 (1 cement: 3 coarse sand). The fixing hooks shall be removed after the backing mortar is set. The joint shall be very fine (almost invisible).

7.4.4 POLISHING AND FINISHING:

This shall be same as for marble floor, except that grinding shall be done by hand with carborandum stones, first grinding with coarse grade stone No. 60, second grinding with medium grade no. 80 and final grinding with fine grade no. 120. the face up and top of skirting shall be machine cut.

7.4.5 Measurement shall be in sq. meter correct to two decimal places. Length and height shall be measured as actually laid at site.

7.5 MOSAIC TILES (Flooring and Dado):

Mosaic tile floor bedding shall be done over the portion on which tiles can be laid within 24 hours. The tiles shall be of approved manufacture and quality and shall be got approved before use. They shall be with level surface. The size of the tiles shall be any standard size specified by the Consulting Engineer/Architect. The rate shall be inclusive of average 40 mm thick lime mortar bedding, cement floating etc. After laying, the joints between the tiles shall be well filled and the surface polished with 3 runs of machine polish. The skirting tiles shall be similarly laid. They shall be polished from factory. Finishing coat with the hand shall be applied to skirting before cleaning. Sills of doors and windows etc. shall truly be in plumb, line and level and joints should be very fine (almost invisible).

7.6 COLOURED CEMENT TILES:

Specifications shall be same as those for Mosaic Tiles.

7.7 CHEQUERED MOSAIC TILES:

The flooring if in chequered tiles, shall be carried out with the tiles provided with grooves in chequered manner. Everything else shall be same as in “Mosaic Tiles”.

7.8 CAST ‘IN SITU’ TERRAZZO:

7.8.1 PREPARATION OF THE BASE

The base may be the sub-floor or the structural slab. Normally a screeded bed of concrete is laid on the hardened base, which is cleaned and prepared for receiving the upper layer. The terrazzo mix is then laid as the wearing coat over the screeded bed. The screeded bed should preferably be laid after the building operations are completed. The bond between the screeded bed and the base depends to a very large extent upon the conditions of the surface of the base at the time of laying the screeded bed. The surface should be absolutely free from dust or contamination from oil, grease, etc. and attempt should be made to obtain a good, mechanical key. A good bond decreases the tendency for shrinkage cracking. In case where the surface is contaminated with oil, grease etc and the area of this contamination is small, it may be cut out and made good before laying the screeded bed. Otherwise the superficial contamination may be removed by using a suitable detergent. Dilute hydrochloric acid may be used for this purpose.

The base should then be thoroughly washed clean with water. The surplus water should be removed by mopping after the surface is left wet overnight. A cement mortar grout of 1:1 proportion is then brushed onto this surface and this operation should be kept just ahead of laying the screeded bed. If this screeded bed is laid on dry slurry, it will result in poor bonding.

The surface of the base concrete (at the time of its laying) should be brushed with a stiff broom before it hardens. This operation will remove all the laitance and loose aggregate from the surface

and will incidentally help to roughen the surface. It is preferable to close back the concrete surface in four different directions by using wire brushes. Where this is not possible, the hardened surface will have to be suitably chipped to give required indentations, and in this case, care should be taken not to damage the structural base.

7.8.2 MATERIALS MIXING AND LAYING OF SCREED BED:

(i) Material of Screed bed:

Cement concrete of specified mix shall be used and specification of concrete shall apply. The water cement ratio shall be kept as low as possible, as a high water cement ratio tends to produce flooring with high drying shrinkage, resulting in a tendency to crack. The slump to be aimed is about 25 mm.

(ii) Mixing of Screed Bed Concrete:

The proportion for the concrete mix of the screed bed shall be 1:2:4 by volume. The other Specifications shall be as per concrete item.

(iii) Laying of Screed bed:

The thickness of screed bed for flooring should be at least 25 mm for floors and 12 mm for walls, when laid on a set and hardened base; the thickness will depend on the conditions of the surface as regards roughness and cleanliness and it should not be less than 40 mm including the thickness of terrazzo layer.

The screed strips shall be fixed over the base concrete dividing it into suitable panels. Dividing strips shall be of glass, PVC or such other material and shall be of full depth of the screeded bed and the proposed thickness of terrazzo layer.

The mix is then spread on the prepared base, leveled with a screed board and well compacted. It should not be trowelled smooth as the rough surface left by the screed board provides a good adhesion to the terrazzo mix. This bed should be laid to the necessary predetermined slopes.

7.8.3 MOSAIC OR TERRAZZO FINISH:

The mix for terrazzo topping shall consist of cement with or without pigment, marble powder, marble chips and water. The cement and marble shall be mixed in the proportion of 3 parts of cement to one part of marble powder by weight. For every part of cement – marble powder mix, the proportion of aggregate by volume shall be as follows:

Size of Aggregate	Proportion of Aggregates to Binder Mix by Volume
00 to 5 mm	1:2
6 mm to 10 mm	1:2.5
12 mm	1:3

The marble chips shall be hard, sound, dense and homogeneous in texture with crystalline and coarse grains. It shall be uniform in colour and free from stains, cracks, decay and weathering. The minimum thickness of the top layer for various sizes of marble aggregate (chips) shall generally be as under:

Grade No.	Size of Marble Aggregate in mm	Minimum thickness of Top Layer (mm)
00	1 – 2	6
0	2 – 4	9
1	4 – 7	9
2	7 – 10	12

The thickness for the finish may be 10 mm for marble chips less than 10 mm size and 16 mm for chips of 12 mm grading.

7.8.4 LAYING OF THE FINISH:

The terrazzo mix should be laid whilst the screeded bed is still plastic (green). If this is not possible, slurry of neat cement should be brushed onto the bed immediately before laying is started. The mix should be spread and well compacted in such a manner that the maximum amount of marble chips come up and are spread uniformly over the surface. The terrazzo layer should be taken at least 10 mm under the wall plaster.
The markings of decorative design layouts are to be removed before the mix begins to harden with as little disturbance to the edges as possible, and damage, if any, should be made good by trowelling. The proportions of the mixes used for decorative designs should be the same as that of the main mix. Trowelling should be done immediately after laying and should be just enough to get a level surface. The trowelling should be with uniform pressure over a uniform period everywhere on the surface. Excessive trowelling or rolling in early stages are to be avoided, for they tend to work up to the surface a layer rich in cement and to produce a flooring liable to cracking.

7.8.5 CURING, GRINDING AND POLISHING:

As soon as the laying is completed, the floor should be covered either with damp Hessian or cloth. Precautions should be taken to prevent the floor from being subjected to extremes of temperature. The flooring should be maintained in a damp condition until ready for polishing.

About 36 hours after the top layer is laid, the surface should be watered and ground evenly with a machine fitted with special rapid cutting grit blocks of coarse grade (No.24 to 60), till the marble chips are evenly exposed and the floor is smooth. After the first grinding, the surface should be thoroughly washed to remove all grinding mud and covered with a grout of cement and colouring matter in the same mix proportion as the topping, in order to fill any pin-holes that may appear. The surface is allowe3d to cure for 5 to 7 days by suitable means such as covering with damp Hessian or ponding water, precautions being taken to prevent the surface being subjected to extremes of temperature. The surface is then ground with a machine fitted with fine grade grit blocks (No.220 to 350) to get even and smooth surface with a minimum of pinholes. The finished surface should show the marble chips evenly exposed.

Where the use of machine for polishing is not feasible or possible, rubbing and polishing can be done by hand, in the same manner as specified for machine polishing, except that carborandum stone of coarse grade (No. 24 to 60) should be used for the first rubbing, stone of medium grade (No.80 to 100) for the second rubbing, and stone of fine grade (No.120 to 150) for final rubbing and polishing.

After the final polish, either by machine or by hand, oxalic acid should be dusted over the surface at the rate of 33 Gms per Smt., sprinkled with water and rubbed hard with a pad of woolen rag. The following day, the floor should be wiped with a moist rag and dried with a soft cloth and finished clean.

7.8.6 Length and breadth shall be measure correct to a cm. before laying of skirting, dado or wall plaster. The area as laid shall be calculated in square metre correct to two decimal places.

Rate quoted shall be inclusive of fixing strips, screeded bed, and top layer of terrazzo, cost of all labour and materials involved and polishing the surface.

7.9 GLAZED TILES FLOORING:

7.9.1 The glazed tiles, shall be of approved make unless otherwise specified in the description of item. The tiles shall be flat, true to shape, free from cracks, crazing spot, chipped edges and corners. The glazing shall be uniform. The tiles shall be 5 mm to 6 mm thick and of size as specified in the items of work or as directed by the Consulting Engineer/Architect and the tiles shall conform to IS: 777 – 1988.

7.9.2 Preparation of surface and laying: The sub-grade concrete or R.C.C slab shall be cleaned, wetted and mopped. bedding for the tile shall be of 15 mm average thickness but not less than 10 mm at any place, consisting of cement mortar 1:3 (1 cement: 3 coarse sand) or as specified. Mortar shall be spread, tamped, and corrected to proper levels and allowed to harden. Over the bedding mortar, neat grey cement slurry of honey like consistency shall be spread. Approximate requirement will be 3.3 kg. of cement for a square meter. Tiles shall then be laid in the grout and gently tapped with a wooden mallet. The joints shall be as thin as possible and in straight line as to suit the required pattern. Where full size tile cannot be laid, it shall be cut (sawn) to required size and edges rubbed smooth to ensure a true and straight joint. The floor shall be checked with a straight edge to obtain a true surface. The floor tile near wall shall enter at least 10 mm under the skirting or dado finish. Before laying, tiles shall be soaked in water.

7.9.3 Pointing and finishing:

The joints shall be cleaned of the grey cement grout and all dust and loose mortar shall be remove. The joints shall then be flush pointed with white cement and floor kept wet for 7 days. The floor shall not give hollow sound when tapped with a wooden mallet.

7.9.4 Measurements:

These shall be in square meter correct to two decimal places. Length and breadth of the actual tile area laid shall be measured correct to a cm. No extra amount shall be paid for the use of cut (sawn) tiles in the work.

7.10 GLAZED TILES IN SKIRTING AND DADO:

7.10.1 The Glazed tiles shall be the same as given above.

7.10.2 Preperation of surface:
The joints of the brickwork shall be racked out to a depth of at least 15 mm. In case of R.C.C walls, the surface shall be hacked and roughened with wire brushes. The surface shall be cleaned thoroughly washed with water and kept wet.

7.10.3 Laying: The surface shall be plastered with cement mortar 1:3 (1 cement:3 coarse sand) or as specified to an average thickness of 12 mm and allowed to harden. The plastered surface shall be roughened with wire brushes or scratching as directed.

The back of tiles shall be buttered with grey cement slurry and edges with white cement slurry and set in the bedding mortar. The tiles shall be lightly tamped, and corrected to proper plane and lines. Tiles shall be set in required pattern with as fine as possible butt joints. Top of dados, skirting etc. shall be truly horizontal and joints truly vertical. Where full tiles cannot be used, cut (sawn) tiles of required size shall be provided as in flooring. The joints shall be cleaned and flush pointed with white cement. The surface shall be kept wet for seven days. The finished work shall not sound hollow when tapped with wooden mallet.

7.10.4 Measurement : This shall be in square meters correct to two decimal places. Length and breadth of the actual tile area provided shall be measured correct to a cm. No extra shall be paid for the use of cut (sawn) tiles in the work.

7.11 CEMENT CONCRETE FLOORING – INDIANT PATENT STONE (IPS):
NOTE : FOR RCC FLOORS REFER PARA 2.19

Selection of materials, method of mixing and compacting shall generally conform to the specifications under Plain and Reinforced Concrete described earlier. A stiff concrete consistent with workability shall be used.

7.11.1 Preparation Surface:
Before laying floor concrete, the sub-grade shall be properly cleaned, trimmed to give required thickness of floor and neat cement slurry applied to give proper bond of floor with the sub grade. Surplus water shall be removed by mopping before the topping is laid.

7.11.2 Laying:

The cement concrete shall be laid in alternative bays, area of each bay not exceeding 5.0 smt. and each bay to be divided by 4/6 thick glass strips/6mm thick A.C.Plain sheet or required angle/channel's framing as shuttering as directed.

The cement concrete shall be finished with trowelling. Finishing operation shall start shortly after the compaction of concrete and the surface shall be trowelled three times at intervals so as to produce a uniform and hard surface. The water cement ratio shall be kept tight to the extent possible. The satisfactory resistance of floor to wear, depends, largely upon the care with which trowelling is carries out. The time interval allowed between successive trowelling is very important. Immediately after placing cement rendering, only just sufficient trowelling is very important. Immediately after placing cement rendering, only just sufficient trowelling shall be done to give a level surface. Excessive trowelling in the earlier stages shall be avoided, as this tends to bring a layer rich in cement to the surface. Sometimes, after the first trowelling, the duration depending upon the temperature, atmospheric conditions and the rate of set of cement used, the surface shall be retrowelled to close any pores in the surface to bring to surface and to scrape off any excess water in concrete or laitance. No dry cement shall be used directly on the surface to absorb moisture or to stiffen the mix. The final trowelling shall be done well before the concrete has become too hard but at such a time that considerable pressure is required to make any impression on the surface.

If directed by the Architect, approved mineral pigment shall be added to the rendering to give desired colour and shade to the flooring, at no extra cost.

7.11.3 Ironite Topping:

Lay M-15 cement concrete and use wooden template for tamping the concrete having recess of 12 mm (for floors with 12 mm thick ironite topping). Top surface of concrete should be roughened with M.S. Wire for proper bond with Ironite topping. 12 mm thick ironite topping should be laid when the base concrete is still green. Mix the ironite and cement in proportion 1:4 (one part of ironite and four part of cement by weight) in dry state uniformly. One part of above mix to be mixed with two parts of grit (6 mm size): in concrete mixer machine within necessary amount of water added, and laid as topping above the concrete base, before initial setting starts. Ironite topping should be leveled up to within 12 mm and then entire surface should be finished with steel trowel and no dry cement shall be used directly on the surface to absorb moisture. Check the top finished surface with string, if any depression is found. It should be rectified by ironite cement immediately. Asbestos sheet, aluminium or PVC strip can be used at the construction joint, if desired.

For this approximately 2 kg. of ironite per square meter is required. Finished surface shall be cured for 10 days. The ironite shall be manufactured by Ferrosite, Heatly and Grysham (I) Ltd., or shall be of other approved quality.

7.11.4 Mixing:

The mixing shall be done in a mechanical mixer. The materials shall be measured accurately and shall be mixed on watertight brick platform. Only that much quantity will be mixed, which can be used within half an hour of mixing. Generally, only one bag mix shall be prepared at a time.

7.11.5 Protection:

Newly laid concrete shall be protected by approved means from frost, sun, storm and hot spell. Approved means shall be taken to protect immature concrete from the damage by debris, excessive loading, vibration and other influences, which may impair the strength and durability of the Concrete.

7.12 I.P.S. (Average 50 mm thick) USING WATER PROOFING CHEMICALS:

7.12.1 The bottom concrete, which is to be made waterproof, shall be clean, free from oil and shall be rough. It shall be rewetted thoroughly before the new concrete topping is placed.

Operation No.1 (Slush Coat):

Mix in a shallow pan, 2 parts of metalcrete No. 2 or its equivalent, one part of fresh Ordinary Portland Cement and gauge with solution, made of 1 part of Bondex Liquid or its equivalent and 8 parts of water to the consistency of thick paint and apply it with a steel bristle brush, beginning at the top and working down, vigorously mixing the same each time when brush is dipped into it.

Operation No.2 (Waterproof Concrete):
Immediately after applying the above slush coat, apply 50 mm, thick concrete, consisting of the following :

- One part of fresh Ordinary Portland Cement.
- Two parts of clean coarse sand.
- Three Parts of grit (12 mm)
- 5 kg.Metalcrete No.2 or its equivalent per bag of cement.

Mix the above material in given proportion in dry condition so as to distribute metalcrete No. 2 or its equivalent evenly and mix the same with a solution made of 1 part of Bondex or its equivalent, added to 8 parts of water. Prepared concrete shall be laid in uniform thickness of 38 mm and after compaction of concrete; the surface shall be trowelled with wooden template. Op surface of concrete should be roughened for proper bond to receive finishing mortar (12mm thick) made as stated in water proof plaster (Operation No.2). Fillets all around the corners shall be provided simultaneously with the bottom concrete. Finish the surface with trowel. The finished surface after 24 hours shall be kept under water for 7 days.

7.12.2 Where is high water pressure from the bottom in underground structure, reinforced concrete of the designed thickness should be provided before providing any water-proof concrete.

7.12.3 Cracks, if any, in the surface shall be filled in as follows before starting treatment.

(i) Chisel out the cracks to a width of 25 mm and depth of 37 mm.
(ii) Prime the surface with a slush coat as mentioned above.
(iii) Fill in the crack with:
  (a) For small opening up to 37 mm. width
    2 parts of cement
    3 parts of sand
    ¾ part of Metalcrete No.2 or its equivalent, by volume.
  (b) For larger openings
    1 part of cement
    2 part of sand
    3/16 part of Metalcrete No.2 or its equivalent, by volume.

(iv) Trowel surface smooth and keep it moist for 48 hours to cure.

Notes:
Treated surfaces are colourless, tasteless and wholly inert, so that the above method can be used on walls swimming pool, water storage tanks, etc. without fear of contamination. It is recommended to fill the water retaining structures once more with water and emptied after 12 hours and then put the structure into use.

Care should be taken to remove all wooden pieces (left after the removal of forms) and nails and wires usually left in the walls and bottom of the concrete.

7.13 BRICKS ON EDGE FLOORING:

7.13.1 BRICKS

Specifications of brickwork shall apply. Broken bricks shall not be used except for closing the line. The bricks shall be laid on edge.

7.13.2 MORTAR

The mortar used shall be as specified. In case of dry brick flooring, fine sand shall be filled in joints.

7.13.3 SUBGRADE:

If the sub-grade is of lean cement concrete the flooring shall commence within 48 hours, of laying of sub-grade, failing which, the surface, of sub-grade shall be roughened with steel wire brushes without disturbing the concrete. Before laying the flooring, the sub-grade shall be wetted and

smeared with a coat of cement slurry at about 2 kg. of cement spread over and are of one Smt. so as to get a good bond between sub-grade and flooring.

Where sub-grade is not provided, the earth shall be properly sloped, watered, rammed and consolidated. Before laying the flooring it shall be moistened.

7.13.4 SOAKING OF BRICKS:

Bricks required for flooring shall be soaked properly before use. In case, the joints are to be filled with sand, the bricks need not be soaked.

7.13.5 LAYING:

The bricks shall be laid on edge, in plain, diagonal, herring bone bond or other pattern as specified or directed by Engineer – in – Charge.

Brick shall be laid on edge on 12 mm thick mortar bed of specified proportion, and each brick shall be set by gentle tapping with hand trowel or wooden mallet, its inside faces shall be buttered with mortar, before the next brick is laid and pressed against it. On completion of a portion of flooring, the vertical joints shall be fully filled from the top with mortar. The surface during laying, shall be frequently checked with a straight edge at least 2 m. long, so as to obtain a true plane surface with the required slop. Finished work shall be cure for 10 days. In case of dry brick flooring, no curing shall be done.

7.13.6 MEASUREMENT:
Length and breadth shall be measured as laid and area shall be calculated in sq. metre correct to two places of decimal. Rate shall include cost of all material and labour including application of cement slurry on sub-grade and cleaning of sub-grade.

7.14 ACID AND ALKALI RESISTANT REFRACTORY TILE FLOORING:

7.14.1 Tiles shall be 230 mm x 113 mm x 37mm thick of approved make and manufacture.

7.14.2 The base shall consist of 50 mm thick cement concrete (1:2:4) mix laid over lean concrete (1:4:8) sub-grade laid to slope as required, finished smooth on top with a trowel to a uniform surface. Plastering is to be avoided.

7.14.3 Laying of Tiles:

(i) The prepared base shall be give a coat of suitable primer.

(ii) The primer, bedding and joining material suitable to resist the effect of spillage of deleterious materials (ACID, ALKALIS and SOLVENTS) shall be used.

(iii) Any of the following materials can be used as per detailed specifications given by manufacturer and as per instruction of Consulting Engineer.

(a) Bituminous based materials for bedding.
(b) Silica based materials for bedding / joining
(c) Carbon filled sulphur for joining.
(d) Furane resin based materials for joining.
(e) Vinyl ester based materials for joining and coating.

(iv) A typical execution details for Acid / Alkali resistant tile flooring is given below:

(a) The prepared base shall be given a coat of special bituminous primer at 1.4 kg. per square meter.

(b) Over the primer surface, 10 mm thick bituminous compound of approved manufacture shall be laid. Over these Acid Proof tiles of above-mentioned size, on 5-6 mm thick bedding of silicate base cement shall be laid. The joint in tiles shall be as fine as possible and filled with material as for bedding. The finished surface shall be neat and clean.

7.14.4 Measurements:
The length and breadth shall be correct to a cm. as actually laid at site and paid per square metre.

8.0 **STRUCTURAL STEEL WORK AND ROOFER:**

8,1 GENERAL

All structural steel used in general construction coming within purview of this contract shall, before fabrication, comply with the specifications of Bureau of Indian Standards, whichever is appropriate.

All rivet steel used in general building construction coming within the purview of this contract shall, before fabrication, comply with one of the following specification, whichever is appropriate.

- IS: 1148 – 1982 Rivet bars for structural purpose.
- IS 1149 – 1982 High tensile rivet bars for structural purposes.

8.2 ELECTRODES:

Mild Steel Electrodes shall comply with requirements of IS 814 – 1991 Specification for Covered Electrodes for Metal Welding of Mild Steel. High Tensile Steel Electrodes shall comply with the requirements of IS: 1442 – 1964 Specification for Covered Electrodes for the Metal Arc Welding of High Tensile Structural Steel.

8.3 BOLTS AND NUTS:

8.3.1 All bolts and nuts shall conform to IS: 1367 – 1980 Technical Supply Conditions for Threaded Fasteners.

All mild steel for bolts and nuts when tested in accordance with IS: 1608-1980 Method for Tensile Testing of Steel Products other than sheet, strip, wire and tube and IS: 1367 – 1980 Technical Supply conditions for Threaded Fasteners shall have a tensile strength of not less than 44 kg/mm^2 and minimum elongation of 23 percent on gauge length of 5.65/A

8.3.2 Plain washers shall be made of steel conforming to IS: 226-1975 Specification for Structural Steel (Structural Quality) or ST 44.0 of IS: 1977-1996 Specification for Structural Steel (Ordinary) or IS: 2062-1992 Specification for Structural Steel (Fusion Welding Quality). The dimensions, form, weight and tolerance of all rolled shapes and other members used in any structure shall, conform to the latest appropriate Specification of BIS.

8.4 FABRICATIONS INSTURCTIONS:

8.4.1 All materials shall be straight, and if not, they shall be straightened and flattened by pressure unless required of particular shape.

The erection clearance shall preferable be not greater than 2.00 mm. The holes should be drilled and not gas cut and the holes made shall not be more than 2.00 mm greater than the diameter of bolts, unless otherwise instructed by the Consultants.

8.4.2 Cutting shall be done by shearing, cropping or sawing. Gas cutting by mechanically controlled torch may be permitted for mild steel only. Except where the materials are subsequently joined by welding, gas cutting may be used.

8.4.3 WELDING:

Welding shall be in accordance with any of the following Standards as appropriate.

- IS: 816 – 1969 Code of Practice for use of Metal Arc Welding for General Construction in Mild Steel.
- IS: 817-1966 Code of Practice for training and testing of metal welders. IS: 1393 – 1961 code of Practice for training and testing Oxy Acetylene Welders.
- IS: 822 – 1970 Code of practice for Inspection of welds. For welding of any particular type of joint, welders shall give evidence for acceptance to the purchaser of having satisfactorily completed appropriate tests as described in any of the following standard as relevant.
- IS: 1181 – 1967 quality tests for Metal Arc Welders (Engaged in Welding Structures other than pipes)
- Welding, wherever indicated on the drawings, shall conform to IS: 814 – 1991. Unless otherwise specified, all welds shall be 6 mm thick single fillet welds.

Welds should be made in the flat position, wherever possible.

Adequate steps shall be taken to maintain the correct are length, rate of travel, current and polarity for the type of electrode and nature of work.

Structural steel shall not be painted or oiled on any areas, where welding, is to be performed and shall be well cleaned to remove any paint, scale, or rust immediately before welding for a distance of at least 200 mm on either side of the weld location.

The work shall be securely held in position by means of tack welds, service bolts, clamps or jigs before commencing welding so as to prevent any relative movement due to distortion, wing or other causes. When welding is liable to cause distortion, the work shall be securely held in approved frames or jigs.

Freedom of movement of one member of the joint shall be allowed, wherever possible. No butt joint shall be welded without allowing one component a freedom of movement of the order of 2mm.

The sequence of welding shall be such that when possible the members, which offer the greatest resistance to compression, are welded first.

The welding of a joint shall b arranged so that the resulting tensile and compressive stress produced by one portion of the weld tends to balance the stress produced by the other. The step back method of welding shall be adopted for continuous runs.

Fusions face may be cut by shearing, chipping or machine gas cutting. Hand cutting by gas may be substituted for machine gas cutting; only if the later is impracticable. The cutter shall be guided so that the full edge is clean and uniform. If the fusion face is rough, it shall be dressed by chipping, filling, or grinding in a satisfactory manner.

Welds showing slag inclusion, porosity or lack of proper penetration shall be cut and re-welded. Overlap of the toe of the weld and under-cutting of the parent metal should be avoided and where present to serious extent, shall be rectified.

All slag shall be removed from each run before another run is super imposed and also from the final run. When cold, the final run shall be protected with clean boiled linseed oil and shall not be painted until approved by the Architects or his representative at site.

Grinding of finished welds is permitted provided the weld is not reduced below the prescribed section. All exposed welds shall be ground smooth.

All welds which have not been ground, shall be scrubbed, with a 10% solution of hydrochloric acid, which shall be washed off with water before paint is applied, unless alkali resisting paint is used.

The Contractor shall employ a competent Welding Supervision or In Charge – Hand to ensure that the standard of workmanship and the quality of the materials comply with the general requirements. The Architect and his representative shall have free access to work being carried out by the contractor at all reasonable times, and facilities shall be provided so that during the course of welding, he may be able to inspect any layer of weld metal. He shall be at liberty to reject any defective welds to be cut and rewelded.

Parts to be fillet welded shall be brought in, as close contact as practicable and in no event shall be separated more than 4 mm. If the separation is 2mm or greater, the size of the fillet welds shall increased by the amount of the separation.

The separation between facing surfaces of lap joints shall not exceed 2 mm. the fit of joints at contact surfaces which are not completely sealed by welds, shall be close enough to exclude water after painting.

Abutting parts to be butt-welded shall be carefully aligned. Mis-alignments greater than 3 mm shall be corrected and in making the correction, the parts shall not be drawn into a sharper slope than two degree (1 in 30)

8.5 PROCEDURE FOR HOLES MAKING:

Holes through more than one thickness of materials for members, such as compound stanchion and girder flanges shall, where possible, be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, provided the holes are punched 3 mm, less in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall be, not greater than 16 mm.

When holes are drilled in one operation through two or more separable parts, these parts, when so specified by the Engineer, shall be separated after drilling and the burrs removed.

Matching holes for rivets and black bolts shall register with each other so that a gauge of 1.5 mm or 2.0 mm (as the case may be, depending on whether the diameter of the rivet or bolt is less than or more than 255 mm) less in diameter than the diameter of the hole will pass freely through the assembled members in the direction of right angle to such members. Finished holes shall not be more than 1.5 mm or 2.00 mm (as the case may be) in diameter larger than the diameter of the rivet or black bolt passing through, unless otherwise specified by the Engineer.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to tolerance specified in IS: 919 – 1993. Preferably, parts to be connected with close tolerance of barrel bolts shall be firmly held together by tacking bolts or clamps and the holes drilled through all the thicknesses at on operation and subsequently reamed to size. All holes not drilled through all thicknesses at one operation shall be drilled and reamed separately through hare bushed steel jigs.

Holes for rivets or bolts shall not be formed by a gas cutting process.

8.6 ASSEMBLY:

The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged, and shall be so prepared that the specified cambers, if any, are provided.

8.7 BOLTING:

Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads and nuts of bolts a satisfactory bearing.

The threaded portion of each bolt shall project through the nut at least one thread.

In all cases, where the full bearing area of the bolt is to be developed, the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted.

8.8 MACHINING FOR BOLTS, CAPS AND BASES:

Column splices and butt joints of struts and compression members depending on contact for stress transmission shall be accurately machined and close butted over the whole section with a clearance not exceeding 0.1 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels, etc. after riveting together should be accurately machined so that the parts connected butt over the entire surface of contact. Care should be taken that those connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 1.0 mm.

Ends of all bearing stiffeners shall be machined or ground to fit tightly at both top and bottom.

8.9 SLAB BASES AND CAPS

Slab bases and slab caps, except when cut from material with true surfaces, shall be accurately machined over the bearing surfaces and shall be in effective contact with the end of the stanchion. A bearing face, which is to be grouted direct to a foundation, need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, walls shall be provided where necessary in stanchion bases for the escape of air.

8.10 BEDDING OF STANCHION BASES, GRILLAGE ETC.:

Bedding of Stanchion Bases and Bearings of Beams and Girders on stone, brick or concrete (Plain or Reinforced Shall be carried out with Ordinary Portland Cement, grout or mortar, as described in the drawings or as instructed by Consulting Engineer.

8.11 PAINTING:

All surfaces, which are to be painted, oiled or otherwise treated shall be dry and thoroughly cleaned to remove all scale and loose rust. Shop contact surfaces need not be painted unless so specified. If so specified, they shall be brought together while the paint is still wet.

Surface not in contact, but inaccessible after shop assembly, shall receive the full specified protective treatment before assembly. This does not apply to the interior of sealed hollow sections.

In the case of surfaces to be welded, the steel shall not be painted or metal coated within a suitable distance of any edges to be welded, If the paint specified or the metal coating is likely to be harmful to welders or impair the quality of the welds.

Welds and adjacent parent metal shall not be painted prior to deslagging, inspection and approval. Parts to be encasesd shall not be painted or oiled.

8.12 SHOP DRAWINGS:

The contractor shall submit shop drawings to the Architects for approval.

These shall show full size sections of all joints and connections, thickness of materials used and details of welds, bots, rivets etc. Shop drawings shall clearly distinguish between shop and field rivets, bolts and welds. Shop drawings shall be made in conformity with BIS. Code for shop drawings and with due regard to speed and economy in fabrication and erection. A marking diagram allotting distinct identification mark to each separate piece of steel work shall be prepared. The diagram shall be sufficient to ensure convenient assembly and erection at site. All shop drawings shall show temporary bracings and connections required during fabrication and erection. All shop drawings shall be prepared in advance of the actual fabrication.

8.13 MARKING:

Each piece of steel work shall be distinctly marked before delivery, in accordance with a marking diagram, and shall bear such other marks to facilitate erection.

8.14 SHOP ERECTION:

The steel work shall be temporarily shop erected complete or as arranged with the Engineer so that accuracy of fit may be checked before dispatch. The parts shall be shop assembled with a sufficient number of parallel drifts to bring and keep the parts in place.

In the case of parts drilled or punched, through steel jigs with bushes resulting in all similar parts being interchangeable, the steel work may be shop erected in such position as arranged with the Engineer.

8.15 PACKING OF FABRICATED MATERIALS DURING TRANSIT:

All projecting places of bars and all ends of members at joints shall be stiffened, all straight bars and plates shall be bundled; all rivets, bolts, nuts, washers and small loose parts shall be packed separately in cases so as to prevent damage or distortion during transit.

8.16 INSPECTION AND TESTING:

The engineer shall have free access at all reasonable time to those parts of the manufacturer's work which are concerned with the fabrication of the steel work and shall be afforded all reasonable facilities for satisfying himself that the fabrication is being undertaken in accordance with the provisions of the Standards mentioned in the Specification.

Unless specified otherwise, inspections shall be made at the place of manufacture prior to dispatch and shall be conducted so as not to interfere unnecessarily with the operation of the work.

The manufacture shall guarantee compliance with the provision these Specifications. Should any structure or part of a structure be found not to comply with any of the provisions of these Specification it shall be liable to rejection. No structure or part of the structure once reject shall be resubmitted for test, except in cases where the Owner or his authorized representative considers the defect as rectifiable.

Defects which may appear during fabrication, shall be made good with the consent of and according to the procedure laid down by the Engineer.

The Manufacturer shall supply all gauges and templates necessary to satisfy the engineer. The Engineer may, at his discretion check the test result obtained at the manufacturer's work by independent test at the Government Test House or elsewhere, and if the material so tested is found to be unsatisfactory, the costs of such tests shall be borne by the manufacturer, and if found satisfactory, the costs shall be borne by the Owner.

8.17 ERECTION

8.17.1 PLANT & EQUIPMENT

The suitability and capacity of all plant and equipment used for erection shall be to the satisfaction of the Engineer.

8.17.2 STORING AND HANDLING:

All structural steel should be so stored and handled at the site that the members are not subject to excessive stresses and damages.

8.17.3 SETTING OUT:

The positioning and leveling of all steel work, the plumbing of stanchions and the placing of every part of the structure with accuracy shall be in accordance with the approved drawings and to the satisfaction of the Engineer.

8.17.4 SECURITY DURING ERECTION:

During erection, the steel work shall be securely bolted or otherwise fastened and, when necessary, temporarily braced to provide for all loads to be carried by the structure during erection including those due to erection equipment and its operations.

No riveting, permanent bolting or welding should be done until proper alignment has been obtained.

8.17.5 FIELD CONNECTGIONS:

Field riveting-rivets driven at the site shall be heated and driven with the same care as those driven in the shop.

Field Welding – All field assembly and welding shall be expected in accordance with the requirements for shop fabrications, excepting such as manifestly apply to shop fabrications only. Where the steel ahs been delivered painted, the paint shall be removed before field welding, for a distance of at least 50 mm on either side of the joints.

8.17.6 PAINTING AFTER ERECTION:

Before painting of steel, which is delivered unpainted, is commenced all surfaces to be painted shall be dry and thoroughly cleaned from loose scale and rust.

8.18 ASBESTOS CEMENT SHEETS-CORRUGATED:

8.18.1 The quality of A.C. Sheets shall comply with IS: 459 – 1992 and laying shall comply with IS 3007 Part – I for corrugated A.C.Sheets and Part – II for semi-corrugated A.C.Sheets and manufacturers specifications and instructions.

8.18.2 LAYING OF A.C.SHEETS:

The purlin spacing shall be as per drawing. Free over hang at eaves shall in no case be more than 380 mm.

In laying the sheets shall have not less than 150 mm end laps and side laps of 0.5 corrugations, unless otherwise specified. The sheets shall be aid from left to right and from bottom upward on the slopes with their smoother side towards the weather. Sheets shall be mitered where four corners meet.

Sheet shall be fixed with 8 mm diameter or as specified 'J' or 'L' G.I. Hook bolts inserted through a 10 mm diameter hole drilled in the crown of corrugation. Holes shall be drilled not less than 40 mm away from the edge of the sheet. The hooks before tightening shall be provided with G.I. washers and bitumen washers. All fixing accessories shall conform to IS: 730.

8.19 ALUMINIUM SHEETS:

8.19.1 The quality of Aluminium Alloy for aluminium Sheets shall comply with IS: 737-1974 and 3100 H(AA3003H4) or 40800 H4 (AA 8011H4) and profile shall conform with IS: 1254 – 1991. The acceptable tolerance in width and length will be $\pm$ 6 mm, as per IS: 2676-1981. The density of Aluminium Alloy Sheets shall be 2.70 grams/$cm^{3.}$. The aluminium sheets should have thickness, profile and width as described in the Bills of Quantities.

8.19.2 LAYING OF ALUMINIUM SHEETS:

Purlin spacing shall be as shown in the drawing and free over hang at eaves shall in no case be more than 225 mm.

The end laps shall not be less than 150 mm and side laps 1 ½ corrugation for circular corrugated sheets and one corrugation for industrial trough sheets. The sheets shall be laid from left to right and from bottom to upward on slopes.

Sheets shall be fixed with 8 mm dia. 'J' ior 'L' bolts as specified. Holes shall be drilled and shall not be less than 40 mm away from the edge of the sheet. The hooks before tightening shall be provided with GI washers, PVC washers and nuts with PVC cap to avoid leakage through holes. In transverse direction, these hook bolts shall be provided at a maximum spacing of three pitches / corrugations.

6.00 mm dia galvanized seam bolts with nuts and PVC washers shall be provided at 300 mm to 380 mm c/c at the side laps.

Filter blocks of expanded polyethylene of required thickness and profile are to be provided for sealing the joints at the ridge between ridge sheet and roof sheeting and at the eaves between flashing and roofing sheets.

8.20 PRECOATED METAL SHEETS:

SUBSTATE MATERIAL shall be M.S. cold rolled sheets as per IS 513 and galvanizing as per IS: 277. The galvanizing (Zinc Coating) material consumption will be 200/275 gms per Smt. The minimum thickness of primer and polyester coating on topside shall be as follows :

Epoxy primer	5 to 7 Microns
Alkyd Back Coat	5 to 7 Microns
Polyester Top Coat	12 to 16 Microns (For better resistance against detergents and Acid Fumes)
Nominal minimum coating	22 to 30 Microns.

The backside of sheet shall be having polyester back coat of 5 microns over and above the primer coats. The sheets shall have trapezoidal profile and thickness as specified in the Bills of Quantities. Sheets are available in thicknesses of 25/50/60 mm.

LAYING OF SHEETS:

The sheets shall be laid from left to right and from bottom to upwards on the slopes with rib up and with overlapping (female) facing towards starting edge. To commence fixing, place the first sheet in position with female rib in line with other building elements and fasten the sheets. Lap the female rib (with tuned down free edge) of the second sheet over the male rib (with turned out bottom edge) of the first sheet and insert side lap fasteners to hold lap firmly in place before fastening second sheet to support.

For fixing the sheets with purlins 8 mm dia. PVC coated G.I 'J' or 'L' bolts of suitable length with PVC washer and nut with PVC caps are to be used and holes are to be drilled and not punched. The end laps should not be less than 150mm and side lap half / full corrugation depending on the profile of the sheets. Self tapping screws / stitch bolts / pop rivets to be fixed at the side laps at centres not exceeding 350 mm.

The over hang at the ends should not exceed 250 mm. The expanded polythene foam filler block of appropriated shape to be used at joint of ridge and roofing sheet and where there is vertical sheet cladding as wall.

8.21 A.C RAIN WATER PIPES:

(a) A.C pipes shall be of asbestos cement conforming to IS: 1626 and diameter as specified in drawing.

(b) A.C Pipes shall be fixed by M.S. brackets/clamps to brick / concrete work, and steel work as per drawings and directions of Engineer – in –charge. All clamps and brackets etc. shall be painted with two coats of approved enamel paint.

(c) The pipes shall be jointed with gaskets of hemp or jute yarn dipped in coal tar and grouted with 1:2 cement mortar. Care shall be taken to ensure that no joining material projects inside the bore of the pipe.

(d) The erection of pipes shall start from the bottom upwards.

(e) Payment shall be made on running metre basis inclusive of all specials, bends, cowls, shoes, clamps, brackets, fixing embedding in concrete or brick work if necessary etc..

9.0 **Plumber & Drain Layer**

9.1 PLUMBER - GENERAL

It shall comply with IS: 1239-1990 (Part-I) and US: 1239-1992 (Part-II) or otherwise specified.

9.1.1 All water supply work shall be in accordance with the requirements of the local authority and detailed drawings as supplied by the Consulting Engineer/Architect and water meters shall be installed as demanded.

9.1.2 PIPES:

All pipes shall be of approved equality B Class galvanized iron of TATA or equivalent approved manufacturer. While fixing main delivery pipes, the ends shall have long screw or tee, complete with plug to give straight direct access to the pipe for cleaning purpose as necessary. A drainage cap shall also be provided at the lowest point in each main supply.

9.1.3 FITTINGS:

Elbows, tees, bends, long screws unions etc of "R" brand or equivalent shall be as per pipes and shall have proper and true threads for screwing.

9.1.4 JOINING:

Joining of all pipes shall be absolutely water tight and as per BIS Standards, unless otherwise specified.

9.1.5 VALVES:

All valves shall conform to IS: 778 & IS: 780. They shall be screwed down heavy type of brass castings of approved quality and manufacture.

The same shall be absolutely water tight when closed and shall precede and follow with unions.

9.1.6 FLOATING VALVE:

Ball shall be of copper/PVC Ball and brass cock shall be of approved quality and manufacturer.

9.2 DRAIN LAYER - GENERAL

All drainage work and sewage disposal shall be in accordance with the requirements of the local authority.

Drainage shall be laid to the true falls and levels commencing at the point of the outfall.

9.2.1 STONE WARE PIPES:

These shall comply with IS: 651 -1992, unless otherwise specified. Pipes shall be of good quality, glazed stoneware, spigot and socket end, joined in cement mortar 1:2 with a water proofing compound added. Joints should be carefully cleaned from inside after joining.

9.2.2. CAST IRON PIPES:

These shall comply with IS: 1537-1976, unless otherwise specified.

9.2.3 CAST (SPUN) IRON PRESSURE

It shall comply with IS: 1536-1989.

9.2.4 SANITARY ENGINEERING

All sanitary work shall be done in conformity with the requirements of the local authority.

9.2.5 VENTS ETC.:

All vent pipes shall be fitted at the top with proper and suitable cowls, Fresh air inlets shall be fitted with a box cap with grating, mica flap valves.

9.2.6 SOIL AND WASTE PIPES:

Pipes and fittings shall be spigot and socket type of cast iron 4.5 mm, minimum thickness of approved manufacture and shall conform to IS: 1537-1976 and IS: 729-1979. Joints shall be provided with cement mortar and spun yarn or lead as directed by Engineer – in – Charge. Plug bends, junctions etc. shall be provided at convenient locations or as considered necessary to give easy access for cleaning.

Horizontal pipes shall be laid with adequate fall.

Joints shall be properly made with shaped end to pipe with brass ferrules and wiped joints.

Connection of sink shall be of C.P. waste coupling of 37 mm dia.

All channel and pipes shall have floor traps at the discharge ends. Floor traps shall be of cast iron, with grating, set at a level, which will permit the floor to be drained to the grating. All built in soil and wastes shall be tested against the water head to check water tightness of pipes and fittings before the work is covered up.

9.2.7 SANITARY AND PLUMBING FITTINGS:

All sanitary fittings shall be of approved pattern and manufacture. Eastern (India) closets shall be grouted with 1:2 cement and sand mortar or with necessary concrete.

Shower roses shall be of approved type and quality.

All bib cocks, stop valves, etc. which are exposed to view shall be chromium plated and those projecting from walls shall have a chromium plated flange to cover the holes in the wall facing materials, and shall be of approved make.

9.3 EXTERNAL DRAINAGE AND WATER SUPPLY:

9.3.1 EXCAVATION AND REFILLING THE TRENCHES FOR LAYING PIPE LINES:

The trench shall be excavated to the grade and depth on the line shown in the approved drawings. Sight rails shall be erected every 30 m. and at the changes in direction and gradient. The centre line of pipe line shall be clearly marked on each sight rail by nails or by an edge of an upright cleat. The same edge of the cleat shall be used to indicate centre line when latter is used. As chord shall be stretched between each mark and the line shall be transferred from the chord line to the bottom of the trench. The depth of excavation and the level of pipe invert shall be checked by means of boning rods of appropriate length.

The bed of the trench shall be watered and well rammed before laying the pipes. Before lowering the pipes into trench, hollows shall be cut in the bed and in a narrow width of the trench and the width of the excavation shall be increased locally if required to receive the socket of the pipe and give adequate room for working.

The width of the trench throughout at the bottom shall be at least 300 mm wider than the socket of the pipe, so as to allow room for ramming the refilled material under and at the sides of the pipe. In no case the trench width shall be less than 750 mm (2.5 ft. approx) for depth exceeding 900 mm (3 ft. approx.). The excavated stuff shall be stacked in regular fashion and at distance from the edge of the trench as directed by the Consulting Engineer/Architect. The contractor in general shall follow the Specification of “Excavation”.

Open cut trenches shall be sheeted and braced as required by any governing state laws or municipal regulations and as may be necessary to protect life, property or the work. When close sheeting is required, it shall be so driven as to prevent adjacent soils from entering the trench either from below or through such sheeting. Sheeting shall be driven to the full depth of the trench or to such additional depths as may be required to protect the work according to local conditions of soil. Trench bracing shall be removed when the backfilling has reached the respective level of such bracing.

To protect persons or animals from injury and to avoid damage to the property, adequate barricades, construction signs, torches, red lanterns and guards as required shall be placed and maintained during the progress of the construction work and until it is safe for pedestrian and vehicular traffic to use the road way. All materials, piles, equipment and pipe which may serve as obstructions to traffic shall be enclosed by fences and barricades and shall be protected by proper lights when the visibility is poor. The rules and regulations of the local authorities regarding safety provisions shall be observed.

The work shall be carried out in such a manner, which causes least interruption to the traffic, and the road or street may be closed in such a manner that it causes the least interruption to the traffic. Where it is necessary for traffic to cross open trenches, suitable signs indicating that a street is closed shall be placed and the contractor shall provide necessary detour signs for proper maintenance of traffic during the time when work is in progress. Contractor shall provide temporary supports, adequate protection and maintenance of all underground and surface structures, drains, sewers and other obstructions encountered in the progress of the work as per the direction of the Consulting Engineer/Architect. The contractor shall restore the structures, which may have been disturbed, upon the completion without claiming extra cost.

Trees, shrubs, shrubby fences, poles and other property and surface structures shall be protected unless their removal is shown on the drawings or directed by the Consulting Engineer/Architect. No valve or other control of the existing services shall be operated without permission of the administrative authority in-charge of such services.

9.3.2 REFILLING:

Refilling the trenches shall start in the section of sewer line after the section is cured, tested and approved by the Consulting Engineer/Architect or their representatives.

The backfilling material shall be free from cinders, ashes, slag, refuge, rubbish, vegetable or organic material, lumps boulders, rock or stone fragments which are min the opinion of the Consulting Engineer/Architect deleterious.

Backfilling up to 300 mm (12 inches approximately) on the top of the pipe shall be done by placing the excavated stuff or any other material, approved by the Consulting Engineer/Architect, in case the excavated stuff is not suitable in their opinion. It shall be laid in layers of 200 mm and shall be compacted by tamping in such a manner as to avoid any damage to sewer, fittings and appurtenances. Refilling with black cotton soil shall be avoided in this zone. The layer shall be compacted well to give dense soil around the pipe. The remaining portion shall be filled with excavated material or any other material approved by the Consulting Engineer/Architect, if the excavated material is not suitable in their opinion for refilling.

9.4 STONE WARE PIPES:

9.4.1 MATERIALS:

The pipes shall be of best quality stone-ware of fire clay, salt-glazed, thoroughly burnt together throughout the whole thickness, of a close and even texture, free from air blows, fire blisters, cracks and other imperfections and the surfaces, external and internal shall be smooth and perfectly glazed.

A piece of stone ware pipe about 50 mm x 50 mm from any part of the pipe, shall not absorb water after 48 hours of immersion, more than 4 per cent of its own dry weight. The stoneware pipe shall be capable of resisting a burst pressure of 2.11 kg./Sq.cm (30.0 lbs/Sq.in.) without showing signs of leakage.

The crushing strength of the stoneware pipe shall be as specified in IS: 651 – 1992 (Specification of Salt Glazed Stoneware Pipes and fittings).

The thickness of barrel, depth and internal diameter of the socket, weight of the pipe, internal diameter of pipes, etc. shall be as per IS: 651-1992. Caulking and joining materials shall be Spun Yarn, cement stand.

9.4.2 LAYING THE STONEWARE PIPES:

The bottom of the trench shall be properly trimmed of to a present a plane surface and also irregularities shall be leveled. Where rock and large stone or boulders are encountered, the trench shall be trimmed to a depth of at least 150 mm (6”) below the level at which the bottom of the barrel of the pipe is to be laid, and filled to a like depth with stones, broken to pass through a sieve of 12 mm, opening size, sand or selected earth as directed by the Consulting Engineer/Architect and well rammed to form a firm bed for pipes.

Wherever necessary or desired by the Consulting Engineer/Architect, the pipes shall be laid over a bed of B.B.C.C. 1:4:8, 100 mm thick, having equal off sets of 150 mm from the edges of socket and shall be completely encased in (1:2:4) concrete, 10 mm thick surrounding the pipe. The pipes shall be handled carefully so as to avoid any kind of damage by either free fall or bumping against another pipe or hard material. The pipes shall not be dragged along concrete or any hard material. The pipe and fittings shall be inspected for defects before laying. All lumps, blisters and excess coating materials shall be removed gently from the socket and spigot end of each pipe and the inside of the socket shall be wiped clean before the pipe is laid. The cutting of the pipe for inserting, fitting or closure pieces shall be done in a neat and workman like manner without damage to the pipe or cement lining so as to leave a smooth surface of cut at right angles to the axis of the pipe.

9.4.3 JOINING THE S.W. PIPES:

The stoneware pipes shall be cement jointed. In each joint, spun yarn soaked in neat cement slurry shall be passed around the joint and inserted into the socket by means of caulking tool. The yarn shall be closely packed into the socket of each joint and shall not occupy more than one fourth of the depth of the socket. Cement mortar (1:1) (one part of cement to one part of sand) shall be slightly moistened and carefully inserted into the remaining space of the joint after caulking the spun yarn. The mortar shall then be caulked with a caulking tool and more mortar shall be applied to fill up the entire space of the joint with tightly caulked mortar. The joint shall, then, be neatly finished with cement mortar (1:1) outside the socket at an angle of 45 degrees to the socket. The cement mortar so prepared shall be cured for seven days. Where the trenches are deep, the pipes shall be lowered into the trench by means of ropes. While lowering, care shall be taken to prevent free fall of the pipe. The pipe shall be placed in the trench with socket end in the up-stream direction. When the pipe runs in up-hill direction, the socket ends shall face the up grade. The centre line of the pipes shall be obtained from the sight rails already established.

After placing the pipe in the trench, the spigot end shall be centered in the socket and aligned to the gradient. The pipe shall be secured in place with approved back fill material or concrete tamped under it where directed, except at the socket.

Pipe and fittings, which do not allow a sufficient and uniform space for joints, shall be removed and replaced with pipe and fittings of proper dimensions to ensure such uniform space. Enough precautions shall be taken to prevent foreign materials from entering the pipe when it is being placed in the line. When the pipe laying is not in progress, open end of the pipe shall be closed by a watertight plug or canvass.

The quantity of cement and spun yarn shall be as per IS: 4127 – 1983.

9.4.4 TESTING:

After seven days of curing, the contractor in the presence of Consulting Engineer or their representative shall conduct hydraulic test. All equipment, necessary for the test shall be provided and fitted in place and operated by the Contractor. No refilling of the trenches shall be done unless the section has been tested and passed by the Consulting Engineer/Architect or their representative in – charge of the work.

The pipeline shall be subject to a 2.5 m of water head and at the end, which is at higher elevation in the section. There shall not be any leakage at joint or in the pipe. Any joint found leaking or sweating shall be rectified or embedded into 150 mm layer of M-15 grade cement concrete, 300 mm (12”) in length and section shall be retested until found satisfactory. Contractor shall not claim extra payments for such rectification works or for testing.

9.4.5 MODE OF MEASUREMENT:

Measurement shall be taken along the centre line over the top of the pipeline and all joints and specials.

9.4.6 RATES TO INCLUDE:

The rates for items of laying and joining the stoneware pipes shall include:

- Supplying of stoneware pipes of specified type, diameter and specials or fittings.
- Excavating trench including laying out, setting up sight rails, ramming, murrum or sand cushioning in rocky bed, shoring and strutting, sloping, dewatering if required, protection measures for men, animals, vehicles, providing lanterns, fencing sign boards, etc.
- Laying pipes including cutting, where necessary and including wastage.
- Joint with cement mortar (1:1) at the joints, spun yarn, including curing the joint, caulking etc.
- Testing the pipeline and making good any defect in the line.
- All necessary labour, material, equipment tools necessary for carrying out the work.

The measurement shall be per Rmt. Of pipeline laid, joined and tested.

9.5 MANHOLES, INSPECTION CHAMBERS AND CHAMBERS FOR VALVES, GULLEY TRAPS ETC.

9.5.1 MANHOLES:

Each manhole shall have at least 150 mm thick bedding of cement concrete (1:4:8) consisting of cement, sand and brickbats below invert, projecting at least 150 mm beyond the outer face of the masonry with necessary haunches, channels, bends etc. in concrete.

Masonry wall shall be at least 230 mm thick in cement mortar (1:6) proportion, giving a uniform finished internal diameter of specified size or internal dimensions of 1.2 m x 1.0 m or 1.2 m diameter up to required depth from top i.e ground level, corbelled and tapered up to 560 mm diameter at top with 80 x 230 mm thick reinforced concrete coping in M-15 mix. Where depth of manhole exceeds 2.5 m. from top of cover to the invert, the thickness of the masonry shall be 350 mm. cast iron frame and cover shall be of size and weight as specified in the Bills of Quantities or as directed. Masonry shall be plastered internally and externally in 12 mm thick (1:4) with the top most step commencing 450 mm from the cover top and each subsequent step at 300 mm interval and the bottom most step shall not be more than 300 mm above the benching or bedding top. The work shall be carried out as per drawings. Rate shall be inclusive of 100 mm thick RCC slab with M-20 concrete, necessary excavation, back filling etc.

9.5.2 RECTANGULAR INSPECTION CHAMBERS:

Each chamber shall have at least 150 mm. thick bedding of cement concrete (1:4:8) of cement sand and brick bats mix below invert, projecting at least 150 mm beyond the outer face of the masonry with necessary haunches, channels, bends, etc. in concrete. Masonry wall shall be 230 mm thick in cement mortar (1:6) giving uniform finished internal dimensions of 600 mm x 750 mm. A cement concrete coping of 80 mm thick shall be provided over masonry. A cast iron frame with cover of 580 mm diameter or (610 x 455 mm size) and 50 kg. weight shall be grouted in the slab. The chamber shall be plastered internally and externally on the exposed faces in (1:4) cement mortar 12 mm thick and the internal faces finished neat with cement. The work shall be carried out as per the drawings. Rate shall be inclusive of 100 mm thick RCC slab with M-20 concrete, necessary excavation, back filling etc.

9.5.3 CHAMBERS FOR VALVES

Each chamber shall have at least 150 mm thick (1:4:8) cement concrete bedding which shall project 150 mm beyond the outer face of masonry. The masonry thickness shal be 230 mm for chamber up to 600 mm to 1500 mm and the masonry shall be in 1:6 cement sand mortar. Inside surface shall have water proof plaster (1:4) and outside surface shall have cement finish cement plaster. An angle frame fabricated from M.S. angle 50 x 50 x 6 tees and 5 mm thick M.S. plate with locking arrangement shall be as per drawing or as directed.

9.5.4 CHAMBER FOR GULLEY TRAPS:

Each chamber shall be with 112 mm thick brick masonry in cement mortar (1:3) over a bed of 100 mm thick brickbat concrete (1:4:8).

Approximate dimensions of chamber shall be 225mm x 225 mm. the stoneware gullley trap (150 x 150 mm) shall be housed in the masonry chamber and the space around shall be finished with plaster (1:4). It shall have cast iron standard heavy cover of 230 mm diameter with frame.

9.5.5 NAHNI TRAPS:

The nahni traps shall be sound and free from surface and other defects; filling shall be such that they may be cut, drilled or machined. It shall give ringing sound when struck with a light hand hammer. The nahni traps shall be of 'Atta' brand or approved make, with at least 65 mm of water seal and shall have heavy grating of type as specified in the Tender. Nahni trap shall be embedded in concrete floors.

9.5.6 RATES TO INCLUDE:

Rate shall be per number. It shall include excavations in all types of soils and hard murrum with necessary shoring, bailing and/or pumping of water, necessary refilling and spreading surplus soil.

The rate shall also include all labour and material, required for concrete bedding, masonry with cement plaster, RCC ring beam, CI/MS cover with frames, cast iron steps and all connections.

9.6 HUME PIP – SEPTIC TANK:

9.6.1 MATERIALS:

Materials shall be precast units and fixtures as per manufacturers Specifications.

- One hume pipe of required diameter, 2.5 m in length, with openings for two vent pipes, manholes and groove on the inside surface for fixing the end slabs and other slabs.
- Two RCC partition slab with a slot for fixing the siphon pipe.
- One RCC slab for baffle wall.
- Two RCC tees for inlet and outlet connections.
- One RCC Siphon pipe to be fixed in the partition.
- Two covers for manholes.
- C.I vent pipe 2 m. in length with C.I cowl and C.I vent pipe 0.6 m long with semi circular bend.

9.6.2 EXCAVATION:

Excavation shall be carried out at required location along the alignment of proposed soil pipe. Excavation shall be carried out to the required depth in all sorts of soil including murrum. The width of the excavation shall be at least 600 mm more than the diameter of the pipe and length shall be at least 300 mm longer than the pipe. The bed of the trench shall be leveled and dressed properly. If rock is met with, the excavation shall be carried 150 mm below the bed level and shall be filled with sand and murrum ant tamped well. If soft soil is encountered the excavation shall be carried to 300 mm below the bed level and brickbat cement concrete (1:3:6) shall be laid and tamped up to the bed level and cured.

9.6.3 When the bed is ready the pipe shall be placed in with manholes on the top side. Care shall be taken to see that the grooves provided for hanging baffles are towards the influent side. The pipes shall be laid perfectly horizontal. To prevent any lateral movement, enough supports shall be provided and partial filling of soil in layers of 300 mm with ramming shall be done.

The partition and baffle walls shall then be fixed in cement mortar (1:2) and siphon pipe shall be fixed in a slot of the partition wall in cement mortar (1:2). The baffle wall shall have a clearance between the bottom edge and the invert as per manufacturer's Specification.

The end slab and the vent pipes shall be fixed in cement mortar (1:2). The centres of the inlet and outlet holes shall be at the heights from invert of the tank as specified by the manufacturer. The tees for inlet and outlet shall be fixed in cement mortar (1:2). Soil pipe shall then be laid and connected to the septic tank. The outlet pipe shall be connected with the soak pit as directed. Curing of the cement mortar shall be done for seven days.

The tank shall then be filled with clear water and commissioned.

9.6.4 RATES TO INCLUDE:

The items on providing laying, and assembling the hume pipes – septic tank includes:

- Hume septic tank of required size with assembly, C.I. vent pipes, cement, sand etc.
- Excavation in all sorts of soils with strutting as necessary, including refilling.
- Laying and assembling the tank with cement mortar, curing, supporting the tank laterally.
- All labour, materials and tools necessary for carrying out the work.
- Construction of chambers over manholes including fixing C.I covers, plaster, finishing etc. complete.

9.6.5 MODE OF MEASUREMENT:

The measurement shall be per number of the hume septic tank.

9.7 SOAK WELL:

9.7.1 SOAKWELL MATERIALS:

Materials shall be those necessary for brick masonry and brickbats for filling in. The respective Specifications for materials shall be referred.

9.7.2 EXCAVATION:

Excavation shall be carried out for soak well, as necessary, in all sorts of soils with necessary slopes, or shoring and strutting including pumping or bailing out the water.

9.7.3 The honeycombed masonry work as per the desired width shall be done in cement mortar over a bed of cement concrete (1:3:6) of cement, sand and brickbats. Solid masonry work over the honeycombed masonry shall be done as per the Specification of brickwork. The cement mortar shall of (1:6) proportion. The work shall be carried out as per drawing or as directed.

The brickwork shall be of circular shape in plan. Necessary curing shall be done. The trench shall be filled in uniform layers of 230 mm thickness and rammed.

After the brickbats shall be filled up as directed and a brick chamber with open joints shall be constructed and the inlet pipe carrying the effluent shall be fitted into drain for the effluent.

RCC slab with C.I Manhole frame and cover (Medium duty) shall be provided over it. The Specification for concrete shall be adhere to.

9.7.4 RATES TO INCLUDE:

All items of soak well (i.e Brick masonry, RCC, Plaster, Excavation etc.) shall be paid in the respective tender items.

9.8 GALVANISED IRON PIPES:

9.8.1 MATERIALS:

(a) GALVANISED IRON PIPES:

The pipes shall be of B class and of diameter specified in the item and shall comply with IS: 1239 – 1990 (Pat-I) and IS: 1239 -1992 (Part-II) for the specified type. the specified diameter shall refer to inside diameter of the bore. Pipes and fittings, which have been damaged, shall not be used.

(b) Clamps screws and G.I. fitting and specials shall be of the standard type to match the pipes.

(c) Fine hemp and “Lock Tight” or equivalent compound shall be used for fixing the fittings.

9.8.2 EXCAVATION AND REFILLING:

The necessary excavation for laying the pipes shall be done by the Contractor and trench shall be refilled. This includes breaking or removal of any kind of pavement and making it good afterwards. Refilling shall be done by tamping the soil in layers and adding water.

9.8.3 LAYING AND FIXING:

The plumbing contractor shall get the layout of the plumbing and drainage system approved by the competent authorities as may be required by the byelaws. Should any changes in the layout be necessary, the contractor shall get the approval of Consulting Engineer/Architect and make necessary changes to comply with by laws. The pipes shall be laid in straight lines and plumb as far as possible. All pipes shall be kept open/concealed in walls or floor as specified. They shall be used in standard lengths. Cut lengths being used where necessary to make up the exact length.

The pipe shall be laid in the trench and screwed with sockets, elbows, bends, reducers, tees etc. as necessary, in making the joints, a few turns of fine hemp dipped in joining compound shall be wound over the threaded end of the pipes and the socket screwed over the pipe with the help of wrench. Pipes connected shall touch each other and the socket shall be covering each end about equally. Any branch connection shall not protrude in the bore of the parent pipe. No joint shall be located in the thickness of the wall or floor.

If pipe is required to be cut and the end threaded the cut end shall be filed smooth and any obstruction in the bore shall be entirely eliminated.

When pipe is to be fixed to the walls, it shall be fixed with standard brackets, clamps or holder bats, keeping the pipe 12 mm clear of the wall. The pipe shall be fixed to the wall horizontally and vertically and parallel to one another, when more than one pipe is laid, unless unavoidable. The supporting clips, etc. for the pipe shall be at about two meters spacing or as necessary.

When holes are not left in the masonry or concrete works, the same shall be made by the contractor to pass the pipe through them or fix the clamps etc. After fixing of the pipes, clamps, etc. the holes in masonry or concrete work shall be made good.

All the pipes laid underground shall be painted with two coats of anticorrosive paint of approved quality and shade or with one coat of approved aluminium paint, where pipes are not embedded.

9.8.4 TESTING:

The pipeline shall be tested for a pressure of 7kg/cm^2. If any leakage is found, the contractor shall rectify the same.

9.8.5 The rates on G.I. pipe items shall include:

- Providing G.I pipes of the specified diameter and type, G.I. fittings, specials, fine hemp, joining compound anticorrosive paint, etc.
- Excavation in all sorts of soils breaking and removal of any kind of pavement, refilling and tamping the soil in layers, making good paved surface.
- Get the layout of plumping approved by the competent authorities, cutting the pipes and threading the ends, making holes in masonry and concrete work, fixing the pipes by means of clamps, applying anticorrosive paint, fixing any valves, taps, testing the pipeline, etc.
- All labour charges, tools, plants and equipments necessary for carrying out the work.
- All the fittings and fixtures to be provided and fixed in G.I. pipes line work shall be open/concealed type as per the respective item of the G.I. pipe line in the Bills of Quantities.

9.8.6 MEASUREMENTS:

The measurement shall be per Rmt of the pipeline laid and jointed. The measurement shall be taken on the top of the pipe also the centre line over the fittings, joints, specials, valves, etc. in the pipeline. Deduction shall be made for linear space occupied by the valve. Open/concealed pipe shall be paid in their respective items.

Note:

All pipes which are concealed in ground, floors, or masonry shall be paid under item of concealed pipe. Rate of concealed item shall include necessary excavation, chasing and restoring to original condition.

9.9 FERRULE CONNECTIONS:

9.9.1 MATERIALS:

The item pertains to provision and fixing of a ferrule for obtaining water supply from the mains.

The ferrule for connection with cast iron water main shall be of gunmetal or hard brass and shall be of the diameter specified in the wording of the item in the Bills of Quantities. The ferrule shall

be fitted with screwed plug or valve, capable of completely shutting off the supply. It shall be got approved before use. One-piece C.I bell mouth cover shall be provided to protect the ferrule connection.

9.9.2 FIXING:

The contractor shall obtain necessary permission of the competent authorities, if required, for making the connection.

The ferrule shall be fixed in the water mains without protruding inside and shall include making hole in the water main, covering with cast iron bell mouth cover. The ferrule shall be fitted in such a way that the connection shall be watertight.

9.9.3 THE RATE TO INCLUDE:

- Ferrule, coupling and C.I bell mouth.
- Obtaining permission, if required, for making the connection, drilling hole in the main and fixing ferrule.
- All necessary labour, materials and use of tools required for completing the item satisfactorily.

9.9.4 MEASUREMENT:

Measurement shall be per ferrule connection of the specified diameter.

9.10 CAST IRON PIPES:

9.10.1 MATERIALS:

CAST IRON PIPES:

The diameter and type or the class of pipe shall be as per the item in Bills of Quantities. The pipes shall be, in all respect, of good casting, easily worked with a drill, free from lapse or other imperfections, neatly dressed so that no lumps or rough places are left in the barrels or sockets. They shall conform to IS: 1537 – 1976 they shall be either spigot and socket or flange pipes as per description of corresponding item in Bills of Quantities.

PACKINGS AT THE FLANGED JOINTS:

Packing shall be of rubber or leather of approved quality and appropriate thickness. Packing shall be of full diameter of the flange with proper pipe holes. The thickness of the packing shall be uniform throughout. The boltholes shall be cut through the packing as required. Such pipes may be used for valve or meter connections, vertical pipes for inlet and outlet of reservoirs, suction pipes of the pumps, pumping mains, delivery pipes, steam lines, where there are vibrations or wherever specified or desired by the Consulting Engineer/Architect.

MATERIALS FOR CAULKING THE TRENCHES:

Fine hemp rope, lead wool or caulking lead conforming to IS: 762 – 1978 or joining with spun yarn and cement mortar (1:1) as specified in item.

9.10.2 EXCAVATION AND REFILLING THE TRENCHES:

The specifications as mentioned for Galvanised Iron Pipes shall be followed.

9.10.3 LAYING THE C.I PIPES:

The pipes shall be place along the outside of the trench for pipe in its proper position for laying with an extra pipe after every 20 pipes to allow fore cutting, if necessary. Where the trench crosses a road or place where such distribution is inadmissible, the pipes shall be stacked in heaps at each end, sufficient to cover in the length. Small pieces below 100 mm, diameter may be stacked at every 30 m distance.

All pipe shall be used in standard lengths as far as possible. Cut lengths may be used only where necessary to make up exact lengths. The Consulting Engineers, for any damage and cracks shall inspect all the pipes. No damaged pipe shall be permitted to be used.

The pipe shall be thoroughly cleaned with brushes to remove any accumulated stones or soil inside socket the outside of the spigot shall also be cleaned similarly. The pipes shall be lowered in to the trench and spigot neatly placed into the sockets for full length and properly supported. When there is a gradient, the pipe laying shall proceed in the uphill direction, with the sockets facing an uphill direction, irrespective of the direction of the flow.

The pipes shall be carefully packed underneath so that they shall bear evenly / properly throughout their length.

Any deviation in plan and elevation less than 11.25 degree shall be met with by laying of the straight pipes along the curve of larger radius such that the deviation at each joint is not greater than 2.25 degrees and the minimum thickness of lead at the face of the socket is 6mm, and the opening between the socket is not increased beyond 12 mm at any joint provided that such deviations are shown in the drawing or permitted by the Consulting Engineer/Architect.

In case of rocky beds, sand or murrum bedding of 100 mm below the bottom of the pipe shall be provided, before laying the pipes.

9.10.4 MAKING LEAD JOINT:

(I) PREPARATION:

The outside of the spigot and the inside of the socket shall be thoroughly cleaned with brush. The spigot shall be carefully centered in the socket by one or more laps of spun hemp yam twisted to ropes of uniform thickness and thoroughly soaked in hot coal tar or bitmen and dried before use.

Approximately quantity of material required for joining cast iron pipes of different diameters per 10 joints shall be as given below :

Dia. For pipe	Lead (Kg.)	Spun Yam (Kg.)
75 mm	19	1.0
100 mm	25	1.8
125 mm	30	2.0
150 mm	38	2.0
200 mm	50	3.0
225 mm	55	3.2
250 mm	63	3.5

Quantity of lead and spun yarn shall be consumed for respective diameter of pipes as indicated above.

Before leading, the alignment and gradient of the pipe shall be checked. Leading of the joint shall be done by using special leading rings or by means of rope covered with clay as directed by the Consulting Engineer/Architect. Leading shall be done by pouring molten lead. The scum from molten lead shall be removed before pouring it in to the joint.

9.10.5 CAULKING:

After a section of a convenient length has been leaded, caulking can be done. After hardening of the lead, the leading ring shall be removed and shall be caulked around the pipe several times. By means of proper caulking tools of increasing thickness and hammer 2 to 3 kg. in weight in a manner that the joint is rendered water tight and no damage is done to the spigot.

9.10.6 JOINT WITH LEAD WOOL:

Consulting Engineer/Architect may direct the contractor, wherever the work is required to be carried out in water, to make the joint with lead wool inserted in strings not less than 6 mm thick and the same shall be very thoroughly caulked.

9.10.7 JOINING FLANGED PIPES:

Flanged pipes shall be joined by providing rubber or leather packing in between, making holes in the packing for bolts and tightening up the nuts. Concrete blocks shall be provided as per the drawings or as per the directions of the Consulting Engineer/Architect and shall be paid separately.

9.10.8 TESTING THE PIPELINE:

After each section of the pipeline is completed, it shall be tested for water tightness before being covered in. Each end of the pipe shall be closed by means of valve or watertight plug or flange and pipe shall be filled with water. The pressure shall then be raised by means of hand force pump or hydraulic pressure pump till the pressure is 15% in excess of highest working pressure in line or 7kg./cm^2 whichever is more. The test shall be carried out in every 150 m length of pipeline or where there is change in the direction or diameter. If any leakage is found in the pipeline, the same shall be rectified till it gives satisfactory test. Unless and until the test is carried out and the length of the pipeline is passed by the Consulting Engineer/Architect, no refilling of the trench shall be done.

9.10.9 RATES TO INCLUDE:

The items on providing, laying and joining C.I pipes shall include:

- Supply of C.I pipes of specified type, diameter, fittings and specials such as flanged socket, flanged spigot, collar flanged bends, flanged duck foot bends, flanged cross, flanged taper, flanged toes, socketed bends, socket and spigot tapers, cap, plug, socketed tapers and tees, etc.
- Excavating trench including laying out, setting up sight rails, ramming, murrum or sand cushioning in rock excavation or rocky bed, shoring, sloping dewatering, if required, protection measures for men, animals, and vehicles, lantern, fencing, sign boards etc.
- Pig lead or lead wool, hemp rope or cement mortar (1:1) joints, as specified.
- Winding the rope on spigot and centering the pipe, casting molten lead or inserting lead wool and caulking the same including watering, if necessary.
- Testing and making good lead joints or cement mortar joints.
- All labour, materials, equipment, tools, necessary for executing every items.

9.10.10 MODE OF MEASUREMENT:

The rate shall be Rmt. Of pipeline laid, joined and tested as per the Specification including excavation and refilling the trench. The measurement shall be taken along the centre line at the top of the pipeline, special - valves, etc. Deduction shall be made for linear space occupied by the valves. In the case of flanged socket or flanged spigot, the measurement shall be taken along with the socket and spigot pipeline. The tapers shall be measure for the large diameter of the pipe. Open / concealed pipe shall be paid in their respective item.

9.11 ASBESTOS CEMENT PRESSURE PIPES:

9.11.1 MATERIALS

ASBESTOS CEMENT PIPES:

The pipes shall be of all the diameters and types specified in the item .The allowable tolerances in length, diameter and thickness shall be as per IS: 1952 – 1963. The pipes shall be perfectly straight, smooth, and free from cracks and with sharp edges at the ends. The ends shall be of uniform thickness perpendicular to the axis of the pipe and shall be free from damage. When any part of the pipe is found damaged, it shall be rejected and removed from the site of work.

The joint for the pipes shall consist of one centre collar and two flanges of cast iron; two rubber rings manufactured in accordance with BIS specifications and wrought iron bolts.

Specials and fittings shall be conforming to IS: 553-1977

9.11.2 EXCAVATION AND REFILLING:

The Specification for excavation and refilling the trenches for laying galvanized iron pipelines shall be followed.

9.11.3 PREPARATION OF TRENCH:

The trench bottom shall be trimmed and dressed to the required grade. Any prominent pieces of rock or other hard material, either loose or projecting from hard bed or subsoil shall be removed. In case of rocky strata, to avoid irregularities, the trench shall be excavated 150 mm below the level at which bottom of the barrel of the pipe is to be laid and shall be filled up with sand or selected earth filling or gravels less than 12 mm size, as directed by the Consulting Engineers. Any irregularities more than 12 mm shall be chiseled off. Before lowering the pipes in to the trench, hollows shall be cut in the bed and in the narrow width of trench to receive the joint and give adequate room for working.

The pipes shall be stacked along the side of the trench before being laid. Extra pipes at requisite distances shall be stacked to make up for any cutting or rejection of the pipe. Where trench crosses a road or place where such distribution is inadmissible, the pipes shall be stacked in heaps at each end of such crossing. The pipes shall be cleaned at each inside before lowering into the trench.

9.11.4 LAYING AND JOINING:

The pipes shall be lowered into the trench either by hand or by ropes. The pipes shall be handled carefully so as to avoid any kind of damage. Before making the joints, the pipe ends shall be cleaned. A tapered AC plug shall be placed at the end of the pipe to fit a rubber ring to the pipe by rolling the same over the taper until it reaches the pipe. The procedure shall be repeated on the end of the other pipe to be coupled with the former. When rubber rings are in position, collar shall be placed and the two pipes ends shall be brought together with approximately 4 mm to 5 mm clearance at the butts. The rubber rings shall be free from any twist before the joint is tightened up. The distance of the rubber ring from the pipe end shall be nearly half the width of collar. The joint shall then be carefully made by placing the bolts in the flange and tightening them.

Wherever, it is necessary, the anchoring or thrust blocks of concreted or bricks as directed by the Consulting Engineer/Architect, shall be provided. Generally they shall be provided at the tees, bends, reducers, crossings, dead ends, valves etc. The trust blocks shall be provided as per the drawings or as directed.

9.11.5 TESTING OF PIPELINE:

Pipe shall be adequately braced at horizontal and vertical curve before testing. No test shall be carried out unless the anchoring or thrust blocks have been given enough setting time.

Before testing, selected soil or excavated stuff, free from stones and lumps shall be tamped under the pipeline.

The open end shall be carefully sealed temporarily be means of end cap. End of the pipe shall be provided with temporary thrust block. The contractor shall make the arrangement for relief of the air. For sizes less than 200 mm diameter hydrants shall be made use of for venting air.

Water and atmospheric pressure shall be retained in the pipe for 24 hours, before actual testing is done by raising the pressure. The working pressure shall be raised gradually. The test pressure shall be 1.25 to 1.5 times the normal working pressure of the pipe. There shall be no leakage in the pipeline. If any leakage is found anywhere it shall be rectified by removing the pipe or joint or any special.

No, refilling of the trench shall be done unless the pipe length is tested and passed by the Consulting Engineer/Architect.

9.11.6 RATE TO INCLUDE:

The item on providing, laying and joining the A.C. pressure pipes shall include:

- Supply of C.I pipes of specified type, diameter, fittings and specials such as flanged socket, flanged spigot, collar flanged bends, flanged duck foot bends, flanged cross, flanged taper, flanged toes, socketed bends, socket and spigot tapers, cap, plug socketed tapers and tees, etc.
- Excavating trench including laying out, setting up sight rails, ramming, murrum or sand cushioning in rock excavation or rocky bed, shoring, sloping, dewatering, if required, protection measures for men, animals and vehicles, lanterns, fencing, sign boards etc.
- Laying pipes including cutting where necessary and including wastage.
- All labour, materials, equipments, tools necessary for laying and joining of pipes, excavation etc.

9.11.7 MODE OF MEASUREMENT:

The rate shall be per Rmt. Length of pipeline laid, jointed and tested as described in Specification. The measurement shall be taken along the centre line at the top of the pipeline passing over all joints, specials valves etc. Deductions shall be made for linear dimension occupied in fitting the valves. The tapers shall be measure for the larger diameter of the pipe.

9.12 CEMENT CONCRETE PIPES (NON PRESSURE):

9.12.1 MATERIALS:

(a) The concrete pipes of specified diameter and collars for these pipes shall conform to IS: 458 – 1988.
(b) Cement mortar shall be in proportion 1:1

9.12.2 EXCAVATION AND REFILLING:

The Specifications for excavation and refilling the trenches for laying Galvanized Iron pipes shall be followed

9.12.3 LAYING:

The pipes shall be laid to lines, levels, and slopes indicated in the drawings or as directed by the Consulting Engineers. The handling and laying of pipes shall conform to IS:783-1985. The joint shall be done as per IS: 83-1985.

9.12.4 RATE TO INCLUDE:

The rate shall include:

- Concrete pipes, collar, hemp yarn and cement mortar.
- Excavation, laying the pipes, joining, refilling the trenches, testing the pipelines.
- All necessary labour, materials and use of tools and equipments.

9.12.5 MEASUREMENT:

The rate shall be per Rmt. Of pipe laid. The measurement shall be net length of the pipe laid, measured along the centre line over the collars from end to end, between inside of two inspection chambers or manholes and over fittings on the centre line of the pipe line.

9.13 HDPE PIPES:

9.13.1 MATERIALS:

The diameter of the pipe and the tolerance in wall thickness shall be conforming to IS: 4984-1987 as mentioned in the item in Bills of Quantities. The pipes shall have wall thickness required to resist working pressure specified as per IS: 4984-1987. The pipes shall in all respect be with good finish surface, free from abrasions, straight and free from any swellings.

9.13.2 PACKINGS AT THE FLANGES JOINTS:

Packing shall be of asbestos (compressed) of standard make. The inside and outside diameter of the packing ring shall match the inside and outside diameter of the stub end. The thickness of the packing shall be 3mm. Such joints shall be used to provide isolating valves and to provide discontinuity in the pipe as specified.

9.13.3 METHOD OF JOINTS:

Following methods shall be used for welding and joining of HDPE pipeline installation work.

- The ends of pipes to be joined should be cut vertically at right angles with a fine toothed saw and trimmed with a file to make both ends smooth so that the pipes when pressed together do not leave any gap.
- Both the inside and outside surfaces of the ends of pipes should be scrapped (up to about 12 mm from the end) with a sharp scraper to remove the thin oxidized layer.
- To ascertain that there are no extraneous particles of dust, mud, grease, polyethylene powder etc. at the joining portions of the pipes.
- Pipes should be held firmly with the use of Mechanical Jack in horizontal position and with adjustment, perfect alignment and which is not affected when pipes are withdrawn from the HEAT MIRROR and again brought together for joining.
- A Electrical HEAT MIRROR (HOT PLATE) is to be used for heating the ends of pipes. The pipes should be pressed fresh against the flat surfaces of the HEAT MIRROR one on each side horizontally and held in position under slight pressure. The HEAT MIRROR should be maintained at a steady temperature of 200^0 C with the help of THERMOSTAT. After a slight rim is formed at the ends of the pipes on both inside and outside, of about 2.50 mm to 3.0 mm the pipes should be pulled apart and the HEAT MIRROR quickly withdrawn. Then the two ends of pipes should be brought together face to face so that the molten portions come in to contact with each other. Then the pipes should be drawn back very slightly (without separating the joined Molten portion) and then against the pipes should be pressed together with a moderate pressure of about 1 to 1.50 kg./cm^2. This ensures that the air bubbles are squeezed out. The pipes are to be held in that position until the pipe joints cools off naturally in atmospheric air. When a perfect joint is made, the rims cohere in such a way that there is only a very fine slight depression between the two rims. If the top surface of the rim is too flat, it will be because the pipe is overheated. If there is too much of depressions (groove) between rims, the pipe is under heated. The rims should not be cut off or erased from the joints. Also correct alignment of the pipes will help in joining the pipes perfectly as otherwise there will be reduction in the area of joining surface rendering the joint week and imperfect.

9.13.4 THERMOCRAYON CHALK:

This is small pencil like rod made of some chemicals. It can be used to detect whether the HEAT MIRROR has attained the requisite proper temperature. The HEAT MIRROR is slightly touched with the Thermocrayon chalk which leaves a thin blue layer on the Teflon coated surface of the HEAT MIRROR. The blue turns in to black within one second. If it becomes black sooner, it means that the HEAT MIRROR is over heated (above 200^0 C). If it takes longer than one second to become black means that the HEAT MIRROR is under heated (less than 200^0 C). Thermocrayon chalks suitable for detecting different temperatures are available (with some chalks the impression left on the HEAT MIRROR vanishes when appropriate temperature is attained).

9.13.5 HEAT MIRROR (HOT PLATE):

The equipment (handle type) consists of two metallic plates between which Electrical resistance wires capable of attaining a minimum temperature of 200^0 C are sandwiched. In between the plates, there is also asbestos sheet of mic insulation enclosing the Electrical wires. The metallic plates are covered with Teflon impregnated cloth, which withstands high temperature and will not allow molten ends of the pipes to stick on hot surface. (Instead of Teflon impregnated cloth, the plate can also be Teflon Coated) A handle (non-conductor of heat and electricity) is fitted to the metallic plates. The Electrical lead wires also pass out through the hollow handle.

9.13.6 MANUALLY HEATED HEAT MIRROR:

At places where Electrical energy is not available the HEAT MIRROR (with Teflon coating) can be used and the heating is done by applying flame of gas cylinder or kerosene operated blowlamp. In

this case, the two metallic plates will have a gap at about 35 mm (There will be no Electrical resistance wires in between). The flame is applied in the gap and the plates are thus heated from inside. When the plates have attained the proper temperature 200^0 C (which can be found with the help of Thermocrayon Chalk) butt-welding is carried out.

9.13.7 FLANGED JOINTS:

Where two pipes are required to be joined by using flanges, the following method is adopted.

The flange is slipped on one of the pipe and the PIPE-END (COLLAR) is butt-welded to that end of the pipe. The PIPE-END serves two purpose.

- It restrains the flanges, which is flush with the back surface of PIPE-END.
- The outer surface of the PIPE-END is plain, flat, serving as a base for the rubber gasket. Similarly PIPE-END and flange are fitted to the other pipe to be joined. A rubber gasket is to be used in between the two PIPE-END. The gasket should have a hole of the same size as the pipe and the surface same as that of the PIPE-END. After bringing the two PIPE-ENDS together, the flanges should be tightened by using bots and nuts. Since polyethylene flanges are liable to bend when bolts are tightened, use of metallic flanges, 6mm to 10 mm thick, in addition to polyethylene flanges is done. A metal flange is incorporated during molding stage of polyethylene flanges.

9.13.8 BENDING OF HDPE PIPES:

COLD BENDING:

Small diameter pipes can be “cold bend” for radius greater than 20 times the outside diameter of pipes. Cold bending should be done only for pipes for which the operating temperatures are ambient temperatures.

HOT BENDING:

Formation of small radius bend may easily be done by application of heat either by hot air oven or by immersion in a suitable liquid at an appropriate temperature. HDPE pipe should be heated in an inert liquid such as Glycerol (or other suitable oil in case of an emergency) at a temperature of 130^0 C. electrical heating coils or plates may also be used but only by experienced technicians.

In preheating operations, the low thermal conductivity of HDPE should be kept in mind. Overheating can usually be recognized by surface discolouration and distortion. On the other hand, bending operations should not be performed at very low temperature, because of excessive stress that could result . Naked flames for heating should be used only by experienced operations.

While bending, the bore of the pipe tends to collapse and these require support during the bending operation. Internal support should be affected by packing the bore of pipe with warm fine dry sand or by inserting rubber pressure hose, rubber rod, or a flexible spring. After the pipe is uniformly heated, it should be pulled around a simple jig and held in correct position until cool.

The radius of bend up to 50 mm dia. HDPE pipes should not be less than 5 times the outside diameter of pipe.

9.13.9 LAYING OF HDPE PIPE LINE:

- When installing pipes in or on buildings, it is best to use brackets with rounded edges or with soft plastic underlay. In the case of horizontally placed pipes, the clamps should be spaced at intervals of 15 to 20 times the outer diameter of the pipe. Any bends or corners must be able to expand or contract freely with varying weather conditions, HDPE pipes shall not be installed near hot water pipes or near any other heat sources.
- While installing the pipe in trenches, the bed of trench should be level and free from sharp edged stones; while laying in rocky area suitable bed of sand or gravel should be provided. The initial backfill about 100 to 150 mm above the pipes should fine sand or screened excavated material.

HDPE pipes are lighter than water. In marshy areas therefore, the pipeline must be evenly submerged with a blunt wooden fork (not with the edge of shovel) before the water logged trenches are filled-in. Sometimes it might even be necessary to increase the weight of the pipe with cement rings so that it will not float up from the bed.

9.13.10 HYDRAULIC TESTS:

For conducting hydraulic test (testing of pipe for pressure) the length of the pipeline being tested should not be more than 500m. The pressure required for testing the pipeline is obtained with manual or power driven hydraulic presses. Centrifugal pumps are not recommended as they cause water hammer, which can damage the joints or even burst the pipes.

Control valves shall be positioned "OPEN" for the duration of the test and open ends temporarily closed with watertight fittings. The testing pressure should not be less than one and a half times the rated pressure of pipe under use. Also care should be taken that at no time the test pressure is exceeded. The system should be slowly and carefully filled with water to avoid surge pressure or water hammer. Air vents should be open at all high points so that air will escape from the system during water filling.
When system is fully charged with water and air is displaced from the pipe, air vents should be closed; pressure may then be applied until the required test pressure is reached.

Due to low modulus of elasticity, pipe will expand and will result in initial fall of pressure even though there is no leakage. The amount of extra water required to build-up a steady pressure is normally termed as make up water. The time frame to build up steady pressure is approximately twelve hours.

9.13.11 MEASURMENTS AND RATE TO INCLUDE:

The measurements shall be in Rmt. Of pipes as laid. The rate includes cost of all materials including all fittings, accessories and including labour for fixing.

9.14 SANITARY WARES

9.14.1 WATER CLOSET – INDIAN PATTERN:

Water closets of Indian Pattern / Orissa shall be approved quality and sizes as specified in the Bills of Quantities. They shall be fitted with 'P' or 'S' trap of the same material and fixed in position and built round solid with burnt brick and cement masonry to level of the floor after all connections are made.

Masonry mortar shall be (1:6) cement mortar and concrete shall be (1:3:6) mix cement concrete of cement, sand and brick bats. Each W.C shall be provided with :

(a) 100 mm dia. C.I pipe outlet joined to vertical solid pipe with necessary accessories having cleaning facility outside of the walls.
(b) 63 mm dia. C.I antisyphon pipe to be provided from 1st floor and upper level floors and take up to 2 metre above terrace level. 32 mm dia. Lead / PVC connection should be provided from top of 'P' or 'S' trap of pan to antisyphon pipe.
(c) 32 mm. dia G.I. (B class) flushing pipe from the bottom of flushing cistern shall be connected to the head of W.C pan with necessary accessories.
(d) Flushing cistern shall be of PVC / ceramic as specified and shall be of approved make. Syphon used shall be of PVC/ceramic as specified in item. Cistern shall rest on C.I brackets with wall plugs and shall have brass/C.P Union and couplings for the 32 mm flushing pipe and with a chromium handle in the cistern.
(e) 15 mm dia PVC/G.I feed pipe to flushing tank, length not exceeding 450 mm and 15 mm diameter PVC/G.I over flow pipe from cistern up to 150 mm above finished floor level.

9.14..2 MEASUREMENT AND RATE TO INCLUDE:

The W.Cs shall be measured by numbers and paid for accordingly. The rate shall be inclusive of every item stated above (i.e. connection of 100 mm dia. C.I. pipe outlet to junction of soil pipe and connection of PVC vent pipe up to junction of vertical antisyphon pipe)

9.14.3 WATER CLOSET – EUROPEAN PATTERN:

The water closet of the European pattern shall be of white / colour glazed ware of approved make and floor mounted / wall mounted type as specified in Bills of Quantities and wash down pedestal type fixed on the flooring material. They shall be provided with plastic seat solid (hygienic type) and solid plastic lid with chromium plated brass bar hinge and fixed to the pan. These shall be provided with the same number of 100 mm. dia C.I outlet pipe, 63 mm C.I antisyphon, feed and over flow pipe as the W.Cs of the Indian pattern to the flushing cistern, which shall be low dons and shall be white/colured and PVC/ceramic type as specified in Bills of Quantities.

Cistern shall be of approved make and having capacity of 12 or 15 lit. with symphonic operated fittings including C.I bracket with three coats of enamel paint to match the walls.

9.14.4 MEASUREMENT AND RATE TO INCLUDE

These shall be measured and paid for in a similar manner as Indian W.Cs and the rate shall be for the water closets fixed complete on the inside up to the junction with vertical antisyphon and soil pipes.

9.14.5 WASH BASINS:

They shall be white/colour glazed of best and approved make of approved quality and of the size specified in the Bills of Quantities complete with 15 mm C.P. hot and cold approved make pillar cocks unless otherwise stated with at least 75 mm nose, 32 mm ida. C.P. brass waste coupling with rubber plug, C.P. brass bottle trap with extension piece, C.P. brass chain, C.I. white painted catilever brackets, and 32 mm dia G.I pipe (waste pipe) up to trap and 15 mm dia. PVC feed pipe and 15 mm brass stop cock complete. The rate shall include cost of all materials and accessories as mentioned above including fixing and shall be paid per unit/number.

9.14.6 SINKS

They shall be of best and approved Indian make of approved quality and of the size specified in the Bills of Quantities and of fire clay, porcelain/stainless steel having over flow arrangement complete with C.I cantilever bracket; 15 mm C.P bib cock, 38 mm C.P. waste plug and chain including 38 mm vertical portion of lead/PVC waste pipe and ‘P’ and ‘S’ trap. The rate shall include cost of all materials and accessories as mentioned above including fixing and shall be paid per unit/number.

9.14.7 UNRINALS:

It shall be white/colour glazed ware of approved make and type as specified in tender item, with auto cistern of specified capacity complete with 15 mm dia. PVC inlet pipe with brass union for cistern, 25 mm dia. C.P.brass main and 15 mm dia distributor for water inlet and 32 mm. dia. External C.P brass pipe work for waste pipe, C.I brackets for cistern, C.P. brass screw etc. complete. The rate shall include cost of all materials and accessories as mentioned above including fixing and shall be paid per unit/number.

10.0 **MISCELLANEOUS:**

10.1 ANTI-TERMITE TREATMENT:

10.1.1 GENERAL:

This Specification covers the anti-termite treatment to foundations and woodwork.

10.1.2 SCOPE OF WORK:

The contractor shall treat the foundation trenches, soil for back filling the trenches, rammed earth surface under plinth and all wood work coming in contact with wall or flooring as per drawing and Specifications.

10.1.3 SPECIFICATIONS:

The contractor shall use the following chemicals as insecticides for the treatment; the chemical emulsion shall be prepared as under using water :

Chemicals	Concentration.
Aldrin	0.5% by weight
Chlordane	1.0 by weight.
Haptachlor.	0.5% by weight.
Chloropyrifos.	As per manufacturers Specification

10.1.4 METHOD OF APPLICATION:

Stages of treatment shall be as under:

A - Bottom and sides of trenches (up to ht. of 300 mm from the bottom)
B - Backfill in immediate contact with masonry foundations.
C - Junction of floor and wall.
D - Top surface of plinth filling
E - External perimeter of building.
F - Soil below apron.

Quantity of Chemical solution to be used (one litre of chemical to be mixed in 19 litres of water).

Stage – A 5 litrs. Per Smt. of surface are to be treated.

Stage – B 7.5 litrs. Per Smt. of the vertical surface of the sub structure for each sid.

Stage – C A small channel of 30 mm x 30 mm shall be made at the junction of wall and columns with floor holes are made in channel by iron rods 150 mm apart and chemical emulsion poured along the channel at a rate of 7.5 litrs. Per Smt. of the vertical wall or columns surface so as to soak the soil right to the bottom.

Stage – D 5 litres per Smt. of the surface before the sand bed or sub-grade is laid. This is required to treat the top surface of the consolidated earth within plinth wall.

Stage – E After the building is complete, the earth along the external perimeter of the building should be rodded at intervals of 150 mm and to a depth of 300 mm (or full depth of filling). The chemical emulsion to be poured along the wall at a rate of 7.5 litres per Smt. of the vertical surface.

Stage – F 5 litres per smt. of the vertical surface before the apron is laid. The top surface of the consolidated earth over which the apron is to be laid shall be treated with the chemical solution at a rate of 5 litres per Smt.

10.1.6 ANTITERMISTE TREATMENT FOR BASEMENT WALLS, RETAINING WALLS ABOVE FLOOR LEVEL:

The soil retained by the walls shall be treated at a rate of 7.5 litres per sq. mtrs. Of the vertical surface so as to effect a continuous outer chemical barrier.

10.1.7 ANTI-TERMITE TGREATMENT AT EXPANSION JOINTS:

The expansion joint shall be treated at a rate of 2 litres of solution per linear metre. This treatment should be supplemented by treating through the expansion joint after the sub-grade has been laid.

10.1.8 SPRAYING EQUIPMENT:

A pressure pump shall be used to carry out spraying operations to facilitate proper penetration of chemicals into the earth.

10.1.9 RATE TO INCLUDE:

Payment for anti-termite treatment shall be on the basis of sq.m. of the area of plinth.

10.2 PAINTING:

10.2.1 GENERAL:

The surface shall be thoroughly rubbed with sand paper to make it free from mortar and foreign matters. All steel work shall be cleaned of loose rust, mill-scale etc. so as to expose the original surface. All broken edges, cracks, loose plaster and wavy surface shall be brought up either by patch plaster work or Plaster of Paris.

All material viz dry distemper, oil bound distemper, oil paint, flat oil paint, synthetic enamel paint, plastic emulsion paint, acrylic emulsion, cement primer, yellow zinc chromate, red lead and other primers and metallic paints shall conform to respective Specifications of BIS and shall be obtained from approved manufactures. All paints shall be brought on site in sealed tins in ready mixed form and shall be applied direct with the addition of thinner, if recommended by the manufacturers.

Note : For all types of painting work, if the smooth and uniform finish is not obtained by applying a number of coats mentioned in the Bills of Quantities, contractor has to apply additional coats to achieve smooth and uniform finish without any extra cost.

10.2.2 PAINTING –OIL/ENAMEL/PLASTIC EMULSION:

Ready mixed oil paint, flat oil paint, plastic emulsion paint, 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 Architect shall be used.

The surface shall be prepared as specified above and a coat of approved primer shall be applied. After 24 hours of drying, approved or specified quality paint shall be applied evenly and smoothly. A filler putty coating may be given to give a smooth finish. Each coat shall be allowed to dry out thoroughly and then lightly rubbed down with sand paper and dust cleaned off before the next coat is applied. Number of coats shall be as specified in the item and if the finish of the surface is not uniform, additional coats are 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 comers of panels, angles mouldings, etc. shall be left on the work. The glass panels, 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 stippled with a stippling brush.

10.2.3 RATE TO INCLUDE:

Payment shall be made on square meter basis. Rate shall include cost of all materials and labour involved in all the above operations. Deductions for voids shall be measured as per clause give under Specification for plastering.

The rate quoted shall include cost of all materials, spray pump, tools, tackles and accessories, all labour, storing facilities of paints as approved by Owner/competent authorities, license if required etc. complete.

10.2.4 DRY DISTEMPER:

Shade shall be got approved from the Architects before application of distemper.

The surface shall be prepared as specified above. The prepared surface shall receive 4 coats of dry distemper wash; at first whit wash shall be evenly applied and scrapped off when dry.

A primer coat using approved primer or sizing shall be applied. Distemper prepared as per manufacturers direction shall be applied in 3 coats, each coat shall be allowed to dry before subsequent coat is applied. The finished surface shall be even, uniform when rubbed and shall show no brush marks. If additional coats are necessary to get even and uniform surface, they shall be given at no extra cost.

Measurement shall be taken and paid as specified in painting item.

10.2.5 OIL BOUND DISTEMPER:

The surface shall be prepared as specified above and shall receive 4 coats as specified below.

A primer coat of either cement primer or and approved distemper primer shall be applied. After the primer coat has dried, the surface shall be lightly sand papered and dusted to make it smooth to receive distemper.

Distemper shall be prepared as per the direction of manufacturer and conforming shade approved. It shall be applied in 3 coats, taking care to allow for drying of each coat before subsequent coats are applied. Measurement shall be taken and paid as specified in painting item.

10.2.6 WATER PROOF CEMENT PAINT:

The surface shall be prepared as specified above and thoroughly wetted with clean water before water proof cement paint is applied.

The paint shall be prepared strictly as per manufacturers Specifications and in such quantities as can be used up in an hour of its mixing, as otherwise the mixture will set and thicken, adversely affecting glow and finish.

The paint thus prepared shall be applied on clean and wetted surface with brush or spraying machine. The solution shall be kept stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so that the direct hear of the sun on the surface is avoided. The completed surface shall be watered after the day's work, for seven days. Number of coats shall be as specified in the item.

10.2.7 ANTI – CORROSIVE BITUMINOUS PAINTS:

Anti corrosive Bituminous Paints shall conform to IS: 158-1968.

TANK MASTIC:

Usage : Tank Mastic is an anti-corrosive non-contaminating black bituminous paint, for protecting the internal surfaces of Fresh Water Tanks, Pipes, Fluid containers, concrete surface etc. against severe corrosive conditions.

It shall be used particularly, where periodic inspection and recoating present no undue difficulties.

PREPARATION OF SURFACE:

The surface shall be prepared as described earlier.

APPLICATION FO PAINT:

Tank Mastic, of a paint like consistency shall be applied on surface by brush or spray which dries rapidly with glossy black finish. It shall be applied strictly in accordance with instructions to get resultant film tough and elastic and to impart neither taste nor taint to contents of tank. The surface to be coated shall be clean and free from moisture.

The solution shall be stirred well before applying and clean brushes shall be used. While applying, adequate ventilation shall be allowed. The first coat shall be thoroughly set before applying a

second coat. When the final coat has dried out, the surfaces shall be flush down with clean cold water before putting into commission.

Brushes shall be kept clean and free from oil and grease. They shall be immersed in clean cold water to keep them soft during intervals in application.

Notes : Drying time and covering capacity vary according to nature of surfaces, ventilation etc.

10.2.8 CHLORINATED RUBBER PAINTS:

These shall be of approved quality and make.

USAGE:

The chlorinated rubber paint is used to protect steel structures against the corrosive action of smoke and fumes.

SURFACE PREPARATION: It shall be as described earlier.

APPLICATION

Three coats of paint shall be applied by brush and spraying shall not be done. Brushing shall be done fairly quick and over brushing shall not be done. A minimum of 24 hours shall be allowed between coats, although it dries to touch within one hour. The final coat should be allowed to dry 72 hours before painted object is brought into use.

10.2.9 HEAT RESISTING PAINTS:

It shall be of approved quality and make.

USAGE :

The paint is applied on combustible materials like wood particleboard etc. and it retards the spread of flame. It is not a decorative paint. It shall be used where decorative effect is not required.

APPLICATION

Two coats of the paint shall be applied to soft wood by brush keeping inter coat interval of 24 hours between successive coats. If for any reason thinner is necessary the brand and quantity of thinner recommended by the manufacturers or as instructed by Consulting Engineer shall be used. It shall be applied to bare wood.

10.2.10 EPOXY PAINT :

USAGE:

The epoxy paints are recommended for painting steel fabric, plant and equipment subjected to chemical environments or handling chemical agents, particularly where contact with chemicals is envisaged. They are also suitable for coating steel plant and equipment handling solvents, oil, grease or weak acids and plaster, concrete and facia brickwork where regularly clean surface is required.

SURFACE PREPARATION: It shall be as described earlier.

APPLICATION:

Immediately before use the base and accelerator shall be mixed in the recommended proportion and allowed to stand for one hour, restirred and then got ready for use. The mixed paint shall be used within about six hours of the initial mixing and this time is known as the pot life. For this reason it is essential that only sufficient paint which is sure to be used up within the above period shall be mixed at a time.

After mixing the components in the recommended proportion, any thinning which is considered necessary shall be done with the recommended Epoxy thinner.

Epoxy paints, actually dry in 4-6 hours but over coating shall be done only after 24 hours of drying.

Curing of epoxy coating to show optimum results, and this being a chemical reaction, depends of the environment temperature.

SPECIFICATIONS FOR DIFFERENT SURFACES :

(i) New Steel :

Shot blast to clean original base, prime immediately with epoxy two pack red oxide zinc chromate primer and finish with 2 or 3 coats of epoxy two pack enamel depending on the anticipated service condition.

Where shot blasting is not feasible, preparation of surface by use of pneumatic tools, and scraping and wire brushing, though not ideal, is recommended. Low standard cleaning affects durability of epoxy coats.

(ii) New Galvanized steel and aluminium:

Degrease solvent and clean the surface free of contaminants.

Prime with etching primer preferably after a simple pre-treatment with wipe off pre-treatment solution.

(iii) Aluminium Alloy, Copper, Brass, Gunmetal and Lead:

Degrease with solvent, and clean the surface free of contaminants. The surface shall be rubbed down with abrasive paper and coated with etching primer to be followed by a coat of Epoxy two-pack red oxide zinc chromate primer. Then the surface shall be finished with 2 coats of epoxy two- pack enamel.

10.2.11 All painting work shall be measured in square metre. Net area of the surface painted shall be measured. No deduction will be made for unpainted surface of ends of joints, beams, posts, etc. and openings not exceeding 0.5 sq.mts each and no addition shall be made for reveals, joints, soffits, sills, etc. of these openings. The multiplying factors for obtaining equivalent areas shall be as per IS;1200 – Parts XIII & XV.

10.2.12 Corrugated Sheet surfaces shall be included with plain surfaces after increasing their areas by the following percentages :

(a)	G.I. Corrugated Sheets	14%
(b)	Asbestos Cement Sheets – Corrugated	20%
(c)	Asbestos Cement Sheets – Semi – Corrugated	10%

10.3 POLISHING & VARNISHING:

10.3.1 FRENCH POLISHING:

French spirit polish shall be of an approved make conforming to IS: 348. If it has to be prepared on site, the polish shall be made by dissolving 0.7g of best Shellac in 4.5 litres of methylated spirit without heating. To obtain required shade, pigment may be added and mixed.

Surface shall be cleaned. All unevenness shall be rubbed down smooth with sand paper and well dusted, Knots, if visible, shall be covered with a preparation of red lead and glue. Resinous or loose knots and gaps shall be filled with seasoned timber pieces and made level with rest of the surface. Holes and indentations on surface shall be filled with putty made of whiting and linseed oil. Surface shall be given a coat of filler made of 2.25 kg. of whiting in 1.5 litres of methylated spirit. When it dries, surface shall again be rubbed down perfectly smooth with sand paper and wiped clean.

Piece of clean fine cotton cloth and cotton wool made into shape of pad shall be used to apply polish. The pad shall be moistened with polish and rubbed hard on the surface applying the polish sparingly but uniformly and completely over the entire surface. It shall be allowed to dry and another coat applied in the same way. To give finishing coat, the pad shall be covered with a fresh piece of clean fine cotton cloth, slightly damped with methylated spirit and rubbed lightly and quickly with a circular motion, till the finished surface attains uniform texture and high gloss.

10.3.2 WAX POLISHING:

Wax polish shall either be prepared on site or obtained readymade from market. Polishmade on the site shall be prepared, from a mixture of pure (bees) wax, linseed oil, turpentine oil and varnish in the ration of 2:1 ½ :1:1/2 by weight. The bee's wax and the boiled linseed oils shall be heated over 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 proportion and the entire mixture is well stirred.

Surface shall be prepared as described under 'French Polishing' except that the final rubbing shall be done with sand paper, which has been slightly moistened with linseed oil.

Mixture or 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 an hour or until the surface is dry. Final coat shall then be applied and rubbed for two hours or more if necessary, until the surface has assumed a 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.

10.3.3 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, and additional coat shall be applied without any extra cost.

10.4 WHITE WASH

White wash shall be prepared from lime slaked on spot, mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for 24 hours and shall be screened through clean cloth. The approximate quantity of water to be added in making cream shall be five litres per kg. of lime; 125 gm Fevicol DDL shall be dissolved in 10 litres of lime slurry. Blue shall be added to give required whiteness. White was shall be applied in specified coats by using flat brushes or spray pumps. Each coat shall be allowed to dry before next coat is applied. If additional coats, more than what have been specified, are necessary to obtain uniform and smooth finish, the same shall be provided at no extra cost.

The finished surface shall not show any signs of cracking and peeling nor shall it come off readily on the hand when rubbed.

10.4.1 COLOUR WASH:

Colour wash shall be prepared by adding mineral colour to lime slurry. No colur work shall be done until samples of the colour wash to the required tint or shade have been got approved from the Architect.

Colour wash shall be applied as specified under white was item.

10.5 GLAZING:

(I) All glass shall be cut to size accurately and neatly to suit all openings to be glazed with a slight margin of about 2 to 4 mm on all sides as directed.

(II) All glass shall be back putted and externally putted up the line of the casement and filling the rebate.

(III) Glazing to steel doors and windows shall be done in compliance with the supplier's instructions, using the clips and the bends supplied.

(IV) Glass in wooden doors and casements shall be springed in position after fixing with back putty.
(V) Broken glass shall be neatly removed and replaced at the contractors expenses.
(VI) Where indicated in the Bills of Quantities, glass shall be beaded with approved beading, properly fixed and primed.
(VII) Edges of glass louvers shall be grounded and left free from any sharp edges.
(VIII) In the case of T.W beading or other specified beading, the putty shall be applied full in line all around the windows in back, in between beading and glass and shall be of same colour as that of the windows of beading.

Notes: The work mentioned in this section shall be measured separately only in cases where it is distinctly specified in the Bills of Quantities

10.6 EXPANSIONS JOINT:

10.6.1 Expansion joints to be provided shall be of 24 gauge G.I. sheet strips of 400 mm width at location shown on drawing or as approved by the Engineer. The G.I. Strip shall be bent to the shape indicated on drawing and embedded properly in concrete. The joint width shall be uniform throughout and special care shall be taken to ensure proper concreting at expansion joints. Expansion joints shall be continuous and where two or more G.I sheets meet, they shall be lapped to the extent of 75 mm and joints properly soldered. The expansion joints shall be filled with pre-moulded joint fillers and sealed with mastic compound. For the purpose of measurement, the laps provided shall be neglected.

Metal or tarfelt flashings shall be fixed as directed by the Engineer. Metal flashings provided shall be welded to obtain continuity. Pre-mould joint fillers shall be of Shalitex sealing compound.

10.6.2 Expansion joints in flooring, foundations and all structures shall be formed in the positions and to the shapes shown in the relevant drawings. When joints are to be filled with joint filling materials as stipulated in the drawings the permanently exposed edges of joints shall be sealed with an approved sealing compound.

Joint filling material shall consist of 25 mm thick impregnated fibre board of the approved make with expansion joint fillers and its equivalent approved quality sealing compound shall be used.

Payment shall be made on SMT basis of the board as laid finally. The rate shall include the cost of preparing the surfaces, fixing and finishing with sealing compound.

10.7 WATER PROOFING (ROOF):

10.7.1 WITH BITUMEN FELT:

(i) MATERIAL

(a) Bitumen primer of approved quality and make shall be used in work and shall conform to IS: 3384-1965.
(b) Special roofing asphalt blown grade shall conform to IS:702 – 1955 and shall be of approved make.
(c) A fibre base water proofing felt and Hessian base felt type 3, grade 1 shall conform to IS: 1322-1970.

(ii) PREPARATION OF SURFACES:

The surfaces shall be dry, free from dust, dirt, oil and other foreign material.

(a) Five layer treatment consisting of the following:
- A layer of cold bituminous primer at a rate of 400 gms per smt.
- A layer of special roofing asphalt (Hot) at a rate of 1.2 Kg. per square metre.
- A layer of bitumen felt Hessian base self finished type 3, grade 1 of approved makes. Minimum lap at the ends and sides of felt shall be 100 mm and 75 mm respectively and joints shall be sealed properly with bitumen.

- A layer of special roofing asphalt (Hot) at a rate of 1.2 Kg. per square metre.
- A layer of pea size gravel of 6 mm down size at a rate of 0.0006 cms per square metre.

(b) Seven layer treatment consisting of the following :

The first four layers shall be same as the first four layers stated above in five layers treatment. The other layers shall be :

- Apply second layer of Hessian based self finished tarfelt, with minimum 100 mm and 75 mm lap at end and sides of strips.
- A layer of special roofing asphalt (Hot) at a rate of 1.2 Kg. per square metre.
- Apply final layer of pea gravel of 6 mm down size at a rate of 0.0006 Cmt./Smt.

The contractor shall give guarantee against any leakage, and rectify any defectg in water proofing, as mentioned in Bills of Quantities.

(iii) RATES TO INCLUDE:

Rates for water proofing shall include following:

(a) Preparatory work shall be as per IS: 3067.
(b) Treatment of gutters and drain mouths.
(c) Treatment of main roof, flat or sloping.
(d) Treatment of flashings and projecting pipes.
(e) Cost of fuel required for heating bitumen up to required temperature and transporting all materials at site of work.
(f) All water proofing work to be carried out as per IS; 1346.
(g) Making Zari in walls if required for flashin.

(iv) MEASUREMENTS:

Only superficial area will be measured and paid and n extra claim for laps, gutters, drain mouth, flashings and projecting pipes etc. will be considered for payment.

10.7.2 WITH FIBREGLASS TISSUE:

(i) MATERIAL:

(a) Bitumen primer and Bitumen (special roofing asphalt) shall be as specified in waterproofing roof with Bitumen felt item.
(b) Fibre glass R.P.Tissue shall be of M/s Fibre Glass Pilkington Ltd. Or approved make with the flowing properties.

Weight	50 gm/smt
Thickness	0.5 mm
Tensile strength in longitudinal Direction	3.2kg/cm^2

(c) The tissue shall not fail in hot bitumen at 300 degree C temperature for one minute.
(d) Pea size gravel/coarse sands.

(e) The tissue shall not fail in hot bitumen at 300 degree C temperature for one minute.
(f) Pea size gravel/coarse sands.
(g)

(ii) PREPARATION OF SURFACE:

The surface shall be dry, free from dust, dirt oil and other foreign material.

(iii) Specification of two layers of fiberglass Tissue shall consist of the following :

(a) A layer of cold bituminous primer at a rate of 400 Gms. Per Smt.
(b) Apply first coat of hot bitumen at the rate of 1.8 Kg./Smt.
(c) Embed first layer of Fibreglass Tissue. The minimum over lapping joints at the ends and sides of the strip of tissue shall be 100 mm and 75 mm respectively. All the laps shall be firmly bonded with hot bitument.
(d) Apply second coat of hot bitumen at the rate of 1.8 Kg/Square metre.
(e) Embed second layer of fiberglass Tissue with minimum over laps as stated in 1st layer.
(f) Apply third coat of hot bitumen at the rate of 1.8 kg/smt.
(g) A layer of pea size gravel of 6 mm thickj or coarse sand shall be embedded at the rate of .006 m^3/m^2 into the hot bitumen while it is being poured by applying minimum pressure.

(iv) Specification of three layer of fiberglass tissue:

Three layers of Fibreglass Tissue consisting of the following (a) to (f) shall be same as in 10.7.2(iii).

(a) Embed third layer of Fibreglass Tissue.
(b) Apply fourth coat of hot bitumen at the rate of 1.8 kg/smt.
(c) A layer of pea size gravel or coarse sand shall be embedded at the rate of 0.006 m^2/smt into the hot bitumen, while it is being pured by applying minimum pressure.

(v) Specification for four layer of fiberglass tissue:

Four layers of Fibreglass Tissue consisting of the following:

Layers (a) to (h) shall be are same as in 10.7.2 (iv)

(i) Embeded fourth layer of fiberglass and Bitumen at the rate of 1.8 kg/smt.
(j) Apply pea size gravel as per (i) of 7.2 (iv)

(vi) FOLLOWING CARE SHALL BE TAKEN:

(a) The joints in Fibreglass Tissue between successive layers shall be staggered midway.
(b) Required length of Fibreglass Tissue shall be cut and rolled before commencing the work.
(c) In case of A.C Sheets/G.I sheets all nuts and bolts shall be properly tightened and wherever necessary the old sheet should be replaced. The sheet overlaps shall be first caulked with a suitable bituminous sealing compound.

10.7.3 WITH CHINA MOSAIC:

The surface to be water proofed shall be cleaned thoroughly and shall be free from oil and other foreign materials. Prepared surface shall receive the following treatment.

(i) The first four layers shall be same as stated above for five layers treatment in Para 10.7.1
(ii)
(ii) A layer of B.B.L.C (Brick Bat Lime Concrete) of specified thickness shall be laid over tarfelt to the required slope as shown in drawing. Proportion of B.B.L.C shall be 2 parts of brickbat and one part of lime mortar (1:2)) i.e 1 part of lime and 2 parts of sand). After 48 hours of laying of B.B.L.C., a bedding of loime mortar (1:2), 18 to 25 mm thick shall be provided and on top of this layer, 10 mm thick neat cement grout shall be provided, immediately on application of cement grout, assorted pieces of coloured glazed china previously soaked in water shall be set closely on the fresh surface and properly tamped to get the required top surface. The surface after completion of work shall be cleaned with sawdust or with diluted acid, if directed by Engineer-in-Charge. The finished surface shall

be cured for 10 days. If so directed by the Engineer, a border colour of white mosaic shall be provided, without any extra cost. Tarfelt, brickbat coba and china mosaic shall be taken up the parapet walls to a height of 100 – 150 mm. Necessary vatas shall be provided towards drain as directed.

(iv) Measurement shall be in square metres correct to two decimal places. Length and breadth of the actual laid area shall be measured and paid. No extra shall be paid for vatas and work carried over parapet.

10.7.4 CEMENT BASED WATER-PROOFING FOR TERRACES:

The work shall be executed by an experienced agency and shall be guaranteed for the period as mentioned in the Bills of Quantities. Waterproofing material used shall be of approved manufacturers and shall be used according to the manufacturers Specification.

(i) Area shall be cleaned of all loose materials and shall be treated with neat cement slurry and mixed with water proofing compound to seal the cracks, pores, etc. appearing on the surface.

(ii) After the slurry coat a layer of new well burnt brick bats shall be laid in cement mortar (1:3) admixed with water proofing compound. This shall be laid in a proper slope. The brickbat joints shall be filled up to half the depth. Coving shall be done at all joints of slab and brick walls, inverted beams etc. Minimum high to coving shall be 300 mm. Brick Bat layers shall be cured for 3 days.

(iv) A coat of cement slurry admixed with water proofing compound shall be applied to the brick bat layer.

(v) A layer of cement mortar (1:3) with water proofing compound shall be applied on the second slurry coat and joints of brick bat layer shall be filled up completely to give a finished plain surface.

(vi) Finally a top layer 20 mm thick of cement mortar (1:3) admixed with water proofing compound shall be laid and finished smooth with cement slurry, admixed with water proofing compound. The finished surface shall be marked with boarder and chequered marks 300 mm x 300 mm to give good appearance.

(vii) The finished surface shall be cured for 10 days by ponding water over it. The drain openings shall be closed during curing period and shall be opened out as soon as the curing period is over.

(viii) The average thickness of this treatment shall be 115 mm.

(ix) The measurement shall be in square meters correct to two decimal places. Length and breadth of the actual laid area shall be measured and paid. Coving shall also be paid in Smt. basis.

10.7.5 TAPECRETE WATER PROOFING TREATMENT:

The surface shall be cleaned of loose materials, dust oil, grease etc. The surface shall be cleaned by grinding, water blasting, sand blasting, and acid washing, if required.

(i) Mixing should be carried out with puddle type mixers operating at low rates of rotation. Rotations should not exceed 360 RPM to prevent aeration of mixes.

(ii) All concrete surfaces shall b thoroughly pre-wetted for at least one hour prior to the application of Tapecrete coatings. When placing Tapecrete coating, all water shall be removed so that surface is only damp. In no case there shall be standing water or a shiny wet surface. Tapecrete polymer is mixed with neat cement in the ratio of 100 kg. of cement to 52 kg. of Tapecrete. The mix has to be applied by brush on prepared surface. Two or more coats are to be done. First coat should be allowed to dry for 5-y6 hours.

(iii) Tapecrete system is cured by air-drying. It must be protected from rain during the first 12 hours of curing. No foot traffic is allowed on any tapecrete work within 12 hours of application and no vehicular traffic is allowed within 48 hours.

GENERAL TECHNICAL SPECIFICATION ELECTRICAL WORKS
APPLICABLE STANDARDS

Following IS Specifications, Standard and rules will be applicable.

Sr. No.	IS No.		Description
1)	IS:2026-1977	:	Distributing transformers & fittings.
2)	IS:7886/ IS:660	:	Installation of Transformer.
3)	IS:2516-1972	:	Specification for AC circuit breakers.
4)	IS:335	:	Insulating oil for Transformers & switch gear.
5)	IS:2705	:	CT for measuring and protection.
6)	IS:3155	:	Voltage (Potential) Transformers.
7)	IS:3236 Part II	:	Voltage Transformer.
8)	IS:373	:	Bus bar arrangement and marking.
9)	IS:2099	:	Bushing
10)	IS:5621	:	Large Hollow Porcelains
11)	IS:2544	:	Insulators
12)	IS:2629 & 2633	:	Hot Dip Galvanizing
13)	IS:3842	:	Relays.
14)	IS:1248-1958	:	Meters (measuring).
15)	IS:3072-1975	:	Installation of Switch gears.
16)	IS:692	:	HV cable.
17)	IS:1255	:	Installation of HV cables and jointing.
18)	IS:3043	:	Code of practice for earthing.
19)	IS:4047-1977	:	H.D. Air breaker, Switch gears and fuses or Voltage not exceeding 1000 volts.
20)	IS:8106-1966	:	Selection, installation and maintenance of fuses up to 650 Volts.
21)	IS:4237-1967	:	General requirements for switch gear & control gear for voltage not exceeding 1000 Volts.
22)	IS:2607-1976	:	Air-break isolators for Voltage not exceeding 1000 Volts.
23)	IS:8623-1977	:	Factory built assemblies of switch gears and control gears for voltage up to and including 1000 Volts A.C. and 1200 Volts D.C.

24)	IS:375-1963	:	Marking and arrangement of switch gear bus bars main connectors and auxiliary wiring.
25)	IS:2147-1962	:	Cubical Boards.
26)	IS:8084-1972	:	Insulated conductor rating.
27)	IS:2675-1983	:	Enclosed distribution fuse boards and cutouts for Voltage not exceeding 1000 Volts.
28)	IS:8828-1978	:	Miniature Circuit Breaker.
29)	IS:9926-1981	:	Fuse wire used in re-wearable type electric fuses up to 650 V.
30)	IS:1554 (PART I)	:	PVC insulated electric cables. Heavy duty.
31)	IS:3961(PART II)	:	Recommended current rating for cables.
32)	IS:2982	:	Copper conductor in insulated cables and cores.
33)	IS:8130	:	Conductor for insulated electric cables and flexible cords.
34)	IS:3975	:	Mild steel wires, strips and tapes for armoring cables.
35)	IS:5831	:	PVC insulation and sheath of electric cables.
36)	IS:1753	:	Aluminum conductor for insulated cables.
37)	IS:4288	:	PVC insulated and PVC sheathed solid aluminum conductor cables of voltage rating not exceeding 1100 Volts.
38)	IS:961	:	Recommended current rating for Cable.
39)	IS:732	:	Code of practice for electrical wiring installation system Voltage not exceeding 650 Volts.
40)	IS:1646	:	Code of practice for fire safety of Buildings(general) electrical installation.
41)	IS:1653	:	Rigid steel conduits for electrical wiring.
42)	IS:2667	:	Fittings for rigid steel conduits for electrical wiring.
43)	IS:3480	:	Flexible steel conduit for electrical wiring.
44)	IS:3837	:	Accessories for rigid steel conduits for electrical wiring.
45)	IS:694	:	PVC insulated cables (wires).
46)	IS:2509	:	Rigid non-metallic conduits for electrical wiring.
47)	IS:6946	:	Flexible (playable) nonmetallic conduits for electrical installation.
48)	IS:1293	:	Three pin plugs and sockets.

49)	IS:8180	:	Conductors for insulated electrical and flexible codes.
50)	IS:9537-1980	:	Specification for conduit for electrical installation.
51)	IS:3419	:	Accessories for non-metallic conduits for electrical wiring.
52)	IS:3854	:	Switches.
53)	IS:6538	:	Plugs.
54)	IS:2834-1954	:	Shunt Capacitors for power systems.
55)	IS:2208	:	HRC cartridge fuse and links upto 660 volts.
56)	IS:1913-1969	:	General and safety requirement for Lighting fittings.
57)	IS:2944-1981	:	Code of practice for lighting public thorough fares.
58)	IS:3528	:	Waterproof electric lighting fittings.
59)	IS:3553-1966	:	Water tight electric lighting fitting.
60)	IS:1239-1958	:	Mild Steel tubular and other wrought steel pipe fitting.
61)	IS:2149-1970	:	Luminaries for street light.
62)	IS:9224	:	HRC fuses having rupturing capacity of 90 KA.
63)	IS:2312-1967	:	Exhaust Fan.
64)	IS:374-1979	:	Class I Ceiling Fan.

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

GENERAL TECHNICAL SPECIFICATION FOR ELECTRICAL WORKS

A CSS

PRE-FABRICATED COMPACT SUB STATION (11/0.433 KV, 1000 KVA)

1.0.0 **CODE & STANDARDS**:

1.1.0 All equipment and material shall be designed manufactured and tested in accordance with the latest applicable IEC standards. The 12KV Pre-fabricated Sub-station (PSS) Design must be as per IEC 61330.

1.2.0 The Pre-fabricated Sub-station (PSS) offered shall in general comply with the latest issues including amendments of the following standards.

Title	Standards
High Voltage Low Voltage Pre-Fabricated Substation	IEC:61330
High Voltage Switches	IEC 60265
Metal Enclosed High Voltage Switchgear	IEC 60298
High Voltage Switchgear	IEC 60694
Low Voltage Switchgear and Control gear	IEC 60439
Power Transformers	IEC 60076

2.0.0 **DESIGN CRITERIA**

2.1.0 Pre-fabricated Sub-station (PSS) consisting of **11KV SF6 Ring Main Unit + Transformer + Low Voltage Switchgear** with all connection accessories, fitting & auxiliary equipment in an Enclosure to supply Low-voltage energy from high-voltage system as detailed in this specification. The complete unit shall be installed on a substation plinth (base) as **Outdoor substation**. 11KV vacuum circuit breaker controls incoming-outgoing feeder cables of the 11KV distribution system and shall be used to control and isolate the 11kV/433V Distribution transformer. The transformer Low Voltage side shall be connected to Low Voltage switchgear. The connection cables to consumer shall be taken out from the Low Voltage switchgear. **PAD mounted substation is NOT acceptable.**

2.2.0 The Pre-fabricated Sub-station (PSS) shall be designed for a) Compactness, b) fast installation, c) maintenance free operation, d) safety for worker/operator & public.

2.3.0 The Switchgear and component thereof shall be capable of withstanding the mechanical and thermal stresses of short circuit listed in ratings and requirements clause without any damage or deterioration of the materials.

2.4.0 For continues operation at specified ratings temperature rise of the various switchgear components shall be limited to permissible values stipulated in the relevant standard and / or this specification.

2.5.0 **Service Conditions**:

The prefabricated substation shall be suitable for continuous operation under the basic service conditions indicated below

Ambient Temperature: 50 Deg C
Relative Humidity upto 95%
Altitude of Installation upto 1000m

The Enclosure of High Voltage switchgear-control gear, Low Voltage switchgear-control gear & Transformer of the Pre-fabricated Sub-station (PSS) shall be designed to be used under **normal outdoor service condition** as mentioned. The enclosure should take minimum space for the installation including the space required for approaching various doors & equipment inside.

2.6.0 The bidder should have manufacturer/official representative of Manufacturer of PSS

3.0.0 **SPECIFIC REQUIREMENT**

3.1.0 The main components of a Pre-fabricated Sub-station (PSS) are Transformer, High-voltage switchgear-control gear, Low-voltage switchgear-control gear and corresponding interconnections (cable, flexible, busbars) & auxiliary equipment. The components shall be enclosed, by either common enclosure or by an assembly of enclosure. All the components shall comply with their relevant IEC standards.

3.1.1 **Ratings**:

Description	**Unit**	**Value**
Rated Voltage / Operating Voltage	kV rms	11
Rated frequency & Number of phases	Hz & nos.	50 & 3
Rated maximum power of substation	kVA	1000 kVA
Rated Ingress protection class of Enclosure	IP:	IP23
Rated temp Class of Transformer Compartment		K10
HV Insulation Level		
Rated withstand voltage at power frequency of 50 Hz	kV rms	28
Rated Impulse withstand Voltage	kV peak	75
HV Network & Busbar		
Rated current	Amp	400A
Rated short time withstand current	kA rms / 1sec	21
Making capacity for switch-disconnector & earthing switches	kA peak	52.5kA
Breaking capacity of Isolators (VCB) (rated full load)	A	400A
LV Network		**As per Bill of material attached Annexure**

OUTDOOR ENCLOSURE

3.2.0 **Outdoor enclosure**:

3.2.1 The enclosure shall be made of Sheet Steel tropicalised to local weather conditions.

3.2.2 The protection degree of the Enclosure shall be IP54 for LT & HT switchgear compartment & IP23 for Transformer compartment**.** Proper / adequate ventilation aperture shall be provided for natural ventilation by way of Louvers etc.

3.2.3 The doors shall be provided with proper interlocking arrangement for safety of operator.

3.2.4 The H.V. & L.V. of the transformer are to be connected to Vacuum Circuit Breaker of RMU & incomer of the Low Voltage Switchgear by means of Cables / Busbars.

3.2.5 **Internal Fault**: Failure within the Pre-fabricated Sub-station (PSS) due either to a defect, an exceptional service condition or mal-operation may initiate an internal arc. Such an event may lead to the risk of injury, if persons are present. It is desirable that the highest practicable degree of protection to persons shall be provided.

3.2.6 **Covers & Doors** : Covers & doors are part of the enclosure. When they are closed, they shall provide the degree of protection specified for the enclosure. Ventilation openings shall be so arranged or shielded that same degree of protection as specified for enclosure is obtained. Additional wire mesh may be used with proper Danger board for safety of the operator. All covers, doors or roof shall be provided with locking facility or it shall not be possible to open or remove them before doors used for normal operation have been opened. The doors shall open outward at an angle of at least 90^0 & be equipped with a device able to maintain them in an open position.

3.2.7 **Earthing**: All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequate terminal intended for

connection to the earth system of the installation, by way of flexible jumpers/strips & Lug arrangement. The continuity of the earth system shall be ensured taking into account the thermal & mechanical stresses caused by the current it may have to carry. The components to be connected to the earth system shall include :

a) The enclosure of Pre-fabricated Sub-station (PSS),
b) The enclosure of High voltage switchgear & control gear from the terminal provided for the purpose,
c) The metal screen & the high voltage cable earth conductor,
d) The transformer tank or metal frame of transformer,
e) The frame &/or enclosure of low voltage switchgear,

3.2.8 There shall be an arrangement for internal lighting activated by associated switch for HV, Transformer & LV compartments separately.

3.2.9 **Labels**: Labels for warning, manufacturer's operating instructions etc. shall be durable & clearly legible.

3.2.10 **Cleaning & Painting :**

The paints shall be carefully selected to withstand tropical heat and rain. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

11KV RMU with Vacuum Circuit Breaker

3.3.0 **11KV SF6 RMU with VCB:** The requirement of 11kv Ring Main Unit is as under.

3.3.1 SF6 Gas filled Non-extensible Ring Main Units with Vacuum Circuit Breaker comprising of panels as indicated in SLD

3.3.2 **The above Isolators, breaker, Bus bars should be mounted inside a robotically welded sealed for life, <u>stainless steel</u> tank of 3 mm thick sheet metal. The tank should be filled with SF6 gas at adequate pressure. The degree of protection for gas tank should be IP67.**

3.3.3 The Vacuum Circuit Breaker is required to control 11 kV/433 volts distribution Transformer of rating 1000KVA and relay settings shall be selected accordingly.

3.3.4 **General Finish**: Totally enclosed, metal clad, vermin and dust proof suitable for tropical climate use as detailed in the specification.

3.3.5 **Ratings**: The bus bars shall have continuous rating of 630 Amps. The isolator shall have a continuous rating of 630 Amps, Vacuum Circuit Breaker shall have a continuous rating of 630 Amps. in accordance with relevant IEC standard

3.3.6 **Breaking & Making Capacity**: The isolators shall be capable for breaking rated full load current. Vacuum Circuit Breaker shall be capable of having rupturing capacity of 21kA symmetrical at 11KV.

3.3.7 **Bus bar**: Switchgear shall be complete with all connection, bus-bars etc. Copper bus bars continuous rating shall be 630 Amps. The bus bars should be fully encapsulated by SF6 gas inside the steel tank.

3.4.0 **Isolator** :

The Isolators offered shall conform to IEC60129. The isolator shall be triple pole, spring assisted, motorized operation with quick break contacts. The operating handle shall have three positions 'ON', 'OFF' and 'EARTH' which shall be clearly marked with suitable arrangement to padlock in any position. A safety arrangement for locking shall be provided by which the isolator operation shall be prevented from 'ON' position to 'EARTH' position or vice versa in a single operation.

3.5.1 Switchgear:

3.5.1.1 The SF6 RMU shall be Sealed for life, the enclosure shall meet the "sealed pressure system" criteria in accordance with IEC: 298 (a system for which no handling of gas is required through out service life of approximate 25 years.) There shall be no requirement to 'top up' the SF6 gas. In addition, manufacturer shall confirm that maximum leakage rate is lower than 0.1% per year. It shall provide full insulation, making the switchgear insensitive to the environment. Thus assembled, the active parts of the switchgear unit shall be maintenance free.

3.5.1.2 The switchgear & switchboard shall be designed so that the position of different devices is visible to the operator on the front of the switchboard & operations are visible as well. The switchboard shall be designed so as to prevent access to all live parts during operation without the use of tools.

3.5.1.3 RMU should be tested for internal arc fault test.

3.5.2 **Vacuum Circuit Breaker**:

3.5.2.1 The Unit shall consist 630A Tee-off spring assisted three position, three pole Vacuum circuit breaker, with integral fault making / dead breaking earth switch. The function shall be naturally interlocked to prevent the main & earth switch from being switched 'ON' at the same time & the CB not allowed to trip in 'Earth On' position. The selection of the main/earth switch lever on the panel, which is allowed to move only if the main or earth switches in the off position. The lever shall be able to pad locked in either the main or earth position.

3.5.3 **Protection** : **Protection Relays**: The CB shall be fitted with microprocessor based self powered relay inside the front cover to avoid any tampering. The relay should be 3 Over Current + 1 Earth Fault, self powered type, fed by protection CTs mounted in the cable box.

3.6 **Cable Box**:

3.6.1 Every isolator shall be provided with suitable and identical cable boxes in front for connecting 3 core, 11kV cable from vertically below. The cable boxes shall be so located at convenient height to facilitate easy cable jointing work. The height available for cable termination should be minimum 500 mm. adequate clearances shall be maintained between phases for Termination.

3.6.2 **Locking Arrangement**: Suitable padlocking arrangements shall be provided as stated below…

a) CB manual operating handle in the "OFF" position.
b) Each feeder Panel operating handles in 'Closed' 'Open" or 'Earth' position.
c) Each isolator operating handle in 'Closed', ' Open', or 'Earth' position.

- RMU must be with Battery / Battery Charger if required.

3.7 **Ratings** :

		Ring main unit with VCB
3.8.1	**Switchgear Data**	
a)	Service	Outdoor but inside Enclosure
b)	Type	Metal clad
c)	Number of phases	3
d)	Voltage	11000V
e)	Rated Frequency	50 Hz
f)	Rated Current	630 Amp (isolator)
g)	Short Circuit rating	
	i) Breaking	21 kA rms for Breaker
	ii) Short time withstand for 3 Sec.	21 KArms
	iii) Rated S/c making	52.5 kA peak for Breaker
h)	Short duration pwer freq.	28 kV
i)	Insulation Level	75 KVpeak
j)	System earthing	Solidly earthed at substation
3.8.2	Breaker	
a)	Type	VCB in SF6 tank
b)	Rated voltage	11kV
c)	Breaking current	
	i) Load breaking	21 KArms.
d)	Making current	52.5 KA peak
e)	Rated current	400 Amps.
f)	No. of poles	3
g)	Operating mechanism.	manual operation
3.8.3	**Busbars: (If any)**	
a)	Material	Copper
b)	Type	SF6 insulated
c)	Rated Current	630 Amps
d)	Short time rating for 3 Sec.	-

3.8 **Tests For RMU**: Each type of 11kV Switchgear shall be completely assembled, wired, adjusted and tested at the factory as per IEC:265, IEC:298.

3.9 **Routine Tests:** The tests shall include but not necessarily limited to the following….

a) Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme and proper functioning of the equipment.

b) All wiring and current carrying part shall be given appropriate High Voltage test.

Distribution Transformer

4.0.0 **Dry Type Resin Cast Transformer:**

4.1.1 **Requirement**: 11000/433 Volt dry type resin cast, 1000 kVA Transformer suitable for installation at outdoor in Enclosure for ground mounting.

4.1.2 **Voltage Ratio:** No load voltage 11000/433 volts within tolerance as stipulated in IEC 76.

4.1.3 **Rating:** The transformer shall have a continuous rating as specified at any of the specified tapping position and with the maximum temperature rise specified.

4.1.4 **Connections:** H.V. Delta and L.V Star connected with neutral brought out on the secondary side for connection to earth; Vector group DYn11.

4.1.5 **Tapping :**

Each transformer shall be provided with tap switch so as to provided for a voltage adjustment on H.V. from +5% to –5% of rated voltage of 11000 volts in 4 equal steps (5 position) to obtain rated voltage of 433 volts on LV side.

4.2.1 Phase Marking & Danger Plate: Phase markings in fluorescent paint on small non-corrodible metallic tags shall be permanently fixed for H.V. and L.V sides. Phase markings tags shall be properly fixed with proper alignment. Danger plates shall be provided on the H.V & LV sides, mentioning the Corresponding Voltages.

4.3.0 Core and Coil :

4.3.1 Core: The core shall be constructed from high grade, cold rolled, non-ageing, low loss, high permeability, grain oriented, cold-rolled grain oriented silicon steel laminations. The transformer shall be so designed as to have minimum humming noise. The percentage harmonic potentials with the maximum flux density under any conditions shall be such that capacitors connected in the system shall not be overloaded.

4.3.2 The core and coil assembly shall be securely fixed in position so that no shifting or deformation occurs during movement of transformer. The core and coil assembly shall be capable of withstanding without injury, the thermal and mechanical effects of short circuit at the terminals of any winding.

4.3.3 Noise: The Contractor shall take special precautions to ensure that the noise and vibration level does not exceed which is obtained in good modern practice.

4.3.4 Impedance Volts: The Percentage impedance value at 75 Deg. C at any tap shall be 5.0% subject to tolerance as specified in relevant IEC standards. The value of the impedance volts at each tapping over the specified range shall be specified in the bid.

4.3.5 Regulation: The regulation at 75° C at full load at unity and 0.8 power factor subject to the usual tolerance as per IEC standards shall be specified in the bid.

4.3.6 Power Freq. High Voltage & Insulation Level (Impulse voltage): The distribution transformer shall be designed so that they are capable of withstanding high voltage & impulse voltages as given below:

a) Impulse Voltage for 11kV winding: 75 kV (1.2/50 Microsecond wave shape).
b) High Voltage : 28kV rms.

4.4.0 **RATINGS (Summary):**

	Application	**1000 kVA Corrugated Tank**
4.4.1	Service	Outdoor in an Enclosure, Step down
4.4.2	Type	Dry type resin cast
4.4.3	Cooling system	Natural air
4.4.4	No. of Phases	3
4.4.5	No. of winding per phase	2
4.4.6	Rated output (MVA)	HV / LV HV-0.750 LV-0.750
4.4.7	Rated voltage in KV (Line to Line	HV-11 kV LV-0.433 kV
4.4.8	Rated frequency	50 Hz
4.4.9	Temperature rise above 50°C	
A	In winding by resistance	45°C
B	In Oil by thermometer	45°C

4.4.10	Guaranteed losses at 75°C and at normal tap position without any positive tolerance	
		1000kVA
A	No Load loss	Vendor to give (Low loss as per IS / ICC)
B	Full Load loss	Vendor to give (Low loss as per IS / ICC)
C	Total loss	<1.5%
4.4.11	Insulation level	
A	H.V. Power Freq. KV rms	28 kV
B	H.V. (kVpeak) Impulse	75 kV
C	L.V. (kV)	-
4.4.12	Vector Group	Dyn11
4.4.13	Parallel operation	Yes
4.4.14	Type of taps provided	Off Load full capacity
A	Taps provided on	H.V. winding
B	Range of taps	±5% in steps of 2.5% (4 steps, 5 position)
C	Method of Tap Change control	Tap link / Switch
D	Manual load	Yes 'Off Circuit'
4.4.15	Percentage impedance at 75 Deg. C	As per IS /IEC
4.4.16	System earthing	
A	H.V.	Solidly earthed
B	L.V.	Solidly earthed
4.4.17	Terminal arrangement	
A	H.V.	From H.V. Bushing on Top.
B	L.V.	From L.V. Bushing on Top.
C	L.V. Neutral	From L.V. Neutral Bushing on Top.
4.4.18	Transformer-bushing voltage class a) H.V. (kV) b) L.V. (kV)	 12 kV class 1.1kV class
4.4.19	System fault level a) H.V. side b) L.V. side	 500 MVA (11 kV) -

LT Panel :

5.1.0 **System**:-

a) **Declared voltage** :– 3 Phase,433V (±6%) 50 Hz,

b) **Neutral**: – Solidly earthed at substation.

5.2.0 **General finish**: - Tropical, totally enclosed, metal-clad, weather-proof, vermin and dust proof.

5.3.0 **Construction :**

Enclosure: - Dead Front type of enclosure shall be able to provide the degree of Protection IP: 42.

5.4.0 **Circuit Ways:**

AS Per Bill of Material Attached (Annexure)

5.5.0 **Earthing**:

5.5.1 Earthing arrangement shall be provided for earthing each cable, PVC cable gland, neutral busbar, chassis and frame work of the cubicle with separate earthing terminals at two ends. The main earthing terminals shall be suitably marked .The earthing terminals shall be of adequate size, protected against corrosion, and readily accessible. These shall be identified by means of sign marked in a legible manner on or adjacent to terminals.

5.5.2 Neutral bus bar strip shall be connected to Earthing terminal with help of GI strip of suitable capacity & nut-bolt arrangement.

6.1.0 **Routine Tests**: The routine tests shall be made on each complete prefabricated substation.

a) Voltage tests on auxiliary circuit.
b) Functional test.
c) Verification of complete wiring.

6.2.0 **Test Witness:** Routine test shall be performed in presence of Owner's representative if so desired by the Owner. The Contractor shall give at least fifteen (10) days advance notice of the date when the tests are to be carried out.

6.3.0 Test Certificates:
Certified reports of all the tests carried out at the works shall be furnished in three (3) copies for approval of the Owner.

Approved makes for CSS –
Pre-fabricated Compact Substation - ABB / Schneider
Ring Main Unit - ABB / Schneider
LT Switchgear - ABB /Merlingerin / Siemens/ L&T
Transformers - Ames Impex / Voltamp

A. DG SETS

Diesel Generating Set capable of developing 600 kVA/480 KW, at 0.8 PF, 3 PH, 4 Wire, 415 V, 50 Hz, Prime Power rating power available in a variable load application (10% overload available for one hour in twelve hours) at a rotational speed of 1500 RPM.

Engine

Diesel Engine, Six Cylinder Inline arrangement, 4 stroke generating gross power of 713 BHP providing governing to BS5514. The engine is supplied with:

- Digital Electronic Governing system.
- Unit fuel injectors with lift pump.
- Full flow spin-on fuel oil filters.
- Standard duty air filter.
- Standard manufacturer lubricating oil filters full flow spin on-type.
- Engine mounted detector switches for low oil pressure, high water temperature, engine over speed.
- Gear driven water pump complete with thermostatic bypass valve.
- Twin thermostats
- Powder coated radiator with fan, pulley, fan belts and safety guard.
- Standard manufacturers high capacity lube oil sump, complete with drain plug
- Close tolerance quick response engine governing system
- 24V DC starter motor, with lead acid starter batteries

Alternator

Stamford / Leroy Somer / Equivalent single bearing @1500 RPM, 50 Hz with IP23 protection, Class H insulation having standard terminal box, suitable for flexible load cabling, 3 phase, 4 wire, voltage as specified.The Steady state voltage regulation shall be within ± 1% from no load to full load.

Baseframe

The base frame is fully welded, heavy duty rolled steel channel for engine and alternator mounting and shall be rigid and free from twist to ensure that proper alignment between components is maintained, and incorporates suitable lifting arrangements.

Mounting

Rubber type AVM's are supplied between the Engine / Alternator and the baseframe.

Fuel tank Fabricated of 14 SWG Sheet Metal, of required Capacity, with Inlet & Outlet arrangement with air vent & drain plug arrangement.

Engine Instruments:
Coolant temperature
Lubricating oil pressure
Engine Hourmeter
Battery Volts – Digital

Other key features:Emergency stop
Common alarm volt free contact (for use by others)
Generator ready to load volt free contact (for use by others)

Control Panel

Floor mounting type, totally enclosed, steel construction control panel suitable for indoor installation, dust & vermin proof comprising of:-
MDO Breaker
Voltmeter
Ammeter
Frequency meter
KW Meter
KWH Meter
Key start switch

Acoustic Enclosure

The complete Genset will be supplied in a totally enclosed and sound attenuated enclosure duly modified and sound attenuated. The complete DG Set will meet the current CPCB noise limit of 75 dB @ 1 metre distance under the conditions defined in the CPCB notification. The Acoustic enclosure will be complete with the following:

1 Hinged doors are provided, on either side, which are also acoustically treated, thereby providing easy access to the DG set while minimizing the operating space requirements. The doors are provided with high quality EPDN gaskets to avoid leakage of sound . The door handles & hinges are zinc plated & lockable.

2 The construction of the acoustic enclosure is such that with acoustic doors open on the either side, full access is available to engine and alternator.

3 For fresh air inlet into the system a parallel baffle / louver system is provided.

4 For hot air discharge, an acoustic discharge plenum is provided in front of the engine radiator, for discharge of hot air into the surroundings through a parallel baffle/louver arrangement. Exhaust air is routed thru' a residential silencer.

5 It is ensured that sufficient clear space is available all around the Acoustic Enclosure to ensure free air flow for the Genset as required and to facilitate accessibility for genset operation and routine maintenance.

6 Adequate ventilation is provided to meet the air requirement for combustion and also to expel heat out of the enclosure.

7 The radiator fan of the water cooled engines is used for ventilation.

8 Two light points controlled by a switch are provided inside the enclosure.

9 Necessary openings are provided for the entry of power cable/bus trunking & control cables, fuel piping, exhaust piping, air inlet pipe etc.

10 Genset/engine control panel is visible from outside the enclosure. Small see through window for reading meters etc. made of transparent polymer sheet of appropriate thickness is provided .

11 Fuel day tank is incorporated inside the canopy. Exhaust piping inside enclosure is suitably lagged(except bellow)

To avoid re-circulation of hot air, durable sealing between radiator & canopy is provided.

C. BUS DUCT

1.1 SCOPE

This specification covers Sandwich type busbar for use as Feeder Busbar for interconnection between separate electrical equipment/ load centers, and for use as Plug in busbar risers.

- **System details**

The busbar shall be suitable for operation in a 690V / 1000 V system with frequency of 50 Hz .System can be either earthed or unearthed. Impulse voltage should be 12 KV.

- **Standards:**

The busbar shall be designed and manufactured in accordance with the following international standards for busbar trunking.

-IS 8623/ 1993 Part I & II : Particular requirements of busbar trunking System
-IEC 60439 Part I & II : Particular requirements of busbar trunking System
-IEC- 60529 : Degree of protection

- **TESTING**

The busbars shall be type tested at a reputable national / International test laboratory (ASTA or CPRI) for short circuit withstand. The test shall be for a minimum duration of one second.

  - Degree of ingress protection (IP rating) shall also be tested at any reputed independent laboratory. This test shall be for IP 55 for indoor and IP 66/67 FOR OUTDOOR application.
  - Short circuit and Degree of protection type test reports will be submitted for verification.

- **MANUFACTURERS**

The manufacturer must have an established track record in design and manufacture of sandwich busbar trunking.

- **Design & Construction requirements – Sandwich Busbars**

General

The busbars shall be of Sandwich construction design. It shall be possible to mount the busbar system in any orientation, without affecting the current rating. The sandwich busbar configuration must be compatible with the cast resin busbar, and must allow for interconnection of the two types, wherever required. The length of each section will be limited to max. 3 meters.

- **Busbars :**

The busbars shall be of high conductivity Copper of 99.9% pure ETP grade and high conductivity Aluminium of 99.59% pure 19501 grade.

Where as earth conductor is required, it shall be separate external earth conductor, of high conductivity aluminium. Cross section of Earth Conductor shall be as per IEC 60439.
It should be possible to provide a 200% Neutral where specified.
Phase cross over box should have busbars crossing over each other not cables.

- **Insulation**

The busbars shall be individually insulated with 2 layers of insulating film. Layers of POLYSTER material class 'B', 130ºC. Alternatively extrusion of class 'B' material in form of epoxy insulation may be provided.

- **Housing**

The housing shall be made of 1.6 mm electrogalvanised sheet steel, with an epoxy powder coated paint finish of RAL 7032 grade. Alternatively Aluminum casing of 2.5mm may also be provided. The housings shall be profiled, to provide higher strength and efficient heat dissipation.

The width of the housings shall be same for all ratings of busbars, in order to provide interchangeability of tap off boxes.

- **Joints:**

The joints between sections shall be made so as to provide flexibility during installation and expansion / contraction of busbar during operation. The joints shall be of the single bolt type. The joint construction must have the following features.

a) Thermal expansion of Busbars at joint of at least 4 mm per joint.

b) The joint insulation must be of one piece moulded design and not have any cut edges which can absorb moisture.

c) Joint assembly shall be removable as separate sub-assembly so that it can be inserted or removed without disturbing the adjacent sections.

d) The joint system must be designed in a way that the installer cannot insert the busduct length too far and damage the bolt insulator.

e) The busbars ends shall not have any holes or slots at the joints – the electrical continuity shall be through pressure plates, achieving a high area of joint cross section and expansion capability.

- **Tap of Units**

a) Plug in boxes will be draw out type, contacts shall be silver plated and spring loaded.

b) The front operating handle will be interlocked with the plug-in boxes cover so that MCCB can be operated only with suitable cover in close position.

c) The door shall be provided with the door knobs.

d) When the MCCB is in 'ON'' position, even with the door knobs unlocked, the operator should not be able to remove the box or open the tap off location cover.

e) During insertion, the earth conductor shall make contact first before the phase conductors. This should follow the sequence of first in last out concept.

f) When the box is open the live conductors shall be safe guarded by a transparent insulator plate which allows for visible inspection but does not allow touching of the live conductors.

g) The tap off unit arrangement must achieve IP 54 without requiring any additional sealing at site.

h) The tap off boxes will be suitable for accommodating MCCBs or other accessories, as required. The tap off units should allow the flexibility of accommodating different, reputed MCCB makes, to be mutually agreed depending on the tender requirements.

- **Accessories**

A full range of accessories like bends, end flanges, end feed units, Rubber Bellows and end cover etc shall be available.

D. MEDIUM VOLTAGE SWITCH GEAR PANEL

1. SCOPE

1.1 This specification covers the requirement for Medium Voltage (MV) Switchboard or Main LT Panel or Power Control Centre (PCC), Motor Control Centre (MCC) or the combination of both of these (PMCC) and Power Distribution Board required to distribute power in the plant / building at medium voltage.

1.2 The enclosed drawings and / or data sheets form part of the specification.

1.3 The drawings and specifications complement each other and what is shown or called for in one

shall be interpreted as being called for in both.

Material(s), if any, which may have been inadvertently omitted but fairly implied as required to make a complete assembly of the switchgear as shown in the drawing and the specification to make the unit properly operational shall be construed as required and covered in the Vendor's scope.

2 CODES AND STANDARDS

2.1 The design, manufacture and performance of the equipment shall comply with all Indian Standards, I.E. Rules, Statutory Regulations and Safety Codes currently applicable in the locality where the equipment will be installed.

2.2 Unless otherwise specified, the equipment shall conform to the latest applicable Indian Standards and, in particular, the following:

i) IS:13947-Low voltage switchgear and control gear. (Part-1 to 5)

ii) IS:9224-Low Voltage Fuses

iii) IS:2705-Current Transformers

iv) IS:3156-Voltage Transformers

v) IS:3231-Specification for electrical relays for power system Protection.

vi) IS:4237-General requirements for switchgear and control gear for voltages not exceeding 1000V A.C.

vii) IS:1248Direct-acting electrical indicating instruments.

viii) IS:5578-Guide for marking of insulated conductors.

ix) IS:11353-Guide for uniform system of marking and identification of conductors and apparatus terminals.

x) IS:8623-Specifications for factory-built assemblies of switchgear and control gear (up to 1000V AC)

3. GENERAL REQUIREMENT

3.1 All identical equipment and parts shall be interchangeable.

3.2 The switchgear shall consist of indoor, floor-mounted, metal-enclosed, compartmentalized (if not indicated specifically in data sheet), modular type, totally front side operated vertical sections.

3.3 It shall be dust and vermin proof and shall be easily extensible on both sides.

3.4 All doors and removable covers shall be gasket all around with neoprene gaskets.

3.5 Each vertical section shall comprise the following:

3.5.1 Metal-enclosed bus bar compartment, running horizontally throughout the length of the switchgear.

3.5.2 Individual feeder modules in multi-tier formation.

3.5.3 Shrouded main and vertical bus bars and individual feeder connection.

3.5.4 Vertical cable alley and bus bar alley with doors or covers covering the entire height of the feeder module panel.

3.5.4 Horizontal wire way for control wiring.

3.5.6 Space heater with thermostat and MCB in each vertical panel.

3.5.7 Sheet steel barrier between two adjacent vertical sections except for horizontal bus bar compartments.

3.5.8 Separate door for each feeder module.

3.5.9 20 % additional space in the panel (in terms of vacant feeder compartments of various sizes), to accommodate the future requirement, if any.

3.5.10 Totally front operated panel, i.e. cable and bus bar alleys of suitable sizes (Minimum 300 mm width) shall be on the panel front side only.

3.5.11 Each vertical panel should be divided into the distinct zones for bus bars, feeders, power cabling, control cabling and power & control terminals.

3.6 The switchgear unit shall consist of rigid structural frame enclosed by 2 mm thick cold rolled (CRCA) sheet steel. Doors and covers shall be of 1.6 mm thick cold rolled (CRCA) sheet steel. Structural framework with foundation bolts, etc. at the bottom shall be provided to mount the switchgear directly on concrete/steel channel base.

3.7 The switchgear shall be provided with removable cable gland plate (of minimum 3 mm thickness), with brass cable glands and crimping type cable lugs, as indicated in the data sheet.

3.8 Separate metal labels shall be provided for switchgear modules, relays, instruments, switches, etc. Approval for the type of label shall be taken from the Owner/Consultant.

3.9 Control switches, push buttons, indicating lamps, meters and relays shall be mounted on the front door. Current Transformers (CTs) and Voltage Transformers (VTs) shall be mounted on the fixed portion. For fully draw out / semi draw out execution, all other equipment shall be mounted on withdraw able chassis with suitable guides for easy withdrawal.

3.10 Painting shall be done by surface coating comprising pre-treatment, electrostatic powder spraying and curing. The surfaces to be coated shall be chemically de-rusted and degreased at a temperature of 70^{o} to 80^{o}C, zinc phosphates and then passivity at about 60^{o}C and, after proper drying, subjected to spraying of powder charged at about 90 KV through electrostatic guns. Curing shall be done in staving oven at 180^{o} to 200^{o} C for 12 to 15 minutes ensuring a uniform and continuous coating. The color of the shade shall be 631 of IS 5.

3.11 Feeder control and motor control equipment not incorporating circuit breaker shall either be of fully draw out, semi draw out or fixed type execution, as specified in the drawing/data sheet.

3.11.1 In the case of fully draw out type withdraw able chassis, all electrical power and control

connections shall be of plug-in type.

3.11.2 In the case of semi draw out type withdraw able chassis, all electrical power connections shall be of plug-in type. All control connections shall be of screwing-in type.

3.12 300 mm clearance shall be provided between the finished floor and the bottom of the lower most feeder compartment.

3.13 Panel lifting lugs shall be of removable type and to be fixed with panel using bolts and nuts.

4. MAIN BUS BARS

4.1 Main bus bars shall be of uniform cross section in aluminum or copper as specified in the drawing/data sheet.

4.2 Wherever aluminum to copper connections is required, suitable bimetallic connections/clamps shall be provided.

4.3 Maximum temperature of the bus bars and the bus connections shall not exceed 85oC.

4.4 The bus bars shall be provided with heat shrinkable sleeves and color coded for identification.

4.5 Separate supports shall be provided for each bus bar. If common support is provided for all bus bars, anti-tracking barriers shall be incorporated.

4.6 In order to avoid any accidental hazards, bus bar compartments shall be protected with 3 mm thick hovel / Bakelite sheets.

4.7 The size of the neutral bus bar shall be similar to that of phase bus bars in the case of Main L.T. Panels, PCCs, PMCCs, PDBs, Main and Sub Lighting DBs. However, the neutral bus bar shall be of half size that of phase bus bars in the case of Motor control centers.

5.1 AIR CIRCUIT BREAKER

5.1.1 These shall be air-break, fully draw-out type, and shall consist of the following:

5.1.2 Shunt and/or series trip as specified in drawing/data sheet. Coordination shall be ensured between successive breakers.

5.1.3 Mechanical OPEN/CLOSE position indicator, visible with door closed.

5.1.4 Emergency trip push button.

5.1.5 'Red', 'Green' and 'Amber' indicating lamps for Breaker ON, Breaker OFF and Breaker trip on fault.

5.1.6 There shall be `Service', `Test' and `fully withdrawn' positions for the breakers along with their indications on the breaker front fascia.

5.1.7 Electrical and Mechanical anti pumping and over & under voltage trip facility should be provided.

5.1.8 It shall be possible to with-draw the breaker only in open position.

5.1.9 Compartment door of the breaker shall not open unless the breaker is in open position.

5.1.10 Automatic safety shutters shall be provided to cover live contacts when carriage is withdrawn.

5.1.11 Relays shall have potential-free contacts.

5.1.12 Facility shall be provided for blocking under-voltage releases.

5.1.13 Manual operating mechanism shall be of spring charged stored energy type or spring assisted type, independent of the speed at which the handle is operated.

5.1.14 Power-operated mechanism shall be of motor-wound spring-charging stored energy type. Emergency manual charging facility shall also be provided.

5.1.15 Indicators shall be provided to show `charged' and 'discharged' conditions of the spring.

5.1.16 The operating mechanism shall be trip-free.

5.1.17 The breaker shall be provided with the microprocessor based release with breaker control through RS 485 port and communication with PC through universally used protocol if asked for in the drawing.

5.1.18 The Micro processor release should have over current / short circuit and earth fault protections along with their indications due to which the breaker has tripped.

5.2 MOULDED CASE CIRCUIT BREAKER

5.2.1 The molded case circuit breaker (MCCB) shall be air break type and having quick make quick break with trip free operating mechanism.

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

5.2.3 Rotary type operating handle of MCCB shall be provided in front and should clearly indicate ON/OFF/TRIP positions and should have padlocking facility.

5.2.4 The electrical contact of the MCCB shall be of high conducting non deteriorating silver alloy contacts.

5.2.5 The MCCB should have shunt trip release, earth fault release with adjustable current setting facility and mechanical interlock facility.

5.2.6 The MCCB shall be provided with adjustable type thermal overload release and adjustable type short circuit protection device. All the release shall operate on common trip bus bar so that in case of operation of any one of the releases in any of the three phases, it will cut off all the three phases and thereby single phasing of the system is avoided.

5.2.7 The MCCB wherever called for in the appended drawings shall provide an earth fault relay.

5.2.8 The MCCB shall provide required sets of extra auxiliary contacts for the indication circuit, control circuit and for remote signaling purpose and should have inbuilt indications for tripping due to over current, short circuit or earth fault.

5.2.9 The electrical parameters of the MCCB shall be as per the description given in the appended

drawings.

6. AIR BREAK SWITCHES

6.1 Switches shall withstand a short circuit current of value equal to the let-through current of the associated fuse for 1 second and peak short circuit current equal to cut-off current of the fuse.

6.2 Switches of motor feeders shall be of motor duty (AC23A), group-operated, fault-make, load-break type. All other switches shall be of heavy-duty type. All the Switches shall be provided with phase barriers and auxiliary contacts.

6.3 Switch handle shall have padlocking facility in `OFF' position.

6.4 It shall be possible to open the door only when switch is in `OFF' position and it shall not be possible to close the switch when the door is open. However, defeat mechanism shall be provided for inspection purpose.

7 FUSES :

7.1 Fuse shall be of HRC cartridge plug-in type, with visible indication of operation.

7.2 1 no. fuse pulling handle shall be provided for each Switch-board / Power Control Centre / Motor Control Centre.

8. MOTOR STARTERS

8.1 Contactors

8.1.1 Contactors shall be air break, double break, single throw, electromagnetic type.

8.1.2 Main contacts shall be of silver faced copper.

8.1.3 Minimum Two `N.O.' and two `N.C.' auxiliary contacts shall be provided for each power contactor. However, additional nos. of auxiliary contactors should be added in the control scheme as per the requirement.

8.2 Direct-on-line (DOL) starters

DOL starters shall be suitable for AC3 utilization category as per IS : 13947

8.3 Automatic star delta starters

8.3.1 These starters shall comprise three sets of contactors and a timer relay.

8.3.2 Starters shall be suitable for AC3 utilization category as per IS: 13947

8.4 Reversing Starters – Not Applicable

8.4.1 Forward and reverse contactors shall be mechanically and electrically interlocked.

8.4.2 Reversing starters shall be suitable for AC4 utilization category as per IS: 13947

8.5 Thermal Overload Relays

8.5.1 Starters shall be complete with three-element, ambient temperature compensated, time-lagged thermal overload relays with adjustable settings.

8.5.2 Thermal overload relays shall be of Auto / hand reset type. A hand reset push button, separate from the stop push button, shall be brought out on the front of the compartment door.

8.6 Micro Computer Motor Protection Relay– Not Applicable

8.6.1 Starters shall be complete with Micro computer based Motor protection relay with display facility for the motors of 20HP and above rating and without display for motors below 20HP rating.

The relay shall have over current protection (with medium tripping characteristics), Under current protection, Instantaneous short circuit protection, Single phasing protection, Current unbalance protection -for all the ratings of motors and for motors above 75HP ratings, in addition to the above standard protections, the relay should be provided with Stator Ground Fault Protection, over temperature protection and locked rotor protection.

9. SINGLE PHASING PREVENTERS

Separate single phasing preventer also shall be provided in the starters. The relay shall be current operated and hand reset type with separate hand reset push button.

10. INSTRUMENT TRANSFORMERS

10.1 CTs and VTs shall conform to the requirement of IS:2705 and IS:3156 respectively. The ratings specified are indicative only and it shall be Vendor's responsibility to ensure that the ratings offered are adequate for the relays/meters provided considering lead resistance, etc.

10.2 CTs and VTs shall be of dry air insulated type.

10.3 Facility shall be provided in the terminal blocks for shorting and earthing the CTs.

10.4 VTs shall be provided with adequately rated primary and secondary fuses.

11. INSTRUMENTS

11.1 Indicating instruments shall be of Digital type, 144 x 144 Sq.mm size, suitable for flush mounting.

11.2 Watt-hour and Var-hour meters shall be suitable for 3 phase, 4 wire system, balanced as well as unbalanced load and suitable for semi-flush mounting.

11.3 All KWH meter shall have computer interface facility through RS 485 port.

12 PROTECTIVE RELAYS

12.1 Relays shall be Micro processor based and suitable for flush or semi flush mounting with connections from rear. Protective relays shall be in draw out cases. Load Analyzer / Load manager shall have Communication port to interface with the Plant DCS / Control room.

12.2 All protective and tripping relays and timers shall be provided with fault display LEDs.

13. AUTOMATIC POWER FACTOR CORRECTION RELAYS

APFCR Panel shall have intelligent Microprocessor based relay, 12 steps based on the requirement. The relay shall have auto manual selection feature and shall adapt the direction of CT besides, it shall possess salient features like –

13.1 Auto self adjustment to any capacitor step value

13.2 Multiple LCD data indication of Power factor at each phase(lead/lag), KW, KVA, KVAR, Voltage, Load Current at each phase, Capacitor current at each phase, Injected KVAR to reach target power factor, Frequency, etc. incl. of all preset parameters & specified installation data

13.3 Automatic Self-adjustment for C/K value.

13.4 Three phase sensing suitable for three phase-unbalanced loads.

13.5 Operation time delay facility for 10-240 sec.

13.6 Memory back up to save the data in the event of power failure.

13.7 Alarm output for Capacitor or Contact failure, abnormal values of voltage, current, KVAR, Power factor, Temperature, Frequency, etc.

13.8 No-volt relay features to immediately disconnect all capacitors in the event of power failure.

13.9 Various protections i.e. over temperature, over harmonics, overload, etc.

13.10 Remote fault alarm indicator.

13.11 Power factor correction fault.

13.12 Facility to connect computer.

13.13 RS 232 serial port.

14. MISCELLANEOUS ACCESSORIES

14.1 Breaker control switch shall be :-Spring return-to-neutral type with pistol grip handle-Lockable in neutral position.

14.2 Indicating lamps shall be multiple LED type made from FR type polycarbonate material with Low voltage glow protection (up to 50V) and translucent lamp covers. Lamps shall be replaceable from front. The power consumption of each indicating lamp should not exceed 0.5 Watts.

14.3 Push buttons shall be momentary contact type rated for 10A at 500 V AC. The color of push buttons shall be as follows:

Start -Green Stop (stay put, mushroom, lockable type) -Red All others -Black

All push buttons are required to have functional labels.

14.4 Alarm Enunciator

14.4.1 Alarm Enunciator shall be provided, if specified in drawing/data sheet.

14.4.2 Alarm Enunciator shall comprise flush mounted fascia units with two lamps and series resistor and ground glass plate in front for inscriptions.

14.4.3 Alarm annunciation scheme shall include fascia units with relay for each fault, a common alarm bell and Accept / Reset / Test Push buttons.

14.4.4 The alarm annunciation scheme shall operate as follows :

Condition	**Visual**	**Audible**
Normal	Off	Off
On occurrence of fault	Flashing	On
Acknowledge fault Steady	Off	
Reset, Fault Cleared	Off	Off
Reset, Fault Not Cleared	Steady	Off
Lamp test	Steady	Off
Alarm Annunciation test	Flashing	On

15. INTERNAL WIRING

15.1 All wiring inside the switchgear shall be carried out with 650V grade FRLS PVC insulated flexible stranded copper wires. Minimum size of conductor for control wiring shall be 2.5 mm^2 Copper.

15.2 Ferrules shall be provided on each wire.

15.3 All wiring shall be terminated on terminal blocks with crimping type Copper cable lugs.

15.4 Power connections above 100A shall be carried out with PVC insulated copper links.

15.5 Vertical / horizontal Al. wire ways shall be provided to run the control wires within the same vertical panel and / or between different vertical panels.

16. TERMINAL BLOCKS

16.1 All terminal blocks for power and control circuits shall be of 650V grade stud type and shall be properly separate from each other.

16.2 Terminal blocks of different voltage groups shall be segregated and suitably labeled.

16.3 Terminals shall be numbered as per wiring diagrams.

16.4 20% spare terminals shall be provided.

16.5 Shorting links shall be provided for all C.T. terminals.

17. EARTHING

17.1 An earth bus extending throughout the length of the Switch-board / PCC / MCC/ PMCC / DBs / APFCR Panel shall be provided.

17.2 The earth bus shall be of sufficient cross section to carry safely momentary short circuit current for 3 sec.

17.3 All non-current carrying metal parts shall be effectively bonded to the earth bus.

18. TESTS

18.1 Vendor shall test the switchgear to conform to IS: 4237 with all components assembled and fully wired.

18.2 The following routine tests shall be carried out on all the components and the assembled switchgear, as per relevant standards :

a) Mechanical and Electrical Operation tests by simulating operating conditions as at site.
b) High voltage test (2.5 KV for one minute).
c) Test for verification of calibration of releases thro' primary injection test.
d) Insulation resistance test.
e) Test for verification of calibration of protective relays thro' secondary injection test.

18.3 Seven (7) copies of the routine and type test certificates shall be submitted for Owner's approval before dispatch of the switchgear

19. INSPECTION

19.1 Inspection, including witnessing routine tests, will be carried out by Owner / Consultant or their authorized representatives.

19.2 Vendor shall notify Owner or his authorized representative(s) in writing at least fifteen (15) days prior to the schedule for inspection and tests.

20. GUARANTEE

Vendor shall guarantee the design, materials, workmanship and performance of all goods to be supplied under the order for a period of twelve months (12) from the date of initial operation or eighteen (18) months after delivery at job site, whichever earlier.

21. DRAWING AND INSTRUCTION MANUALS

21.1 Vendor shall submit two sets of G.A. drawings, bill of quantities, make of materials, standard product catalogues, etc., along with the initial offer and four (4) sets of the following drawings for approval after award of contract :

21.1.1 Complete assembly drawing of the switchgear, showing plan, elevation and typical sections with dimensions and location of terminals for external connections.

21.1.2 SWITCHGEAR elevation and layout plan with floor openings and floor fixing arrangements.

21.1.3 Schematic diagrams with terminal and ferrule numbers for each module/switchboard panel.

21.1.4 Wiring diagram for each module indicating terminal blocks and various apparatus.

21.1.5 Final list of apparatus for each module.

21.1.6 Manufacturer's descriptive literature on various components used in the switchgear.

21.2 One print of each drawing will be returned to vendor with comments and required clarifications, if any. Vendor shall incorporate these and send within fifteen days, seven prints of each drawing

marked “Certified for record and use”.

DATA SHEET FOR MEDIUM VOLTAGE SWITCHGEAR PANEL

1.0 SITE CONDITIONS

1.1	Maximum ambient temperature	:	45 Degree C
1.2	Minimum ambient temperature	:	06 Degree C
1.3	Design temperature	:	50 Degree C

2.0 OPERATING CONDITIONS

2.1	Voltage	:	415V+/-10%
2.2	Frequency	:	50Hz+/-3%
2.3	No. of phases	:	Three
2.4	System fault level	:	50 KA at 415V for 1 Sec.
2.5	System earthing	:	Solid Earthing
2.6	Control supply	:	
	For ACB Closing and Tripping Coils	:	110V DC at PCC. 240V AC at other Panels
	For Protective Relays	:	110V DC
	For indicating lamps	:	110V DC at PCC. 240V AC
	At other Panels		
	For Alarm / Hooter Panels	:	110V DC at PCC. 240V AC at other
	For Panel illumination lamp	:	240V ACF or Thermostat240VAC
	For Contactor coils	:	240V AC

3.0 ELECTRICAL DATA

3.1	1 sec short circuit withstand capacity	:	50KA at 415V for PCC, APFCR Panel,
3.2	Bus bar current rating inside panel at	:	As indicated in the drawings Specified ambient temperature
3.3	Bus bars	:	Electro grade Aluminum Sleeved (heat shrinkable)

3.4	Bus bars current density	:	1 Sq.mm = 0.8 Amp
3.5	Bus bars location	:	at Top / Bottom section of the Panel
3.6	Cable entry (Incoming & Outgoing)	:	TOP & BOTTOM
3.7	Earth bus size and material	:	50 x 6 Sq.mm, Aluminum
3.8	Bus bars and cable alley	:	On front side of the panels
3.9	Cable sizes	:	As indicated in the drawings
3.10	Color shade	:	Powder coating – Azure Blue
3.11	Feeder arrangement	:	All panels are Single front type Tomatch the Panel Room Layout
3.12	Floor fixing	:	Integral base frame
3.13	Degree of protection for panel	:	IP 44 enclosure
3.14	Maximum operating height	:	1800 mm
3.15	Maximum Panel height	:	2300 mm

TO BE FILLED UP BY VENDOR ALONG WITH OFFER

1	Make	:	
2	Type/designation :		
3	Degree of protection	:	
4	Overall weight of complete Panel	:	kg
5	Overall dimensions		
	Length	:	mm
	Depth	:	mm
	Height	:	mm
6	Overall weight and dimensions of largest shipping section		
	Weight	:	kg
	Length	:	mm
	Depth	:	mm
	Height	:	mm
7	Recommended clearances		
	Front	:	mm
	Rear	:	mm
	Above	:	mm
8	Clearance in air of main bus bars.		
	Phase to phase	:	mm
	Phase to earth	:	mm
9	MAIN BUSBAR DETAILS:		
9.1	Bus bar current rating at design Temperature (50 Degree C)	:	
9.2	Main bus bar material	:	
9.3	Main bus bar size	:	
9.4	Main bus bar location	:	
10	Vertical Bus bar Details:		
	10.1 Current rating/size	:	
11	Insulating material	:	
12	Earth bus size/material	:	Sq.mm
13	1 min power frequency voltage	:	KV
14	1 sec.short circuit withstand capacity	:	KA
15	Peak dynamic withstand capacity	:	KA
16	**AIR CIRCUIT BREAKER**		

16.1 Make & Type (s)

16.2 Rated voltage & frequency

16.3 Normal current under site condition

16.4 Rated making capacity

16.5 Rated breaking capacity

16.6 Rated short time rating for 1.0 sec.

16.7 Duty cycle

16.8 Type of operating mechanism

16.9 Voltage and power rating for operating mechanism closing coil trip coil

16.10 Operating time

16.10.1 Closing time

16.10.2 Opening time

16.11 Fixed trip / trip free

16.12 Number and Rating of breaker auxiliary contacts

16.13 Details of releases, if any

17 CHANGE OVER SWITCH

17.1 Rated voltage, frequency & type

17.2 Rated current under site condition

17.3 Test insulation voltage

17.4 Short time with stand current for 1.0 sec.

17.5 Rated fused short circuit current

17.6 Rated operational current

17.6.1 At 415V, AC-23 duty

17.6.2 At 660V, AC-23 duty

17.7 Mechanical operations

17.8 Electrical operations (AC-23)

17.9	Rated operational power at 415V		
17.10	Short circuit making capacity (Peak)		
17.11	AC breaking capacity at PF 0.2 and at 415V		
17.12	Rated capacitor duty -Ic		
18.0	**MOULDED CASE CIRCUIT BREAKERS (MCCBS)**		
18.1	Make & type (s) :		
18.2	Rated voltage, frequency	:	
18.3	Normal current under site conditions	:	
18.4	Symmetrical interrupting current	:	
18.5	Short time current and duration	:	
18.6	Operating mechanism	:	
18.7	Shunt trip	:	
18.8	s / Releases	:	
19.0	**CONTACTORS**		
19.1	Make	:	
19.2	Type designations	:	
19.3	Rated voltage	:	
19.4	Rated current	:	
	AC-3 Duty	:	
	AC-4 Duty	:	
19.5	Thermal rating	:	
19.6	Making capacity	:	
19.7	Breaking capacity	:	
19.8	DC rating	:	
19.9	Switching frequency	:	Operations/hour
19.10	Life :		
	Electrical	:	Operations (at rated voltage)
	Mechanical	:	Operations
19.11	Coil consumption-pick up	:	VA at P.F.
19.12	Coil consumption-Hold on	:	VA

19.13	Closing time	:	Secs.
19.14	Opening time	:	Secs.
19.15	No. of aux. contacts	:	To be provided as required.

20.0 SWITCHES

20.1	Rated voltage	:
20.2	Rated current	:
20.3	AC23A rating	:
20.4	Rated making capacity	:
20.5	Rated breaking capacity	:
20.6	Rated short circuit with stand current	
	with max. Permissible rated fuses	:
20.7	Mechanical life	:

NOTE : Above particulars are required for each rating of switch offered.

21.0 THERMAL OVERLOAD RELAYS

21.1	Make/type	:	
21.2	Setting range	:	
21.3	Type of operation	:	Direct/CT operated

22.0 ANY OTHER SWITCHGEAR, IF ANY.

CONTRACTOR'S SIGNATURE

DATE:

DISTRIBUTION BOARDS

Scope:

It includes Supply, Installation, Testing and Commissioning of Distribution Boards standard company fabricated or to be fabricated by fabricator.

Standards:

AS PER SCHEDULE OF INDIAN STANDARDS, ATTACHED IN THE DOCUMENT.

Distribution Boards:

Distribution boards along with the controlling MCB's/Fuse or Isolator as shown shall be fixed in an M.S. Box with hinged door suitable for recessed mounting in wall. Distribution boards shall be made of 18 SWG steel sheet duly rust inhibited through a process of de-greasing, acid pickling, phosphate and powder coated to an approved color of adequate micron rating duly approved by architect/consultant.

Three phase boards shall have phase barriers and a wire channel on three sides. Neutral bars shall be solid tinned copper bars with tapped holes and chase headed screws. For 3 phase DB's, 3. independent neutral bars shall be provided for per phase isolation. All DB's shall be internally pre-wired using copper insulated PVC wires brought to a terminal strip of appropriate rating for outgoing feeders.

Conduit knockouts shall be provided as required/shown on drawings and the entire board shall be rendered dust and vermin proof with necessary sealing gaskets. The top and bottom side of DB should be detachable.

MCB's shall have quick make and break non-welding self wiping silver alloy contacts for 10 KA short circuit both on the manual and automatic operation. Each pole of the breaker shall be provided with inverse time thermal over load and instantaneous over current tripping elements, with trip-free mechanism. In case of multi-pole breakers, the tripping must be on all the poles and operating handle shall be common. Breakers must conform to BS 3871 with facility for locking in OFF position. Pressure clamp terminals for stranded/solid conductor insertion are acceptable upto 4 sq.mm. aluminum or 2.5 sq.mm. copper and for higher ratings, the terminals shall be suitably shrouded. Wherever MCB isolators are specified they are without the tripping elements.

Fuses shall be HRC link type re-wire able with necessary fuse carriers and with rating of not less than 25 MVA. Bottle type fuses are not acceptable. Fuse carrier terminals shall be suitably shrouded. Re-wire able fuse carriers shall be porcelain. HRC fuses for motor duty should be time lag type.

Distribution boards shall have HRC/re-wire able fuses as shown on the schedule and drawings. Board shall meet with the requirements of IS 2675 and marking arrangement of bus bars shall be in accordance with I.S. standards.

Bus bars shall be suitable for the incoming switch rating and sized for a temperature rise of 35° C over the ambient. Each board shall have two separate earthing terminals. Circuit diagram indicating the load distribution shall be pasted on the inside of the DB as instructed. Two earthing terminal for single phase and two terminals for 3 phase DB's shall be provided with one earth strip connecting the studs and the other earth link should be provided with base insulator in such a way that link should in contact with body of distribution board.

In the case of MCB distribution boards, the backup fuses wherever shown shall be not less than 63 A with a delayed characteristic and a minimum pre-arcing time of 0.5 sec. at 10 KA fault current.

All outgoing feeders shall terminate on a terminal strip which in turn is interconnected to the MCB/Fuse base by means of insulated single conductor copper wires as follows :

Upto	15 a	2.5 sq.mm.
40 A	10 sq.mm.	
25 A	4.0 sq.mm.	
63 A	16 sq.mm.	
32 A	6.0 sq.mm.	

RCCB / MCB :

A) The RCCB should suffices all the requirements of IS as per code IS - 12640 -1988. The RCA should be current operated and not on line voltage.

B) The RCCB should ensure mainly the following functions.

1) Measurement of the fault current value.

2) Comparison of the fault current with a reference value.

C) The RCCB should have a toroidal transformer which has the main conductors of primary (P - N) which check the sum of the current close to zero.

D) All metal parts should be inherently resistant to corrosion and treated to make them corrosion resistant.

E) It should be truly current operated.

G) It should operate on core balance toroidal transformer.

H) It's accuracy should be ± 5 %.

I) It should operate even in case of neutral failure.

J) It should trip at a present leakage current within 30 M.S.

K) It's enclosure should be as per IP 30.

L) It's mechanical operation life should be more than 20,000 operations.

M) It should provide full protection as envisaged by IE rules - 61-A, 71 - ee, 73 - ee, 1985 and also rule 50 of IE rule1956.

N) It should conform to all national and international standards like IS 8828 : 1993, IS 12640 - 1988, BS 4293 - 1983,CEE 27 (International commission Rules for the approved of electrical equipment).

E SPECIFICATION FOR HIGH AND MEDIUM VOLTAGE CABLES

This specification covers requirement of XLPE Cables for High Voltage Systems and XLPE/PVC Cables for Medium Voltage systems.

Unless otherwise specified cables shall conform to the following Indian Standards (as amended latest)

(i) IS : 1554 (Part I)PVC insulated (heavy duty) electric cables Part-I for working 1100 V. voltages up to and including

(ii) IS : 7098 (Part II)-Cross-linked Polyethylene insulated PVC sheathed cables: Part II for working voltages from 3.3 KV up to and including 33 KV.

(iii) IS : 8130-Conductors for insulated electric cables and flexible cords.

(iv) IS : 5831-PVC insulation and sheath of electric cables.

(v) IS : 3975-Mild steel wires, strips and tapes for armoring of cables.

(vi) IS : 3961 (Part II)-Recommended current ratings for cables : Part II PVC insulated and PVC sheathed heavy duty cables.

(vii) IEC : 502-Extruded solid dielectric insulated power cables for rated voltages from 1 KV up to 30

KV.

(viii) IS : 10810 (Part 61)-Flame Retardant Test

(ix) IS : 10810 (Part 62)-Flame retardant test for bunched cables.

(x) IS : 10418-Drums for electric cables.

1 GENERAL CONSTRUCTION OF CABLES

1.1 The cables shall be suitable for laying in trays, trenches, ducts or for underground buried installations with uncontrolled backfill and possibility of flooding by water and chemicals.

1.2 1100 KV Grade Aluminum / Copper and FRLS extruded PVC Outer Sheathed Round / FLAT steel wire armored Cable-Confirming to IS 1554 (Part-1) .

1.3 Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter. The embossing shall be legible and indelible. The size of the cable also shall be indicted on the outer sheath of the cable at regular intervals.

1.4 The overall diameter of the cables shall be strictly as per the values declared in the technical information to be furnished along with bids subject to a maximum tolerance of ±2mm.

1.5 PVC / Rubber end caps shall be supplied free of cost for each drum with a minimum of ten nos. per five hundred meters length. In addition, the ends of the cables shall be properly sealed with these caps to avoid ingress of water during transportation and storage.

1.6 The vendor shall specifically note that approved make of the cable accessories listed in the data sheet shall be used for termination or jointing of the cables offered.

1.7 XLPE CABLES FOR HIGH VOLTAGE (i.e. FOR 3.3KV UPTO & INCLUDING 33KV SYSTEM

1.7.1 Power cables for 3.3 KV up to and including 33 KV system shall be Aluminum Conductor, XLPE insulated screened, sheathed, armored and overall PVC sheathed as detailed below.

1.7.2 The conductors shall be stranded and compacted circular for all cables.

1.7.3 All cables rated 3.3/6.6kv and above shall be provided with both conductor screening and insulation screening. The conductors shall be provided with nonmetallic extruded semi conducting shielding.

1.7.4 The core insulation shall be with cross-linked polyethylene insulating compound applied by extrusion. It shall be free from voids and shall withstand all mechanical and thermal stresses under steady state and transient operating conditions. It shall conform to the properties given in Table-1 of IS : 7098 (part II).

1.7.5 The insulation shielding shall consist of non-metallic extruded semiconducting compound in combination with a non-magnetic metallic screening of copper. The copper screen shall be capable of carrying the single line to ground fault current for the duration specified in the data sheet. Vendor shall furnish calculation in support of selection of the size of copper screen along with bids.

1.7.6 The conductor screen, XLPE insulation and insulation screen shall all be extruded in one operation by “Triple Extrusion” process to ensure perfect bonding between the layers. The core identification shall be by colored strips or by printed numerals.

1.7.7 The inner sheath shall be applied over the laid up cores by extrusion and shall conform to the requirements of type ST2 compound of IS : 5831. The extruded inner sheath shall be of uniform thickness.

1.7.8 For multi-core cables, the armoring shall by galvanized steel strips. If armoring is specified for single

core cables in the data sheet, the same shall be with H4 grade hard drawn aluminum round wire of 2.5 mm diameter.

1.7.9 The outer sheath of the cables shall be applied by extrusion over the armoring and shall be of PVC compound conforming to the requirement of type ST2 compound of IS : 5831. The thickness of outer sheath shall be as per amendment no. 1 to Table 5 of IS : 7098 -Part 2. (Column 3 and 5 for both armored and unarmored cables).

1.8 PVC/XLPE CABLES FOR MEDIUM VOLTAGE GRADE (1100 V GRADE)

1.8.1 All power/control cables for use on medium voltage system shall be heavy duty type, 1100V grade, with aluminum/copper conductor; PVC insulated, extruded PVC inner-sheathed and extruded FRLS PVC outer sheathed, flat strip / round wire armored.

1.8.2 The conductors shall be stranded. Conductors of nominal area less than 25 sq.mm shall be circular only. Conductors of nominal area of 25 sq.mm and above may be circular or shaped. The copper conductor cables shall be tinned. Cables up to 4 Sq.mm Shall be of Solid / Stranded conductors and above 4 sq.mm, shall be of stranded conductors only.

1.8.3 The core insulation shall be with PVC/XLPE compound applied over the conductor by extrusion and shall conform to the requirements of type 'A' compound as per IS : 5831. The thickness of insulation and the tolerance on the thickness of insulation shall be as per Standard. Control cables having 6 cores and above shall be identified with prominent and indelible numerals on the outer surface of the insulation.

2 TESTING AND INSPECTION

The cables shall be examined and tested at the manufacturer's works. Manufacturer shall furnish all necessary information concerning the supply to Employer's inspectors. The inspector shall have free access to the manufacturer's works for the purpose of inspecting the process at manufacturer's works in all stages and he will have the power to reject any material, which appears to him to be unsuitable.

2.1 After completion of manufacture of cables and prior to dispatch, the cables shall be subjected to type, routine, acceptance and special tests as detailed below. Employer's reserves the right to witness all tests with sufficient advance notice from vendor. The test reports for all cables shall be got approved from the Employer's before dispatch of the cables.

2.2 All routine tests, acceptance tests, type tests and additional type tests for improved fire performance shall be carried out on cables as listed in IS : 1554 Part-Iand IS : 7098 Part II.

2.3 Following are the special tests to be performed on the cables. Copies of test reports for similar type of cables shall accompany the offer.

a. Accelerated water absorption test for insulation as per NEMA-WC-5 & WC-7, For PVC Insulated cables and for XLPE insulated cables respectively.
b. Dielectric Retention Test : The dielectric strength of the PVC cable insulation tested in accordance with NEMA WC-5 shall not be less than 50% of the original dielectric strength.
c. Flammability Test : The test shall be carried out on finished cable as per IS : 10810.
d. Test for rodent and termite repulsion property.

3 PACKING AND MARKING

3.1 Cables shall be dispatched in non-returnable wooden drums of suitable barrel diameter, securely

battened, with the take-off end fully protected against mechanical damage. The wood used for the construction of drum shall be properly seasoned, sound and free from defects. Wood preservatives shall be applied to the entire drum. Ferrous parts used shall be treated with a suitable rust preventive finish or coating to avoid rusting during transit or storage.

3.2 On the flange of the drum, necessary information such as Project Title, Manufacturer's name, Type, Size, Voltage Grade of cable, length of cable in meters, drum no., cable code, BIS certification mark, gross weight, etc. shall be printed, with also suitable markings showing the direction of rotation of the drum.

3.3 Cables shall be supplied in drum lengths as follows :
Medium voltage power cables up to and including 16 sq.mm -1000M.
Medium voltage power cables from 16 sq. mm up to and including 300 sq.mm - 500 M / 750 meter.
Control cables up to and including 27 cores – 1000 M.
HV Cables: 500M

A tolerance of plus or minus 5% shall be permissible for each drum. However, overall tolerance on the total length of each size of cable shall be limited, to ±2%. If non-standard drum lengths are specified in the data sheet, the same shall be supplied.

Final confirmations shall be taken from the Owner / Consultants, regarding the drum lengths for various sizes of cables at the time of dispatch.

CABLE JOINT & TERMINATION

1 Connectors :

Cable terminations shall be made with copper/Aluminum Heavy duty long nick copper crimping lugs only crimped type solder less lugs for all aluminum cables and stud type terminals. For copper cables copper crimped solder less lugs shall be used. Crimping shall be done with the help of hydraulically operated crimping tool. All cable lugs should be long neck type only.

1 Cable Glands :

Cable glands shall be of heavy duty brass single compression type as specified. Generally single compression type cable glands shall be used for indoor protected locations and double compression type shall be used for outdoor locations. Glands for classified hazardous areas shall be CMRS approved.

2 Ferrules :

Ferrules shall be of self sticking type and shall be employed to designate the various cores of the control cable by the terminal numbers to which the cores are connected, for ease in identification and maintenance.

3 Cable joints :

Kit type joint shall be done and filled with insulating compound. The joint should be for 1.1 KV grade insulation.

CABLE TRAY

1.1 Ladder type cable tray

The cable tray shall be fabricated out of 2 mm thick slotted / perforated MS sheets as channel sections, single or double bended. The channel sections shall be supplied in convenient lengths and assembled at site to the desired lengths. These may be galvanized or painted as specified.

1.1.1 The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler and cable tray shall be scraped and removed before the installation.

1.1.2 The permissible uniformly distributed load for various type of cables trays and for different supported span shall be as per IS.

1.1.3 The width of the cables tray shall be chosen so as to accommodate all the cables In one tier, plus 30 to 50% additional width for future expansion. This additional width shall be minimum 100mm. The overall width of one cable tray shall be limited to 1000mm.

1.1.4 Factory fabricated bends, reducers, tee / cross junction. etc shall be provided as per good engineering practice. The radius of bends, junctions etc. shall be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

1.1.5 Require Min. 3 Support per Meter for Ladder type cable tray installation. The cable tray shall be run at the surface of wall with the help of 35 mm x 5 mm M.S. Support at specified spacing. These shall be grouted to the wall at the other and through an effective means, as approved by the Engineer – in – charge, to take the weight of the cable tray with the cables.

1.1.6 The entire tray (except in the case of galvanized type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.

1.1.7 The cable tray shall be bonded to the earth Terminal of the switch bonds at ends.

The cable tray shall be measured on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross joints, etc, and paid for accordingly.

The ladder type of cable tray shall be fabricated of double bended channel section longitudinal members with single bended channel section rungs of cross members welded to the base of the longitudinal members at a center to center spacing of 250 cm as per IS.

GENERAL NOTES FOR LIGHTING

1.1 All dimensions are in millimeters, unless noted otherwise.

1.2 Wiring for non-flameproof type lighting fixtures and 6/16 A, 1 phase, receptacles shall be carried out with 250 V grade, stranded, 2.5 / 4 sq.mm copper FRLS PVC insulated flexible wires in heavy gauge PVC conduit. For flameproof type light fixtures and power sockets and for non – flameproof type fixtures wherever asked for, 3C X 2.5/4 sq.mm armored copper FRLS PVC cable of 1.1 KV grade shall be used.

1.3 Lighting fixtures, switch boxes and receptacles shall be earthed by 12 SWG G.I / 14 SWG Cu. wires running all along the conduit / cable, connected to the nearest earth bus.

1.4 Switches and receptacles of same phase located closed to each other shall be housed in a common 14 SWG MS enclosure.

1.5 A maximum of following nos. and size of the wires can be taken through conduits of the sizes indicated. (Conduit of less than 19 mm dia shall not be used).

conduit size mm	maximum nos. of wires in a conduit 2.5 sq.mm	4 sq.mm	6 sq.mm
19	4	2	2
25	6	5	4

38 12 10 9

1.6 Conduits and cables shall be supported at every 400 mm interval respectively with GI. Spacers and clamps.

1.7 Threaded conduit terminating on flameproof equipment shall be made of minimum 25 mm length of engaged threads.

1.8 Conduits shall be sealed properly at entry to flame proof switchgear and also wherever passing from non hazardous area to hazardous area.

1.9 Switches, switch boxes, receptacles, etc. shall be mounted in such a manner that their bottom side shall remain at a height of 1200 mm from the finished floor level. Lighting Panels shall be mounted at 1500mm height from FFL.

1.10 Looping of wires / cables should be made from fixture to fixture.

1.11 Casings / battens shall be fixed by means of screws and PVC wall plugs at intervals of 400 mm.

1.12 Conduits and conduit fittings shall be of heavy duty PVC type.

1.13 Conduits / cable runs shown on drawings are for guidance. Exact locations shall be determined at site by the Electrical contractor.

1.14 Lighting fixtures, switches, receptacles, junction boxes, etc. located in hazardous areas shall be of flameproof construction as per IS : 2148.

1.15 Conduits / cables for lighting fixtures located outside the building shall come out from inside near the location of the lighting fixtures.

1.16 Wiring shall be color coded and wires of the same phase only shall run in the same conduit.

1.17 Three phase lighting distribution board/ lighting panels shall be earthed with two independent earth strips / wires connected to the nearest earth bus, as per std. drawing. Single phase lighting distribution board / lighting panel shall be earthed with one earth wire.

1.18 All emergency lighting units shall be mounted at 2500 mm height from F.F.L.

1.19 All runners, G.I. Pipe sleeves, tray buckets, cleats, supports, etc. required to mount the lighting fixtures / lighting distribution boards / receptacles / switch boxes / lighting panels and laying of cables / conduits shall be provided by the Electrical contractor.

LIGHT FIXTURES

SPECIFICATIONS

Light fixtures as mentioned in the BOQ with the catalogue nos. and makes shall be installed. The fixtures shall be complete with ballast and shall be prewired by the manufacturer.

Fans of the approved makes and size shown in the drawing shall be used and install in the hook type M.S. box used by the CLIENT.

WORKMANSHIP

The fixture shall be installed on wall / ceiling as directed and as per manufacturer's instruction, with necessary accessories for surface, concealed, suspended from ceiling, bracket mounting etc. The job also includes connection of fixture with respective outlet point with heat resistant wires through heat resistance sleeve and PVC connector. The exhaust fan shall be installed complete with M.S. angle iron mounting

frame/ ring, G.I. louvers, wire mesh and plug at the end of the cord including wiring & earthing etc. Proper earthing shall be provided to the fixtures.

MODE OF MEASUREMENT

The unit rate shall be considered for fitting one fixture. The rate shall include following:

All fixing accessories, mounting bracket, ballast condensers and control gear wherever applicable.

Supplying and fixing Ball and socket joints wherever required.

Earthing of fittings.

Electrical connections to fittings/fans from the junction box/ceiling rose.

Installation and interconnection of Electronic regulators for ceiling fans.

Supplying and fixing 300 mm. GI down rod for ceiling fans.

J EARTHING

SPECIFICATION

PLATE ELECTRODE EARTH STATION:

The earth station shall be as shown on the drawing and shall be used for equipment earth grid and/or street light pole earthing and shall be as per IS 3043.

The earth electrode shall plate of copper / GI as per BOQ of size in BOQ with copper or GI strip of required size as per BOQ coming out to ground level.

The earth resistance shall be maintained with a suitable soil treatment as shown on the drawing.
The resistance of each earth station should not exceed 5 ohms.

The earth lead shall be fixed to the pipe with a nut and safety set screws. The clamp shall be permanently accessible.

The earthing grid and the earthing conductor shall be hot dip galvanized iron strips of the size as shown in the drawing.

G.I. pipe with funnel of approved quality shall be used for watering the earth electrode \ station.

The block masonry chamber with Cast Iron hinged cover shall be provided for housing the above referred funnel and pipe.

The hardware and other consumable for earthing installation shall be brass or hot dip galvanized iron material as shown on the drawing.

EARTH LEADS AND CONNECTIONS:

Earth lead shall be galvanized steel as specified with sizes shown on drawings. Copper lead shall have a phosphor content of not over 0.15 %. Galvanized steel buried in the ground shall be protected with bitumen and Hessian wrap or polythene faced Hessian and bitumen coating. At road crossing necessary Hume pipes shall be laid. Earth lead run on surface of wall or ceiling shall be fixed on saddles so that strip is at least 8 mm away from the wall surface.

The complete earthing system shall be mechanically and electrically bonded to provide an independent return path to the earth source.

WORKMANSHIP

Following activities shall be carried out for the earthing station

- Excavation in hard murrum.
- Laying Watering pipe.
- Brick masonry with hinged covers.
- Charcoal and Salt fill.
- Earth station should be 1 mtr. away from building.
- Keep minimum 3 mtr. distance between two earth pits.
- The pit should be minimum 10ft deep.
- The earth resistance should not exceed 5 ohm.
- All earth pits of same category shall be interlinked with strip.

Following points shall be followed strictly.

The plate electrode, as far as practicable, shall be buried below permanent moisture level but in no case not less than 2.5 M below finished ground level.

The plate electrode shall be kept clear of the building foundation and in no case; it shall be nearer by less than 2 M from outer face of the respective building wall \ column.

The plate electrode shall be installed vertically and shall be surrounded with 150 mm. thick layers of Charcoal dust and Salt mixture.

20 mm. dia. G.I. pipes for watering shall run from top edge of the pipe electrode to the mid level of block masonry chamber.

Top of the pipe shall be provided with G.I. funnel and screen for watering the earth \ ground through the pipe.

The funnel with screen over the G.I. pipe for watering to the earth shall be housed in a block masonry chamber as shown in the drawing.

The masonry chamber shall be provided with a Cast Iron hinged cover resting over the Cast Iron frame, which shall be embedded in the block masonry.

Construction of the earthing station shall in general be as shown in the drawing and shall conform to the requirement on earth electrodes mentioned in the latest edition of Indian Standard IS: 3043, Code of Practice for Earthing Installation.

The earth conductors (Hot dip G.I. strips) inside the building shall properly be clamped / supported on the wall with Galvanized Iron clamps and Mild Steel Zinc Passivated screws / bolts. The conductors outside the building shall be laid at least 600 mm. below the finished ground level.

The earth conductors shall either terminate on earthing socket provided on the equipment or shall be fastened to the foundation bolt and / or on frames of the equipment. The earthing connection to equipment body shall be done after removing paint and other oily substances from the body and then properly be finished.

Over lapping of earth conductors during straight through in joints, where required, shall be of minimum 75mm. long.

The earth conductors shall be in one length between the earthing grid and the equipment to be earthed.

Additional equipment earthing shall be done with Cu strip / Bare Cu Wire as per size indicated in drawing.

Lightening arrestors shall be installed at topmost point of the building. The quantity for the same shall be designed & specification in BOQ to cover total building area. Finial type arrestor shall be used with Cu pipe & Cu base plate. The arrestor / base plate shall be connected to separate earth pit with Cu Strip.

Following tests shall be carried out:

The entire earthing installation shall be tested as per requirements of Indian Standard Specification IS: 3043.

The following earth resistance values shall be measured with an approved earth megger and recorded.

Each earthing station
Earthing system as a whole
Earth continuity conductor

Earth conductor resistance for each earthed equipment shall be measured which shall not exceed 5 Ohm in each case.

Measurements of earth resistance shall be carried out before earth connections are made between the earth and the object to be earthed.

MODE OF MEASUREMENT

Earthing stations shall be measured in units whereas earthing strips and wires shall be measured in rmt.

LIGHTNING PROTECTION SYSTEM

1. General

The lightning protection system shall be of the enhanced type which is designed to attract lightning to a preferred point and safely convey the lightning energy to ground with minimal risk of side flashing via a pre-determined route.

The complete lightning protection system will comprise the following key components.

- Advanced Lightning Air terminal.
- Mounting support.
- Downconductor.
- Lightning Strike Recorder.
- Dedicated Earthing System.

Advanced Lightning Air Terminal

2.1 The advanced lightning Air Terminal shall be of a “Early Streamer Emission Terminal” type and will respond dynamically upon leader activity in the near area.
2.2 The advanced lightning Air Terminal shall be configured as a spheroid which is comprised of separate electrically isolated panels surrounding an earthed central finial.
2.3 The insulation material used to electrically isolate the panels shall comprise of a base polymer which provides high ozone and UV resistance with a dielectric strength of 24 – 38 KV/mm.
2.4 The external shape of the advanced lightning Air Terminal shall be such that it will limit the development of sharp point corona discharge under static thunderstorm conditions.
2.5 The central finial shall be elevated above the spheroid to a length of 86mm.
2.6 The upper section of the central finial shall be rated to withstand 200KA.
2.7 An air gap shall be provided between the individual electrically isolated panels
2.8 (4 panels) and the blunt configured tip of the central rod.
2.9 Arcing shall occur between the panel sections of the spheroid and the finial tip only upon the progression of a lightning leader.
2.10 The advanced lightning Air Terminal shall have no moving parts and will have no dependence on external power supply or batteries. There will be no high impedance static drain unit between the central rod and the panels.
2.11 The advanced Lightning Air Terminal will not have any electronic parts or components for propagation of up streamer.
2.12 Under a normal atmosphere all components of the advanced lightning terminal shall be non corroding.
2.13 The advanced lightning Air Terminal shall be insulated from all surrounding points and features of the structure being protected.

2.14 The advanced lightning Air Terminal shall be installed as per the manufacturers instructions.
2.15 The lightning air terminal shall be tested and certified in accordance with the French National Standard – NF C 17-102 and IEC Test Standard – IEC60- 1:1989.

Mounting Support of Lightning Rod

3.1 The mounting pole used to support the lightning Air Terminal shall be a minimum height of 2 meters.
3.2 The mounting pole and supports shall be securely fixed with brackets and guy wires where required.
3.3 Use Supporting Guyed Mast or Cantilever Mast as per site condition.
3.4 Supporting mast must be non corrosive.
3.5 The down conductor shall pass through the centre of the pole mast for the entire length of the pole and exit near the bottom

Downconductor

4.1 Each lightning air terminal should be fixed with one down conductor.
4.2 The down conductor should have a minimum size of 70mm² and can be a bare or insulated round / flat copper conductor.
4.3 The down conductor shall consist of Electrical grade Copper, minimum 70Sq.mm cross-sectional area. Tasted as per ISI 694 Over all dia 15.5mm.The down conductor should be fixed via conductive mounting clamps.
4.4 The down conductor should be fixed securely every one meter.
4.5 As an alternative the use of a high voltage shielded cable is acceptable. The high voltage shielded cable shall consist of a core filler, stranded copper conductor, insulation material, outer copper conductor with external conductive sheath.

Lightning Strike Recorder

5.1 All systems shall be installed complete with the lightning strike recorder.
5.2 The lightning strike recorder shall contain a mechanical 6 digit display which will register all lightning discharges with a sensitivity of 1500A 8/20 µs peak current impulse.
5.3 The lightning strike recorder shall be housed in a IP 65 rated enclosure and will operate without reliance on batteries or an external power source.
5.4 The lightning strike recorder shall be installed as per the manufacturers instructions.
5.5 It shall be shown that the event recording device has been successfully tested under test standard IEC 60-1:1989.

GROUNDING

6.1 The grounding system shall consist of deep driven copper bonded steel core ground rods.
6.2 Each lightning Protection system must have min. 03Nos of earthing pit.
6.3 The use of ground resistance improvement material shall be applied in order to reduce the resistivity levels of the grounding system and maintain a constant low resistivity. The grounding system shall be maintenance free.
6.4 All the earthing pit should be interconnected by use of copper strip/ cable.
6.5 All components of the grounding system shall be electrically connected to the central injection rod which is securely connected to the lower end of the down conductor.
6.6 The grounding system shall be installed so that the final impedance reading does not exceed 10 Ohms unless otherwise stipulated by the lightning protection manufacturer or consulting engineer.

LPI Lightning Protection Specification :

SR. No.	Descriptions	Details

1	Stormaster ESE Air Terminal.	Radius of Protection Min. 32Mtr - 107Mtr.
2	Type	Early Streamer Emission.
3	Material	Anodized Aluminum / S.S
4	Lightning Impulse Current	180KA-200KA.
5	Test Standard	NFC 17-102 & IEC 60-1:1989.
6	External power Supply	Non Electronic Type so no need of power supply.
7	Maintenance	Not required since it is non electronic.
8	Down Conductor : 70Sq.mm Copper Cable	Down conductor PVC insulated single core multi stand copper cable suitable grade for 1.1KV As per IS -694.
9	Lightning Strike Recorder	Operating Range Min. 1500A Max. 220KA
10	Display	06 Digits Mechanical.
11	Test Standard	IEC 60-1:1989.
12	External Power Supply	Non Electronic Type so no need of power supply.
13	Earthing Rod	MAP 10' x 5/8" Copper Bonded. (250micron copper bonded)
14	Earth Enhancing Compound	MAP Ground Resistance Lowering Compound.

UNINTERRUPTED POWER SUPPLY (UPS) SYSTEM

GENERAL SPECIFICATION OF UPS SYSTEM

OPERATION PHILOSOPHY

UPS system with double conversion technology based using two converters, Rectifier (AC to DC) and Inverter (DC to AC) shall be provided.

Under normal conditions, when AC mains power is available, rectifier shall supply DC power for float / rapid charging the battery and simultaneously to inverter.

In case of failure in rectifier/incoming supply, the battery shall feed the inverter without any interruption.

Normally inverters will be synchronized with bypass supply. When a disturbance / fault occurs in inverter, the complete load shall be transferred to connected emergency bypass supply through static switches and retransfer of load from bypass supply to the inverter shall be automatically.

UPS DESIGN & PERFORMANCE REQUIREMENTS
Rectifier

- Incoming AC supply shall be converted to DC through phase controlled rectifier. The rectifier shall operate according to the constant voltage current liming principle and shall incorporate a "Soft Start" feature to gradually accept load on initially energizing.
- The rectifier section of the UPS system shall be capable of precise regulation to prevent damage to the battery. The output voltage of rectifier's DC bus without the battery shall be stabilized to within +/- 1% of set value during load variation between 0 to 100% of the rectifier and specified mains input supply voltage variation.

- Transient / surge protection circuit shall be provided in the input circuit to rectifiers to protect the UPS from surges & voltage spikes.

- The UPS system shall be designed to draw power from the mains supply at a minimum power factor of 0.9 while working at rated load in normal operating UPS configuration.

- Facility for initial charging of batteries shall also provide. The inverter shall be disconnected during initial charging of the battery.

- The rectifier / charger shall be designed to completely charge the battery in a maximum time of 10 hours after complete discharge. Facilities shall be provided to initiate battery rapid charge operation by Manual & Automatic means. An auto charging sequence should be provided for the rapid and floating charging based on current sensing.

- Facility shall be provided to enable testing of rectifier independent without disconnection of inverter.

- The rectifier shall be sized based on the maximum inverter input load when inverter is delivering its rated output at 0.8 p.f. lagging + recharge the battery to nominal rated capacity of the battery.

- The DC rectifier shall sense the battery charging current and adjust the DC bus voltage to maintain the charging current to preset level. A separate current limit circuit shall be provided for adjustment of battery current.

- The rectifier shall be protected against **Reverse battery connection** at DC link voltage bus. Subsequent to a discharge cycle when battery is connected to rectifier, the battery current shall be monitored, controlled and limited to set value automatically irrespective of the inverter input current.

- The battery may be taken output of service for maintenance, during which period it shall be possible for the inverter to continue operation by drawing power from the rectifier. Ripple content at the DC link shall not exceed 2% RMS even with battery battery disconnected.

Battery

- Batteries shall be indoor, stationary type, Sealed Maintenance Free type as specified in data sheets.
- Battery sizing, the following factors shall be considered;
- Load power factor of 0.8
- Battery current = $\frac{\text{Inverter rated KVA x Load P.F.}}{\text{Inverter efficiency x end Cell voltage x No. of cells}}$

- Minimum end cell voltage 1.75 V per cell
- Back up time 30 minutes
- Aging factor 0.8 (As per IEEE 485)
- Capacity Factor

Inverter

- The inverter shall operate satisfactorily for variation of DC bus voltage from fully discharged condition of the battery to rapid charge voltage of the battery and inverter output load current.
- It shall be possible to vary the inverter output voltage sleeplessly within +/- 5% of the specified output voltage. This adjustment shall be possible to be made when the inverter is in operation.
- The steady state output voltage and frequency (free running) variation of inverters shall not exceed +/- 1% from the et value for specified input power supply conditions from no load to full load condition and load power factor variation from 0.6 lag to 1.0
- The UPS output voltage waveform shall be sinusoidal. The Total Harmonic distortion of voltage waveform at inverter output shall not exceed 3% if the RMS value of the fundamental considering any linear load up to maximum rated output of UPS system at rated power factor and not exceeding 5% under non-linear load.
- The UPS shall have capacity to deliver a minimum overload of 125% fir 10 minutes and 150% for 60 secs. UPS shall be provided with current circuit to avoid excessive loading beyond its permissible overload withstand capability.

- Inverter shall be 'phase locked' to the bypass power supply as long as bypass supply frequency remain within +/- 6% of nominal. When bypass supply frequency variation exceeds the above limits, the inverter shall be delinked from mains. Free running frequency tolerance limit shall not be exceed +/- 1% Facility shall also be provided for adjustment of synchronizing frequency from 1% to 6% in the steps of 1%.
- Both Sync and Async transfer facility shall be provided & it should be programmable.
- For Sync and Async mode selection both Frequency and Voltage level programmable

Static Switch

- Suitable rated bi-directional Thyristorised static switch must be provided in the inverter output and bypass supply to ensure positive isolation of faulty section such that the other inverter/bypass circuits do not freed into the fault to under voltage / trip. The short time rating of all the static switches shall be at least 10 times the rated output for than the fault clearing time of the type of fuse provided.
- Facility shall be provided to manually and automatically initiate transfer of the load from inverters to the bypass supply and manually from bypass supply to the inverter. Under voltage and over voltage sensing levels to initiate transfer shall be adjustable. The transfer time between inverters and bypass supply shall not exceed 4 msec and 20 msec in synchronous and asynchronous mode respectively.

Bypass Line Equipment

- Bypass line equipment consist of 3-ph to 1-ph Isolation transformer followed by Solid State Voltage Stabilizer.
- The steady state output voltage and frequency (free running) variation shall not exceed +/- 1% from the set value for specified input power supply conditions from no load to full load condition.

GERERAL REQUIREMENTS:

- UPS Design Temperature : 50 Deg C
- Paint shade : RAL 7032
- Degree of Protection for UPS Enclosure: IP-42
- All the thyristors, diodes and other electronic devices of UPS shall be protected with high speed semiconductor fuses. I2t co-ordination characteristics between fuse and semi-conducting power devices shall be furnished.
- All PCBs shall be provided with a transparent epoxy coating for environmental protection and tropicalisation. They shall be suitably located away from heat sources.
- All electronic control and monitoring and printed circuit cards shall be suitable for easy replacement. Monitoring points shall be provided on each of the PCBs and the PCB shall be firmly clamped in position so that vibration or long usage does not result in loose contacts. All PCBs shall be placed in a manner to avoid replacement of a PCB by a wrong spare PCB. Failure of each PCB shall be indicated by visual alarms.
- Maximum noise level from UPS system at 1 meter distance, under rated load with all normal cooling fans shall not exceed 70 dBA.

ALARM, CONTROL, INDICATION AND METERING REQUIREMENTS

- Following alarm, control, indication and metering will be provided using LCD display. Power flow diagram to be provided on each UPS module.
- SNMP connectivity require.

Metering:

Rectifier

- Incoming line voltage
- Input line current
- DC voltage at each rectifier output
- Battery charging / discharging current.

Inverter

- AC voltage at each inverter output

- AC current at each inverter output
- Frequency meter at inverter output.

Load

- Voltage
- Current
- Frequency

Alternate

- Output Voltage
- Output Current
- Output Frequency
-
-
- Indications :

- Ac mains 'ON' – Rectifier
- Ac mains 'ON' – Alternate

Rectifier

- Rectifier output 'ON'
- Battery on float charge
- Battery on boost charge

Inverter

- Load on Inverter
- Inverter synchronized with mains.

Audio visual alarm

- Input under voltage
- Input over voltage
- Battery discharging.
- End of battery discharge.
- Battery low.
- Inverter overload.
- Inverter under voltage
- Inverter over voltage
- Alternate over voltage
- Alternate under voltage
- Alternate output of limit
- DC over voltage
- Inverter overload trip
- Over Temperature.
- CPU fault
- Inverter disconnected.

Additionally:

- True measurement for all parameters requires.
- Cooling require using 100% redundant fans only.
- Input single phasing facility requires.
- Switchgear must be placed on 300 mm height from the Gland plate of the UPS.
- Panel thickness shall be 1.6 mm for non load bearing & 2 mm for the load bearing require.

Bidder has to submit;

Their Quality plan, UPS & Battery GA drawing & single line scheme along with the type TC of enclosure along with offer submission.

- Technical Datasheet for all rating UPS System and submit dully sign & stamp copy of the same along with the offer.
- Confirmation on the single line scheme provide with enquiry documents.
- Compliance against General specs along with the DEVIATION sheet.
- Battery calculation sheet as per IEEE.
- Product Catalogue.

10 KVA ONLINE UPS SYSTEM

Sr. No.	Description	Technical Specification Requirement	Bidder's Data *
1.00	**Topology**	Voltage & Frequency independent VFI-SS-111	
2.00	**Nominal output power from PF=0.6 lag. to 0.9 leading**	KVA/KW = 10/8	
3.00	**Overall Efficiency at 100% load**	> 85%	
4.00	**Audible noise level**	< dB (A) 70 from 1 mtr. Distance	
5.00	**Battery Bank**	12 V SMF Battery Bank	
5.01	**Battery type & backup time**	30 min. backup	
6.00	**Operating temperature range**	UPS : 0°C ÷ 50°C (Without derating)	
7.00	**Relative Humidity**	Max. 95% (non-condensing)	
8.00	**Max. altitude without power derating**	1000mtr	
9.00	**Enclosure**		
9.01	Construction	CRCA Steel Sheet	
9.02	Protection Class	IP-42 with Air filter cartridge (Type test certificate to be submitted with the enquiry documents)	
9.03	Ventilation	Forced Air (using 100% Redundant Fans)	
9.04	Cable Entry	Bottom	
10.00	**Standards**	IEC 62040-3	
11.00	**Internal protection**	All live parts shrouded	
12.00	**Finish (Powder Coated)**	RAL 7032	
13.00	**Installation**	Floor mounted	
Sr. No.	**Description**	**Technical Specification Requirement**	**Bidder's Data ***
14.00	**Service access**	Front and Back access – For Maintenance purpose only	
15.00	**External cable connections**	Bottom at front of the cabinet	
16.00	**Switchgear placement**	Minimum on 300 mm height from the gland plate.	
17.00	**RECTIFIER cum Charger**		
17.10	Standard input voltage	Nominal: 415V, +15%, -25%, 3Ph, 3W	
17.20	Input frequency	50Hz, +/-6%	
17.30	**Input Power factor**	Better than 0.95 @ Full load	
17.40	**Min. Current rating of Battery Charger to fully charge the Battery in 8-10 Hrs.**	**5.2 Amp rating (min.), Require.**	
17.50	Inrush current	Limited by soft-start circuit	
17.60	Power walk-in	15 seconds	
17.70	Output voltage tolerance	+/- 1%	
17.80	DC voltage ripple	1% With Battery Bank	
17.90	Battery charging current limit	Programmable	
18.00	**BATTERY**		
18.01	Backup time	30 minutes at Full load, 0.8 PF	
18.02	Battery Calculation sheet	Require to submit	
18.03	**Battery bank Monitoring system**	Required	

18.04	Min. discharge voltage (programmable)	up to 305V (i.e., ECV = 1.75 V/Cell)	
18.05	Recharge time	8-10 Hrs, Fully charged	
18.06	Battery Circuit breaker	require	
19.00	**INVERTER**		
19.01	Inverter technology	Full wave, PWM Inverter using IGBT	
19.02	Nominal output voltage (on site programmable)	230 Vac, 1 Phase	
19.03	**Output Isolation transformer (for galvanic separation)**	Require as Inbuilt, Between Inverter & static switch circuitry.	
19.04	Output waveform	Pure Sine wave	
19.05	Efficiency (%)	90% or better	
19.06	Output voltage tolerance:		
19.07	- static	+/- 1%	
19.08	- dynamic (at load step 0 – 100 – 0%)	+/- 5%	
19.09	- dynamic (at load step 0 – 50 – 0%)	+/- 5%	
19.10	- recovery time	98% in <20ms	
19.11	- output voltage THD for 100% linear load	<3%	
19.12	- output voltage THD for 100% non-linear load (EN 50091)	<5%	
19.13	Output frequency	50 Hz	
19.14	**Output frequency tolerance:**		
19.15	- free-running	+/- 0.1%	
19.16	- with mains synchronization adjustable to	+/- 1% to +/-6% Field Programmable	
19.17	**Overload capability**	125% - 10 minutes, 150% - 1 minute	
19.18	Crest factor	CF = 3 : 1	
20.00	**BYPASS**		
20.01	Input connection	Separate (dual input-recommended) or common to the rectifier input	
20.02	Primary components	- Static switch (SCR based) on bypass	
20.03	Type of Switch	Make before break manual bypass switch	
20.04	Voltage limits for inverter/bypass load transfers	+/- 10% (adjustable)	
20.05	Overload on bypass	200% for 5 minutes, 800 % for 10 msec	
21.00	**INTERFACING**		
21.01	Programmable signalling voltage-free contacts	5 nos.	
21.02	**Serial channel RS232 (on Delta 9 pin connector) & SNMP Connectivity**	Required	
22.00	**METERING**	Required in LC Display	
22.00.0	**True measurement**	Require for all below metering;	
Sr. No.	**Description**	**Technical Specification Requirement**	**Bidder's Data ***
22.01	Voltage Metering: 1. Mains 2. Alternate 3. Battery 4. Inverter 5. Load	Required	
22.02	Current Metering: 1. Mains 2. Battery 3. Inverter 4. Load	Required	
22.03	Frequency Metering: 1. Mains	Required	

	2. Alternate 3. Inverter		
22.04	Power Factor Metering: 1. Total KVA & Total KW 2. Total Power factor 3. UPS KVA & UPS KW 4. UPS Power factor	Required	
23.00	**MAJOR ALARMS – WITH TEXT READOUT**	Provided in LC Display	
23.01	INPUT: 1. Under Voltage 2. Over Voltage	Required	
23.02	DC BUS : 1. Over Voltage	Required	
23.03	BATTERY: 1. Discharging 2. Under Voltage 3. End of Battery Discharge	Required	
23.04	INVERTER: 1. Under Voltage 2. Over Voltage 3. IGBT Limb Fault 4. Overload 5. Overload Trip (Inverse Time) 6. Over Temperature	Required	
23.05	ALTERNATE: 1. Under Voltage 2. Over Voltage 3. Frequency out of range	Required	
23.06	STATIC S/W : 1. Transfer to Bypass	Required	
24.00	**INDICATIONS**	Required on Front side of UPS Panel, Using LED's.	
24.01	Bypass Input : Absence, Within range, Out of range	Required	
24.02	Mains Input : Absence, Within range, Out of range	Required	
24.03	Charger Operation : ON, OFF, Trip	Required	
24.04	Battery Discharge	Required	
24.05	Battery Operation : Boost Charge, Float Charge, Discharge	Required	
24.06	Battery MCCB : ON, OFF	Required	
24.07	Inverter Operation : ON, OFF, Trip	Required	
24.08	Load on Inverter : Inverter SSW ON, Inverter SSW OFF	Required	
24.09	Load on Bypass : Bypass SSW ON, Bypass SSW OFF	Required	
24.10	Synchronization: Synch. No Synch.	Required	
24.11	Common Alarm Indication : Any Alarm Present	Required	

Sr. No.	Description	Technical Specification Requirement	Bidder's Data *
25.00	**Additional Requirement**		
25.01	Comprehensive LED Mimic required with the Single line Power Flow Diagram	Required	
25.02	Non-Volatile memory for last 250 Events logging with Date & Time	Required	
25.03	Minimum battery bank VAH Capacity	Min. VAH Capacity = Battery Block Voltage X Battery AH Capacity X No. of batteries **= 15120 VAH, minimum require.**	
26.00	**MANDETORY PROTECTIONS in the contemporary UPS :**		
26.1	Input single phasing protection require	Required	
26.2	Input circuit to be protected through fuse	Required	
26.3	Input surge Protection	Required	
26.4	RFI/EMI protection	Required	
26.5	I/p over & Under voltage protection	Required	
26.6	Soft start feature for Charger & Inverter	Required	
26.7	Charger circuit protection for short circuit	Required	
26.8	Battery protection through current limit	Required	
26.9	DC over-voltage & Under-voltage protection	Required	
26.10	Inverter Over-voltage & Under-voltage protection	Required	
26.11	Inverter short circuit protection	Required	
26.12	Inverter over-temperature protection using Redundant Fans as Forced air cooling	Required	
	All Power Devices are to be protected against di/dt & dv/dt	Required	
PLEASE NOTE : (Following instructions for Bidders)			
01	Product Catalogue of offered UPS model		
02	Enclosure IP class, Type test certificate require.		
03	Battery calculation along with VAH capacity calculation requires.		
04	(*) Bidder has to fill their own data against technical specification requirement and submit us dully sign & stamp copy of the same.		
05	Submit the single line scheme.		
06	Submit the 'DEVIATION SHEET'.		

15 KVA ONLINE UPS SYSTEM

Sr. No.	Description	Technical Specification Requirement	Bidder's Data *
1.00	**Topology**	Voltage & Frequency independent VFI-SS-111	
2.00	**Nominal output power from PF=0.6 lag. to 0.9 leading**	KVA/KW = 15/12	
3.00	**Overall Efficiency at 100% load**	> 85%	
4.00	**Audible noise level**	< dB (A) 70 from 1 mtr. Distance	
5.00	**Battery Bank**	12 V SMF Battery Bank	
5.01	**Battery type & backup time**	30 min. backup	
6.00	**Operating temperature range**	UPS : 0°C ÷ 50°C (Without derating)	
7.00	**Relative Humidity**	Max. 95% (non-condensing)	

8.00	**Max. altitude without power derating**	1000mtr	
9.00	**Enclosure**		
9.01	Construction	CRCA Steel Sheet	
9.02	Protection Class	IP-42 with Air filter cartridge (Type test certificate to be submitted with the enquiry documents)	
9.03	Ventilation	Forced Air (using 100% Redundant Fans)	
9.04	Cable Entry	Bottom	
10.00	**Standards**	IEC 62040-3	
11.00	**Internal protection**	All live parts shrouded	
12.00	**Finish (Powder Coated)**	RAL 7032	
13.00	**Installation**	Floor mounted	
14.00	**Service access**	Front and Back access – For Maintenance purpose only	
15.00	**External cable connections**	Bottom at front of the cabinet	
16.00	**Switchgear placement**	Minimum on 300 mm height from the gland plate.	
17.00	**RECTIFIER cum Charger**		
17.10	Standard input voltage	Nominal: 415V, +15%, -25%, 3Ph, 3W	
17.20	Input frequency	50Hz, +/-6%	
17.30	**Input Power factor**	Better than 0.95 @ Full load	
17.40	**Min. Current rating of Battery Charger to fully charge the Battery in 8-10 Hrs.**	**8.4 Amp rating (min.), Require.**	
17.50	Inrush current	Limited by soft-start circuit	
17.60	Power walk-in	15 seconds	
17.70	Output voltage tolerance	+/- 1%	
17.80	DC voltage ripple	1% With Battery Bank	
17.90	Battery charging current limit	Programmable	
18.00	**BATTERY**		
18.01	Backup time	30 minutes at Full load, 0.8 PF	
18.02	Battery Calculation sheet	Require to submit	
18.03	**Battery bank Monitoring system**	Required	
18.04	Min. discharge voltage (programmable)	up to 305V (i.e., ECV = 1.75 V/Cell)	
18.05	Recharge time	8-10 Hrs, Fully charged	
18.06	Battery Circuit breaker	require	
19.00	**INVERTER**		
19.01	Inverter technology	Full wave, PWM Inverter using IGBT	
19.02	Nominal output voltage (on site programmable)	230 Vac, 1 Phase	
19.03	**Output Isolation transformer (for galvanic separation)**	Require as Inbuilt, Between Inverter & static switch circuitry.	
19.04	Output waveform	Pure Sine wave	
19.05	Efficiency (%)	90% or better	
19.06	Output voltage tolerance:		
19.07	- static	+/- 1%	
Sr. No.	**Description**	**Technical Specification Requirement**	**Bidder's Data ***
19.08	- dynamic (at load step 0 – 100 – 0%)	+/- 5%	
19.09	- dynamic (at load step 0 – 50 – 0%)	+/- 5%	
19.10	- recovery time	98% in <20ms	

19.11	- output voltage THD for 100% linear load	<3%	
19.12	- output voltage THD for 100% non-linear load (EN 50091)	<5%	
19.13	Output frequency	50 Hz	
19.14	**Output frequency tolerance:**		
19.15	- free-running	+/- 0.1%	
19.16	- with mains synchronization adjustable to	+/- 1% to +/-6% Field Programmable	
19.17	**Overload capability**	125% - 10 minutes, 150% - 1 minute	
19.18	Crest factor	CF = 3 : 1	
20.00	**BYPASS**		
20.01	Input connection	Separate (dual input-recommended) or common to the rectifier input	
20.02	Primary components	- Static switch (SCR based) on bypass	
20.03	Type of Switch	Make before break manual bypass switch	
20.04	Voltage limits for inverter/bypass load transfers	+/- 10% (adjustable)	
20.05	Overload on bypass	200% for 5 minutes, 800 % for 10 msec	
21.00	**INTERFACING**		
21.01	Programmable signalling voltage-free contacts	5 nos.	
21.02	**Serial channel RS232 (on Delta 9 pin connector) & SNMP Connectivity**	Required	
22.00	**METERING**	Required in LC Display	
22.00.0	**True measurement**	Require for all below metering;	
22.01	Voltage Metering: 1. Mains 2. Alternate 3. Battery 4. Inverter 5. Load	Required	
22.02	Current Metering: 1. Mains 2. Battery 3. Inverter 4. Load	Required	
22.03	Frequency Metering: 1. Mains 2. Alternate 3. Inverter	Required	
22.04	Power Factor Metering: 1. Total KVA & Total KW 2. Total Power factor 3. UPS KVA & UPS KW 4. UPS Power factor	Required	
23.00	**MAJOR ALARMS – WITH TEXT READOUT**	Provided in LC Display	
23.01	INPUT: 1. Under Voltage 2. Over Voltage	Required	
23.02	DC BUS : 1. Over Voltage	Required	
23.03	BATTERY: 1. Discharging 2. Under Voltage 3. End of Battery Discharge	Required	
23.04	INVERTER: 1. Under Voltage 2. Over Voltage	Required	

	3. IGBT Limb Fault 4. Overload		
Sr. No.	**Description**	**Technical Specification Requirement**	**Bidder's Data ***
	5. Overload Trip (Inverse Time) 6. Over Temperature		
23.05	ALTERNATE: 1. Under Voltage 2. Over Voltage 3. Frequency out of range	Required	
23.06	STATIC S/W : 1. Transfer to Bypass	Required	
24.00	**INDICATIONS**	Required on Front side of UPS Panel, Using LED's.	
24.01	Bypass Input : Absence, Within range, Out of range	Required	
24.02	Mains Input : Absence, Within range, Out of range	Required	
24.03	Charger Operation : ON, OFF, Trip	Required	
24.04	Battery Discharge	Required	
24.05	Battery Operation : Boost Charge, Float Charge, Discharge	Required	
24.06	Battery MCCB : ON, OFF	Required	
24.07	Inverter Operation : ON, OFF, Trip	Required	
24.08	Load on Inverter : Inverter SSW ON, Inverter SSW OFF	Required	
24.09	Load on Bypass : Bypass SSW ON, Bypass SSW OFF	Required	
24.10	Synchronization: Synch. No Synch.	Required	
24.11	Common Alarm Indication : Any Alarm Present	Required	
25.00	**Additional Requirement**		
25.01	Comprehensive LED Mimic required with the Single line Power Flow Diagram	Required	
25.02	Non-Volatile memory for last 250 Events logging with Date & Time	Required	
25.03	Minimum battery bank VAH Capacity	Min. VAH Capacity = Battery Block Voltage X Battery AH Capacity X No. of batteries **= 23400 VAH, minimum require.**	
26.00	**MANDETORY PROTECTIONS in the contemporary UPS :**		
26.1	Input single phasing protection require	Required	
26.2	Input circuit to be protected through fuse	Required	
26.3	Input surge Protection	Required	
26.4	RFI/EMI protection	Required	
26.5	I/p over & Under voltage protection	Required	
26.6	Soft start feature for Charger & Inverter	Required	
26.7	Charger circuit protection for short circuit	Required	
26.8	Battery protection through current limit	Required	
26.9	DC over-voltage & Under-voltage protection	Required	
26.10	Inverter Over-voltage & Under-voltage protection	Required	
26.11	Inverter short circuit protection	Required	
26.12	Inverter over-temperature protection using Redundant Fans as Forced air cooling	Required	

	All Power Devices are to be protected against di/dt & dv/dt	Required	
PLEASE NOTE : (Following instructions for Bidders)			
01	Product Catalogue of offered UPS model		
02	Enclosure IP class, Type test certificate require.		
03	Battery calculation along with VAH capacity calculation requires.		
04	(*) Bidder has to fill their own data against technical specification requirement and submit us dully sign & stamp copy of the same.		
05	Submit the single line scheme.		
06	Submit the 'DEVIATION SHEET'.		

20 KVA ONLINE UPS SYSTEM

Sr. No.	Description	Technical Specification Requirement	Bidder's Data *
1.00	**Topology**	Voltage & Frequency independent VFI-SS-111	
2.00	**Nominal output power from PF=0.6 lag. to 0.9 leading**	KVA/KW = 20/16	
3.00	**Overall Efficiency at 100% load**	> 85%	
4.00	**Audible noise level**	< dB (A) 70 from 1 mtr. Distance	
5.00	**Battery Bank**	12 V SMF Battery Bank	
5.01	**Battery type & backup time**	30 min. backup	
6.00	**Operating temperature range**	UPS : 0°C ÷ 50°C (Without derating)	
7.00	**Relative Humidity**	Max. 95% (non-condensing)	
8.00	**Max. altitude without power derating**	1000mtr	
9.00	**Enclosure**		
9.01	Construction	CRCA Steel Sheet	
9.02	Protection Class	IP-42 with Air filter cartridge (Type test certificate to be submitted with the enquiry documents)	
9.03	Ventilation	Forced Air (using 100% Redundant Fans)	
9.04	Cable Entry	Bottom	
10.00	**Standards**	IEC 62040-3	
11.00	**Internal protection**	All live parts shrouded	
12.00	**Finish (Powder Coated)**	RAL 7032	
13.00	**Installation**	Floor mounted	
14.00	**Service access**	Front and Back access – For Maintenance purpose only	
15.00	**External cable connections**	Bottom at front of the cabinet	
16.00	**Switchgear placement**	Minimum on 300 mm height from the gland plate.	
17.00	**RECTIFIER cum Charger**		
17.10	Standard input voltage	Nominal: 415V, +15%, -25%, 3Ph, 3W	
17.20	Input frequency	50Hz, +/-6%	
17.30	**Input Power factor**	Better than 0.95 @ Full load	
17.40	**Min. Current rating of Battery Charger to fully charge the Battery in 8-10 Hrs.**	**13 Amp rating (min.), Require.**	

17.50	Inrush current	Limited by soft-start circuit	
17.60	Power walk-in	15 seconds	
17.70	Output voltage tolerance	+/- 1%	
17.80	DC voltage ripple	1% With Battery Bank	
17.90	Battery charging current limit	Programmable	
18.00	**BATTERY**		
18.01	Backup time	30 minutes at Full load, 0.8 PF	
18.02	Battery Calculation sheet	Require to submit	
18.03	**Battery bank Monitoring system**	Required	
18.04	Min. discharge voltage (programmable)	up to 305V (i.e., ECV = 1.75 V/Cell)	
18.05	Recharge time	8-10 Hrs, Fully charged	
18.06	Battery Circuit breaker	require	
19.00	**INVERTER**		
19.01	Inverter technology	Full wave, PWM Inverter using IGBT	
19.02	Nominal output voltage (on site programmable)	230 Vac, 1 Phase	
19.03	**Output Isolation transformer (for galvanic separation)**	Require as Inbuilt, Between Inverter & static switch circuitry.	
19.04	Output waveform	Pure Sine wave	
19.05	Efficiency (%)	90% or better	
19.06	Output voltage tolerance:		
19.07	- static	+/- 1%	
Sr. No.	**Description**	**Technical Specification Requirement**	**Bidder's Data ***
19.08	- dynamic (at load step 0 – 100 – 0%)	+/- 5%	
19.09	- dynamic (at load step 0 – 50 – 0%)	+/- 5%	
19.10	- recovery time	98% in <20ms	
19.11	- output voltage THD for 100% linear load	<3%	
19.12	- output voltage THD for 100% non-linear load (EN 50091)	<5%	
19.13	Output frequency	50 Hz	
19.14	**Output frequency tolerance:**		
19.15	- free-running	+/- 0.1%	
19.16	- with mains synchronization adjustable to	+/- 1% to +/-6% Field Programmable	
19.17	**Overload capability**	125% - 10 minutes, 150% - 1 minute	
19.18	Crest factor	CF = 3 : 1	
20.00	**BYPASS**		
20.01	Input connection	Separate (dual input-recommended) or common to the rectifier input	
20.02	Primary components	- Static switch (SCR based) on bypass	
20.03	Type of Switch	Make before break manual bypass switch	
20.04	Voltage limits for inverter/bypass load transfers	+/- 10% (adjustable)	
20.05	Overload on bypass	200% for 5 minutes, 800 % for 10 msec	
21.00	**INTERFACING**		
21.01	Programmable signalling voltage-free contacts	5 nos.	
21.02	**Serial channel RS232 (on Delta 9 pin connector) & SNMP Connectivity**	Required	
22.00	**METERING**	Required in LC Display	
22.00.0	**True measurement**	Require for all below metering;	

22.01	Voltage Metering: 1. Mains 2. Alternate 3. Battery 4. Inverter 5. Load	Required	
22.02	Current Metering: 1. Mains 2. Battery 3. Inverter 4. Load	Required	
22.03	Frequency Metering: 1. Mains 2. Alternate 3. Inverter	Required	
22.04	Power Factor Metering: 1. Total KVA & Total KW 2. Total Power factor 3. UPS KVA & UPS KW 4. UPS Power factor	Required	
23.00	**MAJOR ALARMS – WITH TEXT READOUT**	Provided in LC Display	
23.01	INPUT: 1. Under Voltage 2. Over Voltage	Required	
23.02	DC BUS : 1. Over Voltage	Required	
23.03	BATTERY: 1. Discharging 2. Under Voltage 3. End of Battery Discharge	Required	
23.04	INVERTER: 1. Under Voltage 2. Over Voltage 3. IGBT Limb Fault 4. Overload 5. Overload Trip (Inverse Time)	Required	
Sr. No.	**Description**	**Technical Specification Requirement**	**Bidder's Data ***
	6. Over Temperature		
23.05	ALTERNATE: 1. Under Voltage 2. Over Voltage 3. Frequency out of range	Required	
23.06	STATIC S/W : 1. Transfer to Bypass	Required	
24.00	**INDICATIONS**	Required on Front side of UPS Panel, Using LED's.	
24.01	Bypass Input : Absence, Within range, Out of range	Required	
24.02	Mains Input : Absence, Within range, Out of range	Required	
24.03	Charger Operation : ON, OFF, Trip	Required	
24.04	Battery Discharge	Required	
24.05	Battery Operation : Boost Charge, Float Charge, Discharge	Required	
24.06	Battery MCCB : ON, OFF	Required	
24.07	Inverter Operation : ON, OFF, Trip	Required	
24.08	Load on Inverter : Inverter SSW ON, Inverter SSW OFF	Required	

24.09	Load on Bypass : Bypass SSW ON, Bypass SSW OFF	Required	
24.10	Synchronization: Synch. No Synch.	Required	
24.11	Common Alarm Indication : Any Alarm Present	Required	
25.00	**Additional Requirement**		
25.01	Comprehensive LED Mimic required with the Single line Power Flow Diagram	Required	
25.02	Non-Volatile memory for last 250 Events logging with Date & Time	Required	
25.03	Minimum battery bank VAH Capacity	Min. VAH Capacity = Battery Block Voltage X Battery AH Capacity X No. of batteries **= 27000 VAH, minimum require.**	
26.00	**MANDETORY PROTECTIONS in the contemporary UPS :**		
26.1	Input single phasing protection require	Required	
26.2	Input circuit to be protected through fuse	Required	
26.3	Input surge Protection	Required	
26.4	RFI/EMI protection	Required	
26.5	I/p over & Under voltage protection	Required	
26.6	Soft start feature for Charger & Inverter	Required	
26.7	Charger circuit protection for short circuit	Required	
26.8	Battery protection through current limit	Required	
26.9	DC over-voltage & Under-voltage protection	Required	
26.10	Inverter Over-voltage & Under-voltage protection	Required	
26.11	Inverter short circuit protection	Required	
26.12	Inverter over-temperature protection using Redundant Fans as Forced air cooling	Required	
	All Power Devices are to be protected against di/dt & dv/dt	Required	
PLEASE NOTE : (Following instructions for Bidders)			
01	Product Catalogue of offered UPS model		
02	Enclosure IP class, Type test certificate require.		
03	Battery calculation along with VAH capacity calculation requires.		
04	(*) Bidder has to fill their own data against technical specification requirement and submit us dully sign & stamp copy of the same.		
05	Submit the single line scheme.		
06	Submit the 'DEVIATION SHEET'.		

CONTROL OF WORK (CoW) STANDARD

Contractor should promptly follow work procedures and has to comply thought out the work.

1.	A **written procedure** shall exist describing the CoW process.
2.	All identified roles within the CoW procedure shall have defined **accountabilities**.
3	All persons involved in the CoW process shall be appropriately **trained and competent** to carry out their roles.
4	**Planning and scheduling** of work shall identify individual tasks and their interaction.
5	Tasks shall not be conducted without being **risk assessed.**
6	Before conducting work that involves confined space entry, work on energy systems, ground disturbances, hot work or other hazardous activities, **a permit** shall be obtained.
7	The scope, hazards, control and mitigations shall be **communicated** in writing and signed off by all involved in the task.
8	All ongoing work requiring a permit shall be regularly **monitored and managed** by a

	responsible person.
9	The work site shall be left in a safe condition on **completion or interruption** of the work.
10	The CoW process shall be subject to a program of regular **auditing.**
11	Internal and external **lessons learned** that impact the CoW process shall be captured, incorporated and shared.
12	The CoW procedure shall make it clear to everyone that they have and **obligation to stop unsafe work**.
13	Suitable **Personal Protective Equipments (PPEs)** are to be provided to the workmen to protect them against the unavoidable hazards.

SECTION III

GENERAL & INSTALLATION TECHNICAL SPECIFICATION

ELECTRICAL INSTALLATION - STANDARDS & SPECIFICATIONS

1. GENERAL

a) Scope of Work

The scope of work shall include the furnishing of all labour, materials, appliances, superintendence and services required to construct and install a complete and operable electrical system as herein specified and covered by the accompanying drawings. The items of work include, but are not limited to, the following:

1 Complete electrical power and lighting systems, covering H.T. Switchgear, Transformer, 415 volts Switchgear, switches, starters, lighting installation, cabling and other equipment including all outside conduits, wiring and incidentals as required.

2 Complete branch circuit wiring installation for lighting receptacles and miscellaneous items.

3 Installing and connecting all lighting luminaries complete with lamps, unless otherwise specified.

4 Supply and installing complete earthing system and test thereof.

5 Installing and connecting motor starters where specified.

6 Temporary electric lights and powers facilities, if required on the instruction of Engineer-in-Charge.

7 Complete conduit and wiring system including supply of plugs and sockets for telephones.

8 Materials or appliances, general purpose / weatherproof / flameproof as required, forming part of the electrical system and necessary for its operation, though not specifically mentioned, shall also be furnished and installed without additional charges.

9 Contractor’s scope of work will include liosining & passing work with supply company,all statutory & government authorities.

10 Contractor will have to prepare as built drawings & will submit the same to client after getting verified through consultant.

11 Contractor’s warrenty period will either be of 18 Months from supply of material or 12 months from final acceptance of his work.

b) Drawings

1 The work covered by these specifications is shown on the drawings, which constitute an integral part of the specifications.

2 The electrical contractor shall work in close co-ordination with the architectural, structural, HVAC, plumbing and piping contracting sections, to avert possible installation conflicts.

3 Discrepancies if any on different plans, or between plans and actual field conditions or between plans and specifications shall be promptly brought to the attention of the Engineer-in-Charge at site for a decision before proceeding with the work.

4 The drawings and specifications shall be considered complementary so that anything or any matter shown upon one or described by the other or fairly implied by either or both shall be done and performed as if shown upon and described by both.

5 One set of drawings shall be kept as record drawings. All deviations of the actual proposed installations as shown on the drawings should be marked in red on these drawings. On completion of the project, as-built drawings shall be prepared by the electrical contractor incorporating these changes and four sets of such drawings shall be handed over to the Engineer-in-Charge at the time of final handing over.

c) Personnel

All work shall be performed by Contractor under the direct supervision of a qualified person appointed by him and regularly engaged in the installation of electrical equipment. The contractor shall place in charge of the work at all the times during the construction. A qualified and experienced electrical engineer who shall be responsible for keeping liaison and co-ordination between Employer's personnel and his own men at site. He shall also submit progress reports every fifteen days. Anyone not deemed capable by the owner shall be replaced immediately upon such advice.

d) Tools and Testing Equipment

The work shall be performed using tools and testing equipment designed and approved for the purpose.

The following tools and testing equipments are recommended for carrying out the electrical installation work. The electrical contractor shall bring tools and equipment which may be necessary to carry out / complete the work, in addition to the tools and equipment suggested hereunder, if asked for by Engineer-in-Charge.

- 5000 volts constant pressure type motorized insulation tester (meager)
- 1000 volts constant pressure type insulation tester (merger)
- 500 volts constant pressure type insulation tester (meager)
- Universal Earth Tester
- Welding Sets
- Cutting Tools
- Derricks, if required
- Jacks
- Electric Blower
- Drilling Machines (different sizes)
- Grinding Machine
- Cable Crimping Tool
- H.T. and L.T. Cable termination and Jointing kits.
- Relay testing kit
- Tong Tester

- Portable Voltmeter
- Pipe bending machine
- Phase sequence indicator
- Portable test lamps with prongs
- Tachometer (0-3000 r.p.m.)
- Constant pressure type continuity tester
- Wiremen kits
- Fitter's tools
- Vices
- Die sets with difference dies
- Ladders (different sizes)
- Cable laying tools

e) Materials and Equipment

1 The materials and equipment to be installed as indicated on the electrical drawings and materials and equipment specifications, shall conform to the applicable codes and specifications mentioned in section I (f). The materials and equipment wherever specified and / or indicated as supplied by others shall be installed by the contractor as recommended and advised by the manufacturers of such equipment. Care shall be taken in handling the materials to properly protect them from damage during transport and installation. All electrical materials supplied by the contractor shall be new, unless agreed otherwise in writing by Engineer-in-Charge.

2 The contractor shall obtain the approval of Engineer-in-Charge for all the materials to be used by him prior to installing them. Equipment damaged by the contractor in the course of handling, installation or test shall be replaced or repaired by him without any additional charges and subject to the approval of the owner / engineer-in-charge.

f) Codes and Specifications

All materials and equipment shall be installed in accordance with the latest Indian Electrical Codes and Standards. Installation shall be approved by the Chief Electrical Inspector. It will be the Contractor's responsibility to obtain the approval of the electrical installation work from all Statutory Authorities.

g) Cutting, Patching and Excavation

The contractor shall do all excavation and cutting required for the installation work and shall be responsible for any damage that may be caused to the work of others. He shall, where possible, keep the excavation, cutting and patching to a minimum. If the electrical contractor fails to perform his work in the proper manner or at proper time and due to this, additional excavation, cutting and patching is required, the contractor shall do such additional cutting and patching without any extra cost to employer.

h) System of Working

The work shall be carried out in a systematic way in proper sequence and order. Priorities of work shall be fixed by the Engineer-in-Charge at site. All these priorities shall be strictly adhered to. Until the particular part of the work is approved or certified complete by the Engineer-in-Charge at site; the contractor shall not take up the consequent work connected with the part work completed but uncertified as completed.

i) Protection

The contractor shall furnish and place proper guards for prevention of accidents. He shall provide and maintain any other necessary constructions required to ensure safety of life and property involved in his work.

2. H.T. SWITCHGEAR

a) Inspect the switchgear thoroughly and check during unpacking that all the items stated in the packing list are included and no damage has occurred to any part including all instruments, relays, etc. It is particularly important to be thorough in inspecting the moving mechanism parts as well as items of insulating material of the breakers.

b) If the switchgear is supplied in sections, assembly of the same will be of electrical contractor's responsibility. Relays and instruments, if received separately, will also be installed by the electrical contractor.

c) During installation, the circuit breakers and the operating mechanism must be in the open position. The closing springs should not be charged.

The circuit breakers are required to fit their foundations without any discrepancies. All deviations must be adjusted with shims or spacers in order to avoid any stress.

d) Installation of all parts should be carried out as per the instructions manual supplied by the manufacturer.

e) Lubricate the circuit breaker gears and other sliding surfaces, shaft, etc. with lubricating oil.

f) The spring-closing mechanism must not be subject to any distortion. The springs should not be altered without consulting with the manufacturer.

3 TRANSFORMER

a) Transformer should be lifted by lugs or shackles provided for the purpose and simultaneous use should be made of all such lugs or shackles in order to avoid any unbalance in lifting. Before lifting the transformer, it should be checked and ensured that all cover bolts are tight.

b) Check transformer thoroughly for any external damage that might have occurred during transit. The most likely damages are: Tank sides or cooling tubes dented

ii. Protruding fittings damaged, V12, oil sight glass, valves, etc.

iii. Bushings cracked or broken.

iv. Bolts loosened due to vibration in transit.

v. Oil leakage along the welds or due to loosening of nuts and bolts. Tighten all nuts and bolts as necessary.

c) Prepare a report for any damage and furnish to the Engineer-in-Charge.

d) Check whether all parts and accessories are supplied by the manufacturer as per the packing list and purchase order,and report to the Engineer-in-Charge.

e) Install oil conservator, explosion vent, Buchholz relay, breather, thermometer, oil level indicator, Marshalling box, etc. properly, if supplied loose with the transformer. In such case, rinse and wash the oil

conservator, explosion vent, buchholz relay, etc. with extra transformer oil (supplied loose by manufacturer) and then only install.

f) After installing the transformer on the ready foundation, the wheels should be locked by welding angles placed to the foundation channel.

g) Transformer installation shall be completed in all respects as per IS 10026 and as per manufacturer's recommendation.

4 LT SWITCH BOARD

a) These shall be installed with utmost care as per the recommendations of the manufacturer and the drawings. The electrical contractor shall be responsible to replace or repair any part, free of cost, if it gets damaged during the installation or due to mishandling of equipment.

b) All connections shall be made as per vendor's drawings and before commissioning, over load and relay settings shall be adjusted as directed by the equipment supplier / Engineer-in-Charge.

c) If any switch bends is supplied in sections, assembly of the same will be the electrical contractor's responsibility. Relays and instruments, if received separately, will be installed and connected by the electrical contractor.

d) Installation of all switchgear shall conform to IS -10118.

e) After the installation, assembly and connection, the tightness of all connections shall be checked. All panels and modules shall be cleaned by blower before energizing.

5 WIRES AND CABLES

a) General

i. Installation of wires and cables shall be in accordance with I.S. 732. All wires shall run from box to box without splices.Sharp bends shall be avoided. They shall be pulled in or laid in such a manner that the insulation is not damaged at the time of installation or in service. Care shall be exercised to ensure avoidance of any moisture in terminations. The wire / cable being laid shall be in one length, and straight joints shall be avoided as far as possible.

Insulation shall be removed for making terminations in such a manner that the conductor is not damaged. Conductors shall be clean and free from burrs.

ii. The current carrying ability of the terminations shall be equal to or greater than the wire / cable being terminated, without dependence on the solder. The termination shall be mechanically secure, without dependence on the crimping. Solder and soldering flux, if used, shall be non-corrosive and of a make approved by the cable or wire manufacturer.

iii. Minimum wire size shall be 2.5 sq. mm. copper. Above 10 sq. mm. size, all wires shall be stranded. All wire and cable runs under (i) poured concrete or road beds and (ii) passing through walls shall be in (i) RCC pipes and (ii) conduit sleeves respectively.

No wire or cable shall be run through any equipment foundation unless specifically indicated in the drawings, or directed in writing by Engineer-in-Charge. Cables shall be kept at least 300 mm away from steam or other hot lines. Where closer than this, asbestos barrier shall be used between pipe and cables.

The armoring of all armored cables shall be electrically continuous from Switchgear to equipment and shall be terminated by an appropriate gland fitting and grounded at both ends. Minimum bending radius shall be 12 to 15 times the outside diameter of the cables as recommended by the cable manufacturer.

iv The color code of wires shall be same throughout the installations and shall be approved by the Engineer-in-Charge. (Where more than one neutral is carried in the same conduit, the neutral conductors shall be identified.)

v Where color coding is not practicable or possible, the above scheme shall be achieved by the use of color bands provided by the electrical contractor.

vi No oil, grease or compound other than powdered soap stone shall be used to facilitate the pulling of wires. Buried cable shall be installed with sufficient slack in the trench along the cable length.

vii The electrical contractor shall arrange all cables and wires in neat formations along the wall or in suitable cable trays as shown and indicated in the drawings, including supply and installation of all supporting steel work like angles, channels, etc. and painting of the same.

b) 415/240V System

i Wires drawn in conduit will be unarmored. Cables laid in trays or buried in the ground shall be armored.

ii The number of wires and conduit sizes indicated for the various circuits (control, alarm and signal) were decided for a general scheme of wiring. The actual number of wires installed for each circuit and the required size of conduit shall,however, be as required to accomplish the specified results as required by the manufacturer of the said control equipment. wires connected to the same phase and for the required neutral only can be grouped in one conduit, for lighting installation.

iii No single core wire alone shall run in any conduit unless clearly shown in the drawings.

iv This part of the specifications cover the responsibility of selecting the proper branch circuit designation in the panel boards and to install the branch circuit wiring in accordance with the phasing sequence as shown on the drawings, so that the loads are balanced across all the phases as closely as possible and to cause minimum unbalance in the panel board neutral wires. If any changes are to be made, approval of the Engineer-in-Charge is essential.

v No wire shall be pulled until the complete conduit is installed. No splices or joints shall be permitted in either feeders or branches except at the outlet of accessible junction boxes.

vi Termination of wires and cables at main boards, M.C.Cs lighting /power panels, fixtures, etc. is to be done preferably with solder less tinned copper terminal lugs duly crimped and using petroleum jelly at all connections. Special permission shall be taken from the Engineer-in-charge for termination with soldering method.

6 BURIED CABLES

a) Only armored / cables shall be buried directly in the ground. Trench for H.T. cables shall be minimum 1000 mm deep and for L.T. and other lower voltage cables shall be 1000 mm deep or as specified in the drawings. Where both H.T. and L.T. cables follow the same route, one trench may be used. In that case, the higher voltage cables shall be installed at 900 mm and then the trench shall be filled to 600 mm with sand and pebbles and the low voltage cables shall be then installed. High voltage cables shall be spaced minimum 75 mm on centers.

b) When it is necessary to pull the cable into the trench, rollers or a greased wooden trough should be used to reduce friction. A series of sleeves may be necessary to guide the cable around corners. Care should be exercised to avoid contact with sharp stones and other heavy objects in the trench. A two-inch layer of sand or clean earth shall be placed at the bottom of trench to avoid sharp objects coming in contact with the cables.

c) After the cables are installed, cover the cables with 150 mm of rock-free earth or sand, place a layer of bricks or concrete tiles over that and backfill to grade. Concrete markers shall be placed at each bend and at a approximately 15 meters' intervals along straight runs to show the location of the cables. These markers shall extend above the grade by 25 mm.

d) Cables shall be laid with slight slack in the trench to allow for the settlement of earth.

e) After confirming with the Engineer-in-Charge, necessary loops shall be made at the locations indicated by him.

f) Concrete-lined cable trenches for cables inside buildings, if shown on the drawings, shall be provided by others.

7 MOTORS

a) Normally, along with the driven equipment, motors may be installed by other contractors but whenever the electrical contractor installs a motor, he shall coordinate with the other contractor to align the motor properly with the driven equipment.

b) The electrical contractor shall be responsible for checking and correcting the direction of all electrical motors connected by him.

c) At least 300 mm. length of flexible conduit shall be provided before connecting cables / wires in conduit to the terminal box for all motors which are belt driven. In case belt driven motors are connected directly with cable, then some slackness in the cable shall be provided.

d) Installation of motors shall conform to IS-900.

8 LIGHTING

a) The lighting system will operate from 415/240 V, 3 phase,4 wire, 50 cycles A.C. supply. Lighting branch circuits will be supplied from miniature circuit breakers in the lighting panel as indicated in the applicable drawings. All branch circuits shall be operated on single phase 240 V supply.

b) Lighting panels and lighting fixtures shall be installed as shown in the applicable drawings.

c) All lighting circuits will run in rigid PVC heavy duty conduits unless otherwise indicated on the drawings.

d) Any lighting fixtures so located that the light from them would be obstructed by pipes or other objects shall be brought to the attention of the Engineer-in-Charge or his authorized representative for necessary correction or change in location as may be desired.

e) The street light fixtures shall be installed on R.C.C. / steel tubular poles as per details in the drawings. The tubular poles and cable box shall have a primer coating and two final coats of Al. paint.

9 CONDUITS

a) All conduits shall be heavy duty, PVC as specified in the schedule of quantities. Minimum size shall be 19 mm unless specifically stated otherwise. Conduits and fitting shall be cleaned to remove sludge, dirt or trash from the inside, prior to installation.

b) The conduits shall be securely fastened by means of straps and hangers designed for the purpose. Conduit runs on walls, columns or partitions shall be secured with hot dip galvanized C-Clamps or saddles and back spacers. These straps and hangers shall be fastened at each 400 mm length. Where supported on masonry walls, the conduit shall be spaced at a minimum of 6 mm from the wall using galvanized mild steel spacers. Conduit half straps (C- Clamps) attached to masonry or concrete walls, floors screw anchors or lead anchors. A maximum of four 90^0 bends only shall be used from pull point to pull point. The maximum distance between pull points shall be 90 meters but this shall be reduced by 15 meters for each 90^0 bend. Screws used for fixing C-Clamps on to spacers shall be of brass only. Special permission shall be taken from the Engineer-in-Charge for using hot dip galvanized screws.

c) All conduit bends shall be made with conduit benders designed for the purpose. Bends shall not be less than 6 times the nominal size of the conduit. They shall be free from creeps and flattening. In general, exposed conduit runs shall be in straight lines parallel to or 90^0 to the building or pipe racks in which they are running. Each conduit run shall re completed before the wire or cable is pulled in. Whenever conduit enters outlet boxes, panels, pull boxes, switches or conduit fittings, an offset shall be formed on the conduit as close to the fittings as possible.

d) In no case shall conduits be fastened to other pipes or installed in such a manner as to obstruct the ready removal of pipes for repair or replacement.

e) All conduit openings shall be capped with steel / PVC caps (conduit plugs) during or immediately after installation. Before wires are drawn into conduits, the conduits shall be thoroughly cleaned by use of a swab or blown out with compressed air.

f) All outdoor conduit fittings shall be provided with neoprene gaskets.

g) Conduit installation should conform to I.S. 732.

h) In concealed conduit system, grooving in the wall shall be neatly carried out by electrically driven cutter only and be of ample dimensions to permit the conduits to be fixed in the manner desired. Chases in the wall shall be done before the plaster work is done by civil section, and after laying of conduit in wall, the chased portion should be filled in by electrical contractor with suitable material and to the satisfaction of the Engineer-in-Charge.

i) Fixing of conduit pipes in chase should be done by means of staples or saddles not more than 400 mm apart.

j) Suitable inspection boxes shall be provided to permit periodical inspection and to facilitate removal of wires when necessary.

k) Positions of lighting panels, switches, sockets etc. shown in drawings shall be adhered to. If desired by the Engineer-in-Charge, the positions of these shall be changed without any extra cost.

l) The heights for switches and receptacles are as indicated on the respective drawings / standard notes.

m) All conduit drops from ceiling to the wall must be nearly in the centre of the wall. Conduit drops going out of the wall will have to be made good by the contractor at his cost without damaging / weakening the building structure.

10 EARTHING

a) General

i All electrical equipment shall be earthed as per details on applicable drawings.

ii All metal vessels, process pipe lines, tanks, buildings and other metal structures that may receive lightning stroke or develop a static charge shall be earthed, as per details on applicable drawings.

iii All equipment to be earthed shall be cleaned down to bare metal before attaching the ground wire.

iv NEUTRAL CONDUCTORS SHALL NOT BE USED FOR EQUIPMENT EARTHING.

v All earthing connections shall be carried out in an approved manner and with specified materials. Typical methods of earthing as per standard drawings, will be adopted for the earthing, as indicated in the applicable drawings.

vi The entire plant shall be earthed by a series of ground loops. The loops will be effectively earthed by means of earthed electrodes.

vii All earth connections shall be applied bitumen compound if welded with the system earthing grid / equipment. However, welding should be avoided as far as possible.

viii Sizes of the earth wires shall be as shown in the applicable standard drawings.

ix Copper strip if used shall be tinned at the joints.

x Armoring of cables shall be earthed at both ends through suitable cable glands.

xi Earthing wires and cables shall be terminated on the earth bus with solder less cable sockets with silicon bronze / G.I. bolts.

xii Each earthing wire shall be in one length from the equipment to the earth bus.

xiii Pipe electrodes in earth pit as per standard drawing shall be provided unless otherwise indicated in the relevant drawings. The earthing electrode and pits shall be in accordance with IS: 3043.

xiv The earth pit centre shall be at a minimum of 2 meters distance from the nearest building. Distance of not less than 3 meters shall be maintained between centers of two earth pits.

xv The neutrals of transformers shall be connected to separate earth electrodes.

xvi Specialized Earthing shall be provided to the sensitive equipment by means of dedicated Cu. earthing pits, Cu. earthing conductor and Cu. earth bus bar mounted on the insulators.

b) 240 V Equipment

i) All 240 V equipment shall be earthed with minimum one number of 12 SWG cu. wire unless stated otherwise on the relevant drawing.

ii) For lighting circuits in conduits, one number 12 SWG. copper wire shall run inside the conduit for earthing.

iii) Fluorescent fixtures and all other fixtures provided with earthing terminals shall be earthed by 12

SWG copper wire.

iv) Switch and single phase lighting receptacle housings shall be earthed with 12 SWG copper wire. The earthing wire shall be connected to the earthing screw on the switch or receptacles by a solder less cable socket duly crimped.

All street lighting poles shall be earthed as indicated in the drawings.

c) 415 V Equipment

All 415 V equipment shall be earthed by 2 independent paths to earth through earth wires. The earthing conductors shall be of the sizes as specified on the drawings and be of G.I., aluminum or bare copper where buried. Outside the building, a minimum of 300 mm of cover shall be provided.

i) All motor frames, hoist rails, pipe racks, etc. shall be effectively earthed, as shown on the applicable drawing.

ii) Earth strip extending above the floor shall be protected from mechanical injury by running it through GI pipe sleeve to at least 300 mm height.

iii) The entire conduit system, supports, cabinets, transformers, motor control centers and equipments shall be effectively earthed as shown on the drawings and in accordance with the latest Indian Codes.

iv) All three phase receptacles shall be earthed with 8 SWG G.I. wire or as specified in the drawing.

d) Connection

The Earthing system connections shall generally cover the following:

i) All The Earthing system connections shall generally cover the following:

- Equipment earthing for personnel safety
- System neutral earthing
- Static and lightning protection

ii) The following shall be earthed:

- System neutral
- Current and potential transformer secondary neutral
- Metallic non current carrying parts of all electrical apparatus such as transformers, EHV / HV / MV and LV switchgears, bus ducts, motors, neutral earthing resistors, capacitors, UPS, battery charger panels, welding receptacles, power sockets, lighting / power panels, distribution boards, control stations, lighting fixtures, etc.
- Steel structures / columns, rail loading platforms, etc.
- Cable trays and racks, lighting masts and poles.
- Storage tanks, spheres, vessels, columns and all other process equipments.

- Fence and gate for electrical equipment (e.g. HV switchyard, transformer yard, etc.)
- Cable shields and armour.
- Flexible earth provision for wagon, truck.
- Shield wire

11 RECEPTACLES AND SWITCHES – COMMERCIAL TYPE Conforming to IS 3854, IS 1293, IS 3854, IS 2500

a) All single pole switches shall be commercial modular type and shall be connected to phase wire only.

b) The switches shall be mounted in such a way that circuit is ON when the knob is pressed in at the bottom.

c) All three phase receptacles shall be wired with the same sequence of rotation of phases.

d) The electrical contractor shall consult the architectural plans to check for door swings. Where switches are located near doors, they shall be located "on the lock side" ensuring that the switch board is not covered or hidden by the door.

e) In general, all receptacles and switches shall be mounted at a height of 600 mm from the finished floor level unless otherwise shown in the drawings.

f) Where more than one switch of the same phase are shown at one place, then these should be all mounted in a common hot dip galvanized M.S. box. Switches of different phases shall be mounted in different boxes.

12 PUSH BUTTON STATIONS

The contractor shall check the actual location of the push-button stations in the field so that the mounting channel does not interfere with the removal and maintenance of the motor or equipment.

13 EMBEDDED OR RECESSED EQUIPMENT

The electrical contractor shall take special care to co-ordinate this work with the civil contractor.

If recess or opening is not provided where it is required, the electrical contractor shall draw the attention of the Engineer-in-Charge at site to this fact. But, the electrical contractor may have to provide such recess or opening, if it is called for, without any additional cost.

14 BATTERY AND BATTERY CHARGER

a) Inspect battery and battery charger thoroughly for any damage to meters, push buttons or to the panel and report to Engineer-in-Charge.

b) Check whether all parts and accessories are supplied by the manufacturer, as per the packing list and purchase order and report to the Engineer-in-Charge. Check that the electrolyte (acid) is supplied in a separate container by the manufacturer.

Proposed electrical work for workshop building and related services

Purpose of this tender is to provide electrical facilities for workshop building and related service like:-

Lighting and power requirement in main workshop building including office (refer drawing)

a) Providing high bay (HB) and Medium bay (MB) sodium light filling at app 6.75 mtr height on two side walls total 6 nos for high intensity required in control area.
b) Providing floodlights at 12 mtr height 2 nos one on each wall at 90 degree to the wall on which HB filling are provided (refer drawing)
c) Providing double TL filling at 3/3-5 mt height for localised and low intensity requirement.
d) Providing single TL filling at 13 mtr height to facilitate lighting for working on crave
e) Lighting for tool box area by 2 nos conical poles with sodium fillings.
f) Provide MCB/MCCB with enclosure to feed power to crane. Incoming power from meter Box (source).
g) Usual lighting and power required of office room and other services room by suitable light fitting/fans requested of plug sockets and curing.
h) Provision of wall moulded FANS in main workshop area.
i) Provision of lighting and power for service duct and lamps.
j) Provision of pump with necessary piping for washing of vehicles.
k) Provision of pump with necessary piping removal of slurry from cleaning area.

General requirements for Electric

1.1 Scope of works:

The work covered by electrical specification consists supplying and installing, electrical wiring system complete in 'strict accordance with this specification and the applicable drawing and subject to. The terms and conditions the contract. It includes.

(a) Conduit a wiring system far fans, lighting paints bells, clacks sockets, EIC. including fixing of lighting fixtures and fans EIC. and miscellaneous paints.
(b) Conduit and wiring system' far exhaust fans, power sockets.
(c) Panel boards, distribution boards. Switch fuses units.
(d) Complete power and lighting cable systems. Grounding system.
(e) Grounding system.
(f) Conduits system.
(g) Street lighting system.
(h) Other miscellaneous electrical work.

1.2 Completeness of Contract:

Any work fittings accessories or apparatus which may not have been specifically mentioned in the specification but which are necessary in the equipment for efficient working of the plant should be deemed to be included in the contract and should be executed and provided by the contractors. All plant and apparatus should be complete in all the details, where such details, are mentioned in the specifications or not. Three prints and one permanent negative of each' of the finally approved drawings incorporating all the modifications proposed by the Department should be submitted. No modifications should be made in a drawing already approved by the Engineer-in-charge without his prior consent. Approval of the contractor's drawing will not relieve the contractor of any part of his obligation to meet all the requirements of the contract.

1.3 Guarantee:

The performance of all the equipments and the installations should be guaranteed at least for a minimum period of one year from the date of taking ove`r the installation by the Department'. All equipments must comply with the relevant IS-BS specifications.

1.4 Interchangeability:

All corresponding parts of similar plant and equipment should be interchangeable in every way.

1.5 Tools:
All special tools required for dismantling and assembly of the equipment covered by the contract shall be supplied as obligation under the contract. A list of items to be supplied by the Contractor should be submitted along with the tender.

List of I.E Rules and I.S Specification

All Specification, standard. Publication EIC. Specified mean the latest standards publication EIC. Pertaining to Electrical Installation and should conform to the following wherever applicable.

National Electrical Codes -1986

1) Indian Electricity Act, 1910 with its amendments.

2) Indian Electricity Rules, 1956 and its amendments.

3) Indian Electricity supply Act, 1948.

4) Regulation for Electrical Equipment in building by I.E.F. Landon.

5) The Factory Act. 1948 and its amendments.

6) I.S.-732-1982 Part-I, II & III code of practice for Electrical wiring and fittings in buildings for low and medium voltages.

7) I.S. 4064-1967 H.D. Air break switches and fuses for Voltages not exceeding 1100 volts.

8) I.S. 3043 - Earthing code of practice for

9) I.S. - 1554 Part-I - 1970 PVC insulated (Heavy duty) Electrical Cables for working voltages upto and including 110 volts.

10) IS : 1554 Part II for working voltage from 3.3 KV up to and including 11 KV

11) I.S. : 694 - 1964 Part- II - PVC insulated cable with Aluminum conduits (revised) for voltages upto 110 volts.

12) I.S: : 5908-1970 - Electrical installations in buildings. method of measurements of.

13) I.S.: 4237-1967 - General requirement for switchgear and control gear for voltage not Exceeding 1000 volts.

14) IS: 1653-1964 - Rigid steel conduits for electrical wiring (revised)

15) IS : 2509-1973 - Rigid steel conduits for electrical installation. (First revision).

16) IS: 1258-1967 - Beyonet lampholders (First revision).

17) IS: 418-1957 - Tungston-Filament General Service electric lamps (Third revision).

18) IS: 374-1966 - Fans and Regulators. Ceiling type, electric (second revision).

19) IS : 2667-1964 - Fittings. For rigid steel conduits for electrical wiring.

20) IS: 3419-1976 - Fitting for rigid non-metallic conduits (First revision).

21) National Electric Code, 1986.

22) IS : 9537 (part- I)-1980Conduit for electrical installation: part I General requirements.
22) IS: 6946-1973Flexible (Pliable) non-metallic conduits for electrical installations
23)IS: 4615-1968 Switch – socket outlet (non-inter locking type)
24)IS:3854-1966 Switch for domestic and similar purposes (superseding IS:1087-1957 and IS:2120-1963
25) IS:1293-1967: Three pin plugs and sockets outlets
26) IS: 4160-1967 Inter locking switch socket outlet
27) IS: 6665-1972 Industrial lighting , code of practice
28) IS: 1947-1980 Flood Light
29) IS: 2149-1970 Luminaires for street lighting
30) IS : 2268-1966 Electric call bells and buzzers for indoor use
31) IS: 8828-1978 Miniature air break circuit –breakers for voltages not exceeding 1000 volts
32)IS: 375-1963 Switch gear bus-bars ,main connections and auxiliary wiring , making arrangement
33) IS :4288-1967 PVC-insulated and PVC – sheathed solid aluminium conductored cables of voltage rating not exceeding 1100 volts
34) IS : 7098 (part-I) -1977 Cross linked polyethylene insulated PVC sheathed cables :
Part-I for working voltages upto and including 1100 volts

Contract Drawings:

The contractor shall submit to the Engineer for his approval on or before the dates stipulated for this Purpose in the specification copies of all the drawings of the general arrangements of the plant as set out there in and of such detail drawings as may be reasonably necessary. Within Fourteen days from the receipt, by. Him of such copies the Engineer shall signify his approval or otherwise of the same and if he does not do so he shall be deemed to have approved thereof. Within Fourteen days from the notification by the Engineer to the Contractor of his approval such copies or in the absence of such notification within thirty days from the receipt of such copies, the copies in ink on tracing cloth or ferrogallic prints mounted on cloth. of all drawings as approved shall be supplied to the engineer by the contractor respectively and shall thereupon the signed by the contractor and become the property of the Governor of Gujarat. Such signed copies of the drawing shall not be departed from in any way whatsoever except with the written permission of the Engineer. During the execution of the works of the signed copies shall be always kept available for reference on the site. In the event of the Contractor desiring to keep in his own possession a signed copy of the drawings as approved he shall supply three copies Instead of two and in this case the Engineer shall sign the third copy and return the same to the Contractor.

Manner of Execution, Quality of materials EIC. :
The plant shall be manufactured, constructed, provided, put in position and maintained in the best and most substantial and workmen like manner and materials of the best and approved qualities having regard to their respective uses.

Tests on site:
In all cases where the special conditions are provided for tests on the site whether of plant, materials or workmanship the Governor of Gujarat except where otherwise specifically stipulated shall provide free of charge such labour, materials fuel stores, apparatus and instruments as may be requisitioned from time to time efficiently to carry out such tests in accordance with the condition.
Where electrical energy is required for tests on site and a supply is available on the site from an Existing installation such electrical energy shall be supplied to the contractor by the Govt. free of charge at the pressure and frequency of the ordinary supply is available the electrical energy necessary for such tests shall be provided by the contractor.

Delivery of plants & materials:

No Plant materials shall be tendered for delivery until intimation in writing shall have been given to the contractor by the Engineer that Governor' of Gujarat is ready to take delivery.

Tests on completion:

On the completion of the works on the site in accordance with the contract the contractor shall give the Engineer notice in writing of such completion. The Engineer shall after receipt of such notice by notice in writing under his hand for date and an hour on that date for the making of the test on site if any such are provided for the contract. The contractor shall carry out such tests upon the date and at the hour so fixed and if the Engineer or his authorized representative shall attend on that date at those hours such test shall be carried out in the presence of the Engineer or such representative. If any portion of the plant fails under the tests to satisfy the contract conditions similar tests according to the contract of the portion so failing shall if required by the Engineer or by the Contractor be repeated within a time to be fixed by the Engineer and the provisions of this clause shall apply to such repeat test as if they were the original tests and the contractor shall pay to the Governor of Gujarat all reasonable expenses to which he may be put by such tests.

If the tests or any repeated tests so required as aforesaid be not made by the Contractor *on* the date fixed as aforesaid for the same by the Engineer may proceed to make such test himself at the contractor's risk and expense. If in any test under this clause the plant tested shall fail to satisfy the contract conditions the Governor of Gujarat shall as from the date stipulated by the contract for completion nevertheless have the right of using such plant until the same shall satisfy such conditions and such use shall be at the contractor's risk. In the event of the question whether the works have been completed in accordance with the contract or any question regarding such completion being submitted to Arbitration as any portion of the plant the Engineer may certify to be capable of being used on condition of paying to the contractor a sum calculated (according to the period or the use) at the rate of 5 percent per annum upon the amount withheld or deducted in respect of such plant.

Rejection of Defective work:

If the works, or any portion thereof shall not in the opinion of the Engineer on the stipulated tests (if any) being made in accordance with the contract satisfy the contract condition within three months after the date stipulated for completion the engineer may give notice in writing to the contractor setting for the particular of the defects of particulars in respect of which the works in his opinion fail to comply with the contract conditions and requiring the contractor to make good. after or replace the same within such time to be specified in the notice as the engineer may consider reasonable and the contractor shall make good, after or replace the same as required by such notice and so as to make itemploy with the requirements of the contract condition within the time so specified. Should he fail to do so within that time the Governor of Gujarat may make good alter or replace the same as so required and the cost ,} such making alteration good or replacement (less in the case of any replacement any sum which would have become due to the contractor under the contract in respect of the works replaced and which shall) of have been paid to him) shall be paid by the contractor to the Governor of Gujarat on demand or should the Governor of Gujarat not make good, after or replace any defective works in respect of which such notice as aforesaid shall be given within ,six weeks from the date of the given of such notice the contractor shall repay to the Governor of Gujarat all sums (if any) paid by him to the Contractor in respect of such works. Nothing contained in

this clause shall prejudice or affect the rights of the Governor of Gujarat under the contract whether in the way of enforcement of penalties or otherwise in respect of any delay in the completion of this work.

Important Clauses of Indian Electricity Rules, 1956. Following clauses of Indian Electricity Rules, 1956 shall in particular be taken care of in the execution of electrical works

Clause No.	Subject
3	Authorisation :
29	Construction, installation, protection, operation and maintenance of electric supply lines and apparatues.
31	Cut-out on consumer's premises.
32	Identification of earthed and earthed neutral conductors and position of switches and cutous therein
33	Earthed terminal on consumer's premises
34	Handling of electric supply lines and appartus.
41	Distinction of circuits of different voltages.
42	Accidental charge.
43	Provisions applicable to protective equipment
44	Instructions for restoration of persons suffering from electric shock.
45	Precautions to be adopted by consumers, owners, electrical contractors, Electrical workmen and suppliers.
46	Periodical inspection and testing of consumer's installation.
48	Precautions against leakage before connection.
50	Supply to consumers.
51	Provisions applicable to medium, high voltage installations. Point of commencement of supply.
58	Point of commencement of supply.
59	Precautions against failure of supply; Notice of failures.
61	Connection with earth, (low and Medium Voltage system.
64	Use of energy at high and extra-high voltage system.
67	Connection with earth. (High & Extra-high voltage system.
68	General conditions as to transformation and control of energy.
All clauses under Chapter VIII on Overhead Lines.	
138	Penalty for breaking seal.
139	Penalty for breach of rule-45.
140	Penalty for breach of rule-82.
141	Penalty for breach of rules.