VOLUME-3

TECHNICAL SPECIFICATIONS

FOR CIVIL WORKS

1.0 GENERAL

1.1 This specification establishes and defines the requirement of various materials to be used in Civil and Structural works.

1.2 Whenever any reference to IS Code is made, the same shall be taken as the latest revision (with all amendments issued thereto) as on the date of submission of the bid.

1.3 Apart from the IS Codes mentioned in particular in the various clauses of this specification, all other relevant codes related to specific job under consideration regarding quality, tests, testing and/or inspection procedures shall be applicable. Reference to some of the Codes in the various clauses of this specification does not limit or restrict the scope of applicability of other referred or relevant codes.

1.4 In case any variation/contradiction between the provision of IS Codes and this specification, the provision given in this specification shall be followed:

1.5 All materials shall be of standard quality and shall be procured from renowned sources/manufactures approved by the OWNER/CONSULTANT. It shall be the responsibility of the Contractor, to get all materials/manufactures approved by the OWNER/CONSULTANT prior to procurement and placement of order.

1.6 Whenever called for by the OWNER/CONSULTANT, all test of the materials as specified by the relevant IS Codes shall be carried out by the contractor in an approved laboratory and test reports duly authenticated by the laboratory, shall be submitted to the OWNER/CONSULTANT for his approval. If so desired by the OWNER/CONSULTANT, tests shall be conducted in the presence of the OWNER/CONSULTANT or his authorised nominee.

1.7 Quality and acceptability of materials not covered under this specification shall be governed by the relevant IS codes. In case IS code is not available for the particular material, manufactures specifications shall be considered. The decision of the OWNER/CONSULTANT, in this regard, shall be final and binding on the Contractor.

1.8 Whenever asked for, the contractor shall submit representative samples of materials to the OWNER/CONSULTANT for his inspection and approval. Approval of any sample does not necessarily exempt the contractor from submitting necessary test reports for the approved material, as per the specification/relevant IS Codes.

1.9 The contractor shall submit manufacture's test reports on quality and suitability of any material procured from them and their recommendation on storage, application, workmanship etc., for the intended use. Submission of manufacturer's test reports does not restrict the OWNER/CONSULTANT from asking fresh test results from an approved laboratory of the actual material supplied from an approved manufacture/source at any stage of execution of work.

1.10 All costs relating to or arising out of carrying out the test and submission of test reports and or samples to the OWNER/CONSULTANT for his approval during the entire tenure of the work shall be borne by the contractor and included in the quoted rates.

1.11 Materials for approval shall be separately stored and marked, as directed by the OWNER/CONSULTANT and shall not be used in the works till these are approved.

1.11.1 All rejected materials shall be immediately removed from the site by the contractor at his own cost.

1.11.2 **Workmanship**:

The workmanship shall be the best of its kind and shall conform to Specifications as per relevant Indian Standard Specifications in every respect or the latest trade practice and shall subject to the approval of the OWNER/CONSULTANT All materials and / or workmanship which in the opinion of the BNPM. MYSORE. /Architect is

defective or unsuitable shall be removed immediately from the site and shall be substituted with proper materials and/ or workmanship forthwith.

1.11.3 All materials shall be of approved quality as per samples and approved by the BNPM/CONSULTANT. MYSORE.

2.0 MATERIALS

2.1 WATER

2.2 Water used in construction for all civil & structural works shall be clean and free from injurious amount of oil, acids, alkalis, organic matters or other harmful substances which may be deleterious to concrete, masonry or steel. The pH value of water samples shall be not less than 6. Potable water shall be considered satisfactory. Underground water can also be used with the prior approval of the OWNER/CONSULTANT, if it meets all the requirements of IS:456.

2.2.1 Tests on water samples shall be carried out in accordance with IS:3025 and they shall fulfil all the guidelines and requirements given in IS:456.

2.2.2 The OWNER/CONSULTANT may require the contractor to prove, that the concrete prepared with water, proposed to be used, shall not have average 28 days compressive strength lower than 95% of the strength of concrete prepared with distilled water.

2.2.3 The OWNER/CONSULTANT may require the contractor to get the water tested from an approved laboratory before starting the construction work and in case the water contains any oil/organic matter or an excess of acid, alkalis or any injurious amount of salts etc., beyond the permissible maximum limits given in IS:456, the OWNER/CONSULTANT may refuse to permit its use. In case the water is supplied by the owner, contractor shall get himself satisfied regarding its quality before using the same in his works at his own expenses. In case there is any change in source of water, water samples shall be tested again to meet the specified requirements. The water test must be conducted periodically at least once in 3 months or as directed by Engineer in-charge.

2.2.4 Water shall be stored in tin barrels, steel tanks or water-tight reservoirs made with bricks/stone or reinforced concrete. Bricks/stone masonry reservoirs shall have RCC base slab and shall be plastered inside, with 1 part of cement and 4 parts of sand and finished with neat cement punning. These reservoirs be of sufficient capacity to meet the water requirement, at any stage of construction.

2.2.5 Water for curing shall be of same quality as used for concreting and masonry works. Sea water shall not be used for preparation of cement mortar, concrete as well as for curing of plain/reinforced concrete and masonry works. Sea water shall not be used for hydro testing and checking the leakage of liquid retaining structures also.

2.3 AGGREGATE

2.3.1 GENERAL

2.3.1.1 Coarse and fine aggregates for Civil and Structural works shall confirm in all respects to IS:383 (Specification for coarse and fine aggregates from natural sources for concrete). Aggregates shall be obtained from an approved source known to produce the same satisfactorily. Aggregates shall consist of naturally occurring (crushed or uncrushed) stones, gravel and sand or a combination thereof. These shall be chemically inert, hard, strong, dense durable, clean and free from veins, adherent coatings, injurious amount of alkalis, vegetable matter and other deleterious substances such as iron pyrites, coal, lignite, mica, shale, sea shells etc.

2.3.1.2 Source and type of aggregates shall be got approved by the OWNER/CONSULTANT prior to procurement. Change in source and type of aggregates, at later stage, shall not be generally permitted; but under specific circumstances, OWNER/CONSULTANT can allow a change in source and type of aggregate. Contractor shall produce necessary test certificates from approved laboratories regarding the quality and suitability of the proposed aggregates and submit fresh mix design for approval of the OWNER/CONSULTANT. Any such change, if permitted by the OWNER/CONSULTANT, shall be without any time and cost implication to the owner. Whenever there is any change in the source of material, and if the material is approved by Engineer in-charge with necessary test certificates from approved laboratory, mix design of concrete shall also be revised and approved. The concrete so approved should have the required

workability with new source of materials and also the characteristic strength of the concrete. All design makes must be as per I.S. 456 / 2000

2.3.1.3 Aggregates which may chemically react with alkalis of cement or might cause corrosion of the reinforcement, shall not be used. If so desired by the OWNER/CONSULTANT, the Contractor shall carry out alkali reactivity tests and submit the results to him for approval.

2.3.1.4 The maximum quantities of deleterious materials in the aggregates as determined in accordance with IS:2386 – Part II (Method of Test for aggregates for concrete), shall not exceed the limits defined in IS:383. No special test is required to prove the absence of such deleterious matters if the aggregates are from a known source with satisfactory prior data on the properties of concrete made with them. In case of newly developed quarry sites, the contractor shall submit necessary test results as per IS:383 and IS:2386 to the OWNER/CONSULTANT prior to his acceptance with the requirements given in IS:2430

2.3.1.5 Coarse and fine aggregates shall be batched separately. All-in-aggregate shall be used only where specifically permitted by the OWNER/CONSULTANT.

Separate sieve analysis and grading curves shall be prepared by the contractor for any/all batches of coarse and fine aggregates, and submitted to the OWNER/CONSULTANT, whenever asked for, to ensure conformity with those submitted along with the mix design.

2.3.1.6 Whenever required by OWNER/CONSULTANT, the aggregate (coarse/fine) shall be washed and/or sieved by the Contractor before use in the works to obtain clean and graded aggregate at no extra cost to the owner

2.3.1.7 Aggregates not in conformity with the specifications shall be rejected and the contractor shall immediately remove them from the site of work.

2.3.2 Coarse aggregates.

2.3.2.1 Coarse aggregates are the aggregates, which are retained on 4.75mm IS Sieve. It shall have a specific gravity not less than 2.6 (saturated surface dry basis).

2.3.2.2 These may be obtained from crushed or uncrushed gravel or stone as per clause 2.2.1 and may be supplied as single sized or graded. The grading of the aggregates

shall be as per IS:383 or as required by the mix design, to obtain densest possible concrete. For this purpose, the contractor shall submit to the OWNER/CONSULTANT at least three sets of mix design and test results, each with different gradings of coarse aggregates, proposed to be used. The OWNER/CONSULTANT may allow "All-in-aggregates" to be used provided they satisfy the requirements of IS:383.

2.4 Fine Aggregates

2.4.1 Fine aggregates are the aggregates which pass through 4.75mm IS sieve but not more than ten percent (10%) pass through 150 microns IS sieve. These shall comply with the requirements of grading zones I, II and III of IS:383. Fine aggregates conforming to grade zone IV shall not be used for reinforced concrete works.

2.4.2 Fine aggregates shall consist of material resulting from natural disintegration of rock and which has been deposited by streams or glacial agencies, or crushed stone sand or gravel sand. Sand from sea shores, creeks or river banks affected by tides, shall not be used for filling or concrete works.

2.4.3 Sampling and Testing

The contractor shall carry out all tests including mix designs of concrete, at his own expense, at the start of works as well as during any stage of construction as required by the OWNER/CONSULTANT. Test shall be carried out in accordance with IS:516 – Methods of test for strength of concrete and IS:2386 – Methods of test for aggregates for concrete. Testing shall be carried out from laboratories approved by the OWNER/CONSULTANT. The method of sampling shall be in accordance with the requirements given in IS:2430.

2.4.4 Storage of Aggregates

2.4.4.1 Storage of all types of aggregates at site of works shall be at contractor's expense and risk and shall be stored as specified in IS:4082. Aggregates shall in no case be stored near to the excavated earth or directly over ground surface.

2.4.4.2 The contractor shall maintain sufficient quantities of aggregates, near to the place of work, required for the continuity of the work. Each type and grade of aggregate

shall be stored separately on hard, firm surface having adequate slope of drainage of water.

2.4.4.2.1 Aggregates delivered at site in wet condition or becoming wet due to rain or any other means, shall not be used for at least 24 hours. The contractor shall obtain prior approval of the OWNER/CONSULTANT for the use of such aggregates and shall adjust the water content in accordance with IS:2386 to achieve the desired mix. In the absence of test results, and to allow variation in mass of aggregates and water content on account of moisture content, the Contractor can make suitable adjustment in the masses as per IS:456, for preparation of nominal mix concrete only.

2.5 SAND

2.5.1 Sand for Masonry Mortars

2.5.2 The sand shall consist of natural sand, crushed stone and or crushed gravel sand or a combination of any of these. The sand shall be hard durable, clean and free from adherent coatings and organic matter and shall not contain the amount of clay, silt and fine dust more than specified in IS:2116.

2.5.3 The sand shall not contain any harmful impurities such as iron pyrites, alkalis, salts, coal or other organic impurities, mica, shale or similar laminated materials, soft fragments, sea shells in such form or in such quantities as to affect adversely the hardening strength or durability of the mortar.

2.5.3.1 Unless found satisfactory as a result of further tests as may be specified by the OWNER/CONSULTANT, or unless evidence of such performance is offered which is satisfactory to him, the maximum quantities of clay, fine silt, fine dust and organic impurities in the sand when tested in accordance with IS:2386, shall not be more than 5% by mass in natural sand, or crushed gravel sand or crushed stone sand. For organic impurities, when determined in accordance with IS: 2386.colour of the liquid shall be lighter than that indicated by the standard solution specified in IS:2386

2.5.4 Grading of sand

The particle size grading of sand for use in mortars shall be within the limits as specified below:

GRADING OF SAND FOR USE IN MANSONRY MORTARS

IS SIEVE DESIGNATION IS: 460 (PART I)	PERCENTAGE PASSING BY MASS	REF TO METHOD OF
4.75 mm	100	IS: 2386 (Part I)
2.36 mm	90 to 100	
1.18 mm	70 to 100	
600 microns	40 to 100	
300 microns	5 to 70	
150 microns	0 to 15	

In case of sand whose grading falls outside the specified limits due to excess or deficiency of coarse or fine particles, this shall be processed to comply with the standard by screening through a suitably sized sieve and/or blending with required quantities of suitable sizes of natural sand particles or crushed stone screenings which are by themselves unsuitable. Based on test results and in the light of practical experience with the use of local materials, deviation in grading of sand may be considered by the Engineer –in-charge. The various sizes of particles of which the sand is composed shall be uniformly distributed the mass.

2.5.5 Sampling and Testing

The method of sampling shall be in accordance with IS:2430. The amount of material required for each test shall be as specified in relevant parts of IS:2386. Any test which the Engineer –in-charge may require in connection with this, shall be carried out in accordance with the relevant parts of IS:2386

If further confirmation as to the satisfactory nature of the material is required, compressive test on cement mortar cubes (1:6) may be made in accordance with IS:2250 using the supplied material in place of standard sand and the strength value so obtained shall be compared with that of another mortar made with a sand of acceptable and comparable quality.

2.5.6 Sand for Filling

Sand for filling shall meet, the requirements IS:383 and shall be natural sand, hard, strong, free from any organic and deleterious materials. Any sand proposed for filling, shall be used only after it is approved by the OWNER/CONSULTANT. Sand obtained from sea shores, creeks or river banks affected by tides, shall not be used for filling. Fine aggregate suitable for concreting works shall be suitable for filling also. No sand below grading zone-III as per IS-383 shall be allowed for filling.

2.6 Cement

Cement to be used for civil and structural works, shall be one of the following or in combination thereof. For plain and reinforced concrete works normally 43 grade ordinary Portland cement conforming to IS:8112, shall be used. Specific requirement for any other type of cement shall be as shown in the drawings or as specified in contract or as directed by OWNER/CONSULTANT. All masonry and plaster work shall be with PPC or other blended cement as approved by Engineer-in charge.

Specification for grade ordinary Portland cement	IS:8112
Specification for Portland slag cement	IS:455
Specification for Portland pozzolana cement	IS:1489
Specification for Masonry cement	IS:3466
Specification for high alumina cement for structural use	IS:6452
Specification for super sulphated cement	IS:6909
Specification for rapid hardening Portland cement	IS:8041
Specification for 43 grade ordinary Portland cement	IS:8112
Specification for 53 grade ordinary Portland cement	IS:12269

Specification for Sulphate Resisting Portland cement IS:12330

2.6.2 Storage at Site

2.6.3 The storage of cement at the site of work shall be at contractor's expense and risk and shall meet the requirements of IS:4082. The cement shall be stored above ground in a suitable weather tight building or go down and in such a manner as to permit easy access for proper inspection and also to prevent deterioration due to moisture. Apart from this, the cement so stacked should be replaced once in three months top bag to bottom row and bottom to top to avoid clotting. Such cement in long stored condition shall be retested for properties

2.6.3.1 All approved cement shall be arranged in batches with type, brand and date of receipt flagged on them. A maximum of eight bags shall be stacked one over the other. Cement bags shall be used in the same order as received from the manufacturer. The contractor shall maintain a register on day to day basis, giving the details of the receipt / consumption, source of supply and type of cement etc. The register shall always be accessible to the OWNER/CONSULTANT for verification.

2.6.4 Test after Delivery

Each consignment of cement procured by contractor, shall after delivery at site and at the discretion of the OWNER/CONSULTANT, be subjected to any or all of the tests and analyses, required by the relevant Indian Standard Codes. The contractor shall carry out and bear the cost of all tests and analyses required to ensure quality of cement before using in actual works.

2.6.5 Rejection

The OWNER/CONSULTANT may reject at his discretion any cement, which has deteriorated owing to inadequate protection from moisture or due to induction of foreign matter or any other cause. Any cement which is considered defective, shall not be used and shall be promptly removed from the site by the contractor

2.6.5.1 Lime

Lime shall be stone lime and conform to the specification building Limes – IS: 712, Lime putty may be prepared from hydrated lime or quicklime. Hydrated lime shall be mixed with water to form a putty and stored with reasonable care to prevent evaporation for at least 24 hours before use.

Quick lime shall be slaked with enough water to make a cream, passed through a No. 10 sieve and then stored with reasonable care to prevent evaporation for at least 7 days before use. Quick lime or hydrated lime as instructed by the Engineer shall be used for masonry work. Hydrated lime will be supplied as hydrated lime and used for structural purposes. Fat lime will also be supplied as quick lime or hydrated lime as instructed by the Engineer and used for the finishing coat in plastering, white washing etc. Field tests according to IS:1624 shall be carried out from time to time to determine the soundness of lime.

2.7 Nero:

Shall be made of class 'C' lime (i.e., pure fat lime) as mentioned in IS:712. It shall be slaked with fresh water and then sifted and reduced to a thick paste by grinding in a mill. Nero thus prepared shall be kept moist until used and no more than what can be consumed in 15 days shall be prepared at a time.

2.8 Surbhi:

Shall be made by grinding well burnt bricks, bricks bats, burnt clay balls etc. the quality shall conform to IS:1344.

Brick bats etc., shall be ground in a mechanical disintegrator to a fine powder passing through IS Sieve, No.9 (2.36mm) with a residue not exceeding 10% by weight.

Sorkin for lime Surbhi plaster shall be ground to fine powder in a mortar mill to pass through IS Sieve of 150 microns (No. 100).

Surbhi shall be stored in a weather-proof shed on a brick-paved platform.

2.9 STEEL

2.9.1 General

All steel bars, sections, plates and other miscellaneous steel materials. etc. shall be free from loose mill scales, rust as well as oil, mud, paint or other coatings. The materials, construction specifications such as dimensions, shape, weight, tolerances, testing etc., for all materials covered under this section, shall confirm to respective IS Standards.

2.9.2 Reinforcement Bars

High Yield Strength deformed bars conforming to IS 1786 –1990 Fe 500(thermo mechanically treated bars) and Mild Steel confirming to IS432(part-1). Specific requirement for any other type of reinforcement bars shall be as shown in the drawings or as specified to Contract or as directed by the OWNER/CONSULTANT.

Specification for mild steel and medium tensile bars and hard drawn steel wire for concrete reinforcement (grade I)	IS:432
Specification for hard drawn steel wire fabric for concrete reinforcement	IS:1566
Specification for plain hand drawn steel wire for prestressed concrete	IS:1785
Specification for high strength deformed steel bars and wires for concrete reinforcement	IS:1786
Steel for general structural purposes (Grade A)	IS:2062
Specification for high tensile steel bars used in prestressed concrete	IS:2090
Specification for indented wire for prestressed concrete	IS:6003

Specification for corrosion resistant steel	IS:1786

2.9.3 Structural Steel

Structural steel to be used for general structural purposes shall be of grade A conforming to IS:2062. Specific requirement for any other type of structural steel shall be as shown in drawings or as specified in the contract or as directed by the OWNER/CONSULTANT. Structural steel sections shall conform to following IS specifications.

Steel tubes for structural purposes	IS:1161
Mild steel tubes, tubulars and other wrought steel fittings	IS:1239
Steel for general structural purposes (Grade A)	IS:2062
Hollow steel sections for structural use	IS:4923

2.9.4 Miscellaneous Steel Materials

Miscellaneous steel materials shall be conforming to the following IS Specification.

Expanded metal steel sheets for general purposes	IS:412
Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement (grade I)	
(For mild steel bars of anchor bolts, rungs, metal inserts, grating etc.)	IS:432
Hexagonal head bolts screws & nuts of product grade C	IS:1363
Cold formed light gauge structural steel sections	IS:811
Technical supply conditions for threaded steel fasteners	IS:1367

Plain washers	IS:2016
Steel wire ropes for general engineering purposes	IS:2266
Thimbles for wire ropes	IS:2315
Building grips	IS:2361
Mild steel tubes, tubulars and other wrought steel filling (for hand rail tubular sections)	IS:1239
Drop forged sockets for wire ropes for general engineering purposes	IS:2485
Steel chequered plates	IS:3502
Hexagonal bolts and nuts (M42 to M150)	IS:3138

2.9.5 Aluminium Windows & Doors:

Aluminium windows and doors shall be fabricated out of Aluminium sections as in IS:305 and shall conform to IS:8256 Unless otherwise specified the details of construction etc., shall be as described under 'Specification'.

2.10 Bricks

Bricks shall subject to the following, generally comply with IS 1077; the sizes, however, will be as locally available.

Bricks shall be of the quality locally available, table moulded if so specified and if locally made, well burnt but not over burnt, have plane rectangular faces with parallel sides, and sharp, right angled edges, of compact and uniform texture, without cracks, chips, flaws stones and nodules. They shall not show efflorescence, either dry or subsequent to soaking in water and shall emit a clear ringing sound, on being struck, and not absorb water more than 15% by weight. The bricks shall

also have compressive strength not less than as stipulated in the item specifications.

Common clay burnt bricks of no stipulated compressive strength shall generally be as specified in the previous paragraphs but be only ground moulded, may be slightly distorted and have slightly rounded edges. They shall have a compact and uniform texture and shall not absorb water more than 15% by weight and shall have a minimum compressive strength of 35kg/cm^2. The size of the bricks i.e., dimensions must be well within the tolerance allowed as per I.S. 1077 /1970.

Blocks: Hollow and Solid concrete blocks - shall conform to the requirements of IS:2185-1979. Specification for hollow and solid concrete blocks except with regard to the mix of cement concrete and sizes of aggregates which shall be as indicated. Hollow blocks shall be sound, free from cracks, broken edges, honey combing and other defects that would interfere with the proper placing of block or impair the strength or performance of construction.

2.11 STONE

2.11.1 General

All stones used for masonry works shall conform to the requirements of following IS Codes:

Method of identification of natural buildings stones	IS:1123
Recommendations for dimensions and work-Manship of natural building stones for masonry work	IS:1127
Recommendations for dressing of natural building stones	IS:1129

2.11.2 Quality of Stones

Stones shall be of approved quality, hard, dense, strong, sound, durable, clean and uniform in colour. They shall also be free from veins, adherent coatings, injurious amount of alkalis, vegetable matters and other deleterious substances such as iron pyrites, coal, lignite, mica, sea, shells etc. Unless otherwise approved, stones from

one single quarry shall be used for any one work. The strength of stones should be adequate to carry the imposed load and shall meet all the requirements of IS:1905, considering the appropriate crushing strength of stone and type of the mortar used. The percentage of water absorption, when tested in accordance with IS:1124, shall not exceed 5 percent.

Stones normally used, shall be small enough to be lifted and placed by hand. The length of the stone shall not exceed 3 times the height. Width of stone on base shall not be less than 150mm and in no case exceed 3/4th thickness of the wall. Height of the stone shall not be more than 300mm.

2.11.3 Unloading/stacking

The stones shall be unloaded from the trucks to a site near to the place of work as defined in IS:4082 and shall be stacked on a firm ground having adequate stop for drainage. The supply of stones shall be so arranged that as far as possible at least two day's requirements of stone are available at site at any time.

2.11.4 PVC PIPES

PVC pipes shall conform to the requirements of IS:4985.

2.12 WOOD/TIMBER

2.12.1 Second class Indian Teak wood shall be conforming to IS 4021 of good quality, well-seasoned and free from defects such as cracks, dead knots, sapwood etc. No individual hard and sound knot shall be more than 15 sq.cm in size and the aggregate knot shall be more than 15 sq.cm in size and the aggregate are of such knots shall not exceed 2% of the areas of the piece. The timber shall be fairly close grained having not less than 2 growth rings per cm. width in cross-section.

2.12.2 Hard wood /Jack wood

Hard wood shall be first class wood conforming to IS 12896-1990 of good quality, well-seasoned and free from defects such as dead knots, cracks, sapwood etc. No individual hard and sound knot shall exceed 6 sq.cm in size with no dimension more than 50mm and the aggregate area of such knots shall not be more than 1% of the area of the place. There shall not be less than 5 growth rings per cm. width in

cross-section. and shall be approved by the OWNER/CONSULTANT No wood work shall be placed in position covered in the wall unless it is approved by the Architect

2.13 Timber required to be used for form work shall be fairly dry before use. It should maintain its shape during the use and even when it comes into contact with moisture from the concrete. Storage of wood/timber shall be as per the requirement of IS:4082.

For proper identification and selection of suitable timber for form work, following codes shall be referred.

Classification of commercial timbers and them Zonal distribution	IS: 399
Specification for bellies for general purposes	IS: 3337
Specification for plywood for concrete shuttering	IS: 4990

Timber: Shall be of best quality as specified in the schedule of quantities perfectly dry, well-seasoned and free from sap wood, sound straight, free from loose knots, cracks shakes and any appearance of root and any other defect and conforming to IS: 12896 – 1990 and shall be approved by the OWNER/CONSULTANT No wood work shall be placed in position covered in the wall unless it is approved by the OWNER/CONSULTANT

Hardware Fittings for Doors: All the doors shall be provided with MS powder coated hinges, a drop, tower bolts, locks etc or as specified in schedule of quantities. The external doors shall be provided with Godrej make locks. All the fittings shall be approved by the OWNER/CONSULTANT

2.13.1 Laminates

The Laminates are thin sheets of plywood, polymer derivatives all pressed together to form thick boards of 3mm upwards. The laminates may also glued / pressed on to block boards particle boards etc depending on the production methods and end use.
The following IS standards shall be referred to for products

1. Ply wood IS:303
2. Marine plywood IS:710

3. Decorative plywood IS:1328
4. Flush doors IS:2046
5. Laminates IS:2046
6. Shuttering plywood IS:4996
7. Laminates boards IS:12823

For the physical and mechanical properties of these products are covered by these codes. The property of resistance to surface wear, to dry heat, water, impact, cracking, steam, etc be ascertained for the given applications.

For carpentry applications the manufactures instruction shall be followed in storage, handling, cutting, edge treatment and for use of appropriate tools.

2.14 FLOOR TILES:

2.14 Glazed Tiles:

White or coloured glazed tile shall comply with IS: 777. They shall be from an approved manufacturer and shall be flat and true to shape they shall be free from cracks, crazing, spots, chipped edges and corners, the glazing and colour shall be of uniform shade and unless otherwise specified the tiles shall be minimum 5mm thick

2.14.1 Other Tiles:

Burnt clay tiles for terracing, roofing and flooring, ceramic tiles, unglazed, vitreous acid resisting etc., shall all conform to the relevant I.S. Codes.

2.14.2 Ceramic Tile:

Tiles shall be of approved make and confirm to IS: 13630 / 1992 all parts. They shall be flat and true to shape and free from blisters, crazing chips, welts, crawling or other imperfections detracting from their appearances. The tiles shall be square in shape and of nominal size 300 x 300mm. Thickness of tiles shall be 8mm. Permissible deviations in length, squareness, straightness of sides and surface

flatness shall not be more than +- 0.5% and that is thickness of +- 5.0%. For other types of ceramic tiles manufacturers specifications may be referred.

2.14.2 **Vitrified Tiles** .: Tiles shall be of approved make and confirm to IS: 15622 / 2006

2.14.3 **Granite:** Polished granite slab and tiles shall be of the kind specified in the schedule of quantities conforming to samples approved by the Architect for colour & texture. The slab shall be machine cut to required dimensions and shall conform to IS Standards

2.15 PAINTING

2.15.1 Primer coating of structural steel shall be ready mix paint of red oxide zinc chrome, conforming to IS: 2074.

2.15.1.1 Synthetic enamel to be used, for painting of structural steel, shall conform to IS: 2932.

2.15.1.2 Primer/Enamel shall be tested as per the requirements of IS: 101.

2.15.1.3 **Plastic (Acrylic) Emulsion Paint and Enamel Paint: Plastic emulsion** painting will be of approved brand of paint and colour conforming to IS: 5411 –1991 & will be applied over a coat of primer & putty (including preparation of wall surface).

2.16 Storage, test and rejection`

2.16.1 Storage

The storage of all materials at site of work shall be at the contractor's expense and risk and shall be done as per the requirements given in IS: 4082. The contractor shall maintain the proper record of receipt/consumption. The records shall always be accessible to the OWNER/CONSULTANT for verification.

The reinforcement bars, structural steel sections and other miscellaneous steel materials etc, shall be stored in such a way as to avoid and prevent deterioration, corrosion, bending, twisting and wrapping. In case of any damage occurring to the material on account of faulty storage or negligence by the contractor, same shall be borne by the contractor himself.

2.16.2 Test after Delivery

Materials supplied by the owner or contractor, shall, after delivery at site and at the discretion of OWNER/CONSULTANT, be subjected to any or all of the tests, required by the relevant IS Codes. The contractor shall carry out and bear the cost of such tests.

2.16.3 Rejection

The OWNER/CONSULTANT may reject at his discretion any material, notwithstanding the manufacturer's certificate or failing to meet the requirements of relevant IS codes for testing of materials. He may similarly reject any material, which has deteriorated or corroded etc., due to improper storage, handling or transport. Defective materials shall not be used and removed from the site by the contractor at his own expense.

2.16.3.1 Admixtures: Admixtures if used shall comply with IS 9103. Admixtures to concrete shall not be used without the written consent of the OWNER/CONSULTANT When permitted, the contractor shall furnish full details from the manufacturer and shall carry such test as the Architect may require before any admixture is used in the work to check particularly for Chlorides.

Admixture may be used to modify one or more of the following properties of

2.16.4 FRESH CONCRETE.

a) To increase workability without increasing water content or to decrease the water content at the same workability.

b) To retard or accelerate both initial and final setting times.
c) To reduce or prevent settlement.
d) To increase slight expansion in concrete and mortar.
e) To modify the rate or capacity for bleeding or both.
f) To reduce segregation of concrete, mortars and grouts.
g) To improve penetration & or pump ability of concrete, mortars& grouts.
h) To reduce rate of slump loss

xv) Admixtures may also be used to modify one or more of the following properties of:

HARDENED CONCRETE:

1. To retard or reduce heat generation during early hardening.
2. To accelerate the rate of strength development.
3. To increase the strength of concrete or mortar (Compressive, tensile or flexural)

- To increase the durability or resistance to severe conditions of exposure including the application of devising salts.
- To decrease the capillary flow of water.
- To decrease the permeability to liquids.
- To control the expansion caused by the reaction of alkaline with certain aggregate constituents.
- To produce cellular concrete.
- To increase the bond of concrete to steel reinforcement
- To increase the bond between old and new concrete.
- To improve impact resistance and abrasion resistance.
- To inhibit the corrosion of embedded metal.
- To produce coloured concrete or mortar.

- Integral waterproofed: Admixture used as integral waterproofed shall be free of chlorides sulphates and shall conform to IS: 2645, the application and doses shall be as per manufacturer's specification

- If there are any discrepancies in specification of items of work in schedule of quantities and in specification schedule and also items not covered in technical specifications, latest. IS specification shall apply.

Whenever items of materials not covered in IS specification, the approval of Architect/employer will apply

TECHNICAL SPECIFICATION

FOR

CLEARING OF SITE, EXCAVATION &

EARTH FILLING

1.0 CLEARING OF SITE, EXCAVATION & EARTH FILLING

1.1 General:

Trenches, pits for foundations of walls, column footings, rafts, pile caps, plinth beams, water tanks, cess pits, etc. shall be excavated to the length, width and depth as shown or figured on the drawing or as may be directed by the OWNER/CONSULTANT If excavation is done to length, width or depth greater than as shown or required, the extra work occasioned thereby shall be deemed to have been done at contractor's expense and no payment will be due therefor. Extra depth shall be brought up by plain cement concrete filling of 1:4:8 proportion and extra length and width filled in by rammed earth or more, or if the OWNER/CONSULTANT thinks it necessary for the stability of the work by 1:4:8 cement concrete, as may be directed by him at the contractor's cost.

Excavated material shall be used for filling in plinth, or the sides of the foundation blocks or trenches or spread on or near the site of work or elsewhere in the premises including watering, ramming and consolidating or carted away from site, if surplus, free of charge, as provided in the item specification.

The contractor shall at his own expense and without extra charge, make provision for supporting all utility services, lighting the trenches, pits, separating and stacking serviceable materials neatly, shoring, timbering, strutting, bailing out water whether of subsoil or rain water including pumping at any stage of the work. Trenches and pits shall be kept free of water while masonry or concrete works are in progress and till the OWNER/CONSULTANT consider it necessary.

1.2 Excavation excluding/other than in Hard rock:

Excavation shall be carried out in any type of soil, more (soft or hard), soft rock, boulders, old foundations, concrete, asphalt or stone paved surfaces, old masonry or concrete (plain or reinforced).

1.3 Soft Rock: This shall include rock, boulders, slag, chalk, slate, hard mica achiote, laterite etc., which are to be excavated with stray blasting/ without blasting or could be excavated with picks, hammer, crow bars, wedges. This shall also include excavation in macadam and tarred roads and pavements. This shall also include rock boulders not bigger than 1 metre in any dimension and not more than 500mm

in anyone of the other two dimensions. Rubble masonry to be dismantled will also be measured under this item.

1.4 Excavation in Hard Rock:

Rock which is in solid beds, which can only be removed either by blasting or by wedging or chiselling shall betreated as hard rock. A boulder or detached rock measuring one cubic metre or more, shall also be treated as hard rock if the same cannot be removed without blasting, wedging or chiselling.

Where hard rock is met with and blasting operations are considered necessary, the contractor shall notify the OWNER/CONSULTANT of the same. Blasting is prohibited in the premises, the same shall be done by chemical blasting or excavation shall be done by wedging or chiselling and shallbe restricted to the quantity required to enable the necessary foundations etc., to be put in. In case, the dimensions of trenches, pits, exceed those shown in drawings or as directed by the OWNER/CONSULTANT, the excess quantity shall not be paid for. The item also covers bailing out subsoil orrainwater including pumping at any stage of the work, shoring, strutting etc.

1.4.1 Earthwork excavation in general surface grading:

Earthwork is to be done by excavation using mechanical equipment for cutting and levelling and transporting earth within the campus of 4 acres as directed, and in depths as directed at site.

The excavated earth shall be deposited within the campus as defined above, in layers of 15cm, consolidated and levelled. Excess earth if any shall be transported off the campus at contractors' risk and cost.

The levels taken, before and after cutting and levelling at intervals of 3-5m shall be the basis for excavation quantities and in assessing the surplus quantities general specifications for earthwork excavation and filling will be applicable for this item also except for the additional clauses stated above. Excavation with blasting/ stray blasting is separated taken as

1.5 Earth Filling:

1.5.1 General:

Filling shall be done with good approved earth, murmur, gravel, or quarry dust. It shall be free of salts, organic matter, black cotton or slushy earth and combustible material. All clods shall be broken thoroughly and properly.

1.5.1.1 Filling in Plinth /sides of foundation:

Shall be done in layers not exceeding 15cm, adequately watered and consolidated by ramming with iron orwooden rammers weighing 7 to 8 kgs. and having a base square/circular of 20cm side/diameter. When the fillingreaches the finished levels, the surface shall be floodedwith water for at least 24 hours, allowed to dry and thenrammed and consolidated after making good any settlement in order to avoid such settlement at a later stage. Special care shall be taken to pack earth under plinth beams and column corners. Finished level of filling shall be kept to the slope intended to be given to the floor.

1.5.1.2 Filling in Outdoor portions and for site development:

Shall be done in layers of 15 to 30cm as may bespecified in the item specification. Each layer shall be adequately watered. When filling reaches the required level, the topmost layer shall be dressed to proper section, grade and camberand rolled by 8-ton power roller, adequately watered to aid compaction.

Compaction

a) where compaction of 90% standard proctor density is called for such compaction shall be by mechanical means but the contractor may be permitted to adopt manual means only if the Engineer finds that the desired compaction is achievable in the field.

b) For compacting each sand layer, water shall be sprayed over it to flood it and it shall be kept flooded for 24 hours to ensure maximum compaction. Vibro-compactors shall also be used if necessary to obtain the required degree of compaction. Any temporary works required to contain sand under flooded condition shall also be undertaken. The surface of the consolidated sand shall be dressed to required levels or slope.

c) After the compacted fill has reached the desired level, the surface shall be flooded with water for 24 hours, allowed to dry and then rammed and consolidated to avoid any settlement at a later date. The compacted surface shall be properly

shaped, trimmed and consolidated to an even gradient or level. All soft spots shall be excavated filled and consolidated.

d) The degree of compaction of compacted fill in place will be subject to tests in accordance with relevant Indian Standards as desired by the Engineer. As the work progress, the contractor shall provide the necessary facilities to make such tests. If any test indicates that the compaction achieved in less than the required as per design and functional requirements degree of compaction, the Engineer may require all fill placed subsequent to the last successfully test to be removed and recompacted by the contractor. Compaction procedure shall be amended as necessary to obtain satisfactory results.

Filling in plinth and ground with earth brought from outside

A. Filling shall be carried out with approved material. The material shall be free from clods, salts, sulphates, organic & other foreign material. All clods of earth shall be broken or removed. The material and source shall be subject to prior approval of OWNER/CONSULTANT. The approved area, from where the fill material is to be dug, shall be cleared or all bushes, roots plants, rubbish material shall be removed. The materials so removed shall be burnt or disposed of as directed by OWNER/CONSULTANT. The contractor shall make necessary access roads to; those areas and maintain the same, if such access road does not exist, at his cost

B. If any material is rejected by OWNER/CONSULTANT, Contractor shall remove the same forthwith from the site at no extra cost to the owner. Surplus fill material shall be disposed of by uniform spreading within the site as instructed by the OWNER/CONSULTANT.

C. The compaction shall be carried out as specified in the item no.1.5.1.2. a.

Mode of Measurement:

Backfilling, plinth filling etc. with borrowed earth will be paid for under specified items. The quoted rate shall include all operations such as clearing, excavation, lead and transport, fill, compaction etc. as specified. Actual quantity of consolidated filling or actual quantity of excavation in the borrow pits (less such top soil which has been excavated and not used for filling) whichever is; less shall be measured and paid for in cubic metres. The lead, lift etc. shall be as indicated in the schedule of quantities.

1.5.2 Dry Rubble Packing:

Ground shall first be levelled up and thoroughly consolidated by means of heavy log hammers or from rams. Rubble of specified thickness shall then be laid and set with hand. It shall be consolidated by either hand roller or wooden log hammers, water being freely used during consolidation. All hollows and interstices after consolidation shall be filled up with quarry spalls, stone chips, etc., and the packing blinded with stone grit, watered and consolidated by log hammer.

Rubble packing in road work shall be thoroughly consolidated by means of power roller of 8-ton capacity instead of log hammers and the surface shall be brought to proper grade and camber. After checking the level, grade and camber the surface will again be watered and rolled to receive road structure.

1.5.3 Levelling course:

The ground shall be prepared as for Dry Rubble Packing as above. The course shall be either plain cement concrete of lean mix or lime concrete which shall be proportioned as stipulated in the relevant item and mixed and placed in position, conforming to line and level shown on the drawing and compacted by approved means and cured adequately.

Lime concrete shall be prepared by mixing sand and slaked lime in proportions of three parts of sand and one part of lime and ground in a suitable mill and the mortar so prepared shall be added to six parts of brick bat passing through 50mm mesh, mixed well and placed in position and compacted by approved means, the concrete shall be cured adequately.

1.5.4. Sand filling in plinth/foundation

1.5.4.1 Filling shall be carried out in layers not exceeding 15cms and shall be compacted mechanically or by saturation to specified grade and level and to obtain 90% laboratory maximum dry density or as specified in schedule of rates.

1.5.4.2 Compaction by flooding may be accepted at the discretion of the OWNER/CONSULTANT, provided the required compaction is achieved.

The contractor shall not commence filling in and around any work until it has been permitted by the OWNER/CONSULTANT.

Disposal of surplus earth.

1.6.1 The Contractor is free, within the framework of rules and regulations of the local authorities, to deal with the surplus earth in any manner suitable to him. The Contractor may dispose of the surplus earth from the project site except top 300 mm layer to a place/ places as may be permitted by the appropriate authority/ body. The transportation of the surplus earth shall be done by mechanical means only. The Contractor shall at his own cost obtain necessary clearances/ permissions statutory of otherwise needed for the purpose.

1.7 Measurements

1.7.1 Measurement for excavation shall be recorded only for the plan dimensions of the building, structure, trenches, tunnels etc. up to edges of PCC levelling course below foundations as shown on the drawings. The Contractor's rate shall be deemed to include for extra excavation required for working space and side slopes and/or benching. The length and the breadth shall be measured in meters to the nearest centimetre and the depth/ height shall be taken in meters to the nearest 5 mm and the cubical contents shall be calculated in cubic meters up to 2 places of decimal.

1.7.2 Backfilling shall be measured and paid for separately and is need not to be included in the rate quoted for excavation. Disposal of surplus earth shall not be measured and paid for separately and is deemed to be included in the rate quoted for excavation.

1.7.3 Only 65 % of the rate quoted for excavation shall be released on completion of excavation and the balance amount shall be released only after the completion of the backfilling over the complete area and satisfactory disposal of the surplus earth.

1.8.0 Rate

1.6.1 The quoted rate shall include the cost of all the labour and materials involved in all the operations described above.

1.9 Dewatering:

Rate to excavation shall include bailing or pumping out water which may accumulate in the excavation during the process of work both from seepage, rain water or any other cause and for diverting surface flow, if any by bunds or other means. Pumping out water shall be done in such approved manner as to preclude

the possibility of any damage to the foundation trench, concrete or masonry or any adjacent structure inside or outside the wall front. When water is met in foundation trenches or in tank excavation, pumping out water shall be from auxiliary pit of adequate size dug slightly outside the building excavations. The depth of auxiliary pit shall be more than the working foundation trenches / levels. The auxiliary pit shall be refilled with approved excavated materials after the dewatering is over.

The Contractor shall adopt an appropriate method of dewatering work and shall submit its proposal for carrying out the dewatering work for the approval of the Project Manager. The water shall be pumped continuously to keep the water level at a minimum of two 2' (feet) below the lowest point of excavation level. The operation shall be continued until the entire excavation has been completed so as to ensure the excavation is always dry.

a) Adequate number of pumps shall be deployed to ensure a continuous dewatering process.

b) Power / Fuel required for the operation of pumps etc shall be provided and paid for by the Contractor.

Softening of the bottom of excavation will not be allowed. If softening occurs due to weather or any other source, the Contractor shall remove the affected area and replace as specified and directed by the Project Manager at no extra cost.

Necessary grading, trenching and temporary sumps shall be made around excavations as required to prevent water runoff into excavation and to ensure proper protection to slopes from erosion.

The excavation shall be kept free from water:

a) During inspection and measurement

b) From start to completion of concreting till they come above existing ground.

c) Till the Project Manager considers that the concrete is sufficiently set.

d) Till the underground reservoir is tested for water tightness

1.10 Cutting of trees of height 3m and above from ground level:

While clearing jungle, growth trees above 30 cm girth (measured at a height of one metre above ground level) to be cut, shall be approved by the Engineer-in charge and then marked at site. Felling trees shall include taken out roots up to 60cm below sub-grade level, whichever is lower.

All excavation below general ground level arising out of the removal of trees, stumps etc. shall be filled with suitable material in 20cm layers and points conform to the surrounding area. The trunks and branches of trees shall be cleared of limbs and tops and cut into suitable pieces as directed by the Engineer-in charge.

1.11 Special Conditions:

1.11.1 The contractor shall keep the site of works neat and clean during the execution of work. Any debris found at or near the site of work shall be removed immediately as directed by the Engineer-in-charge.

1.11.2 On completion of work, the site of work shall be thoroughly cleaned and all debris removed before the work is handed over satisfactorily.

1.12. Payment

Payment shall be made on cubic metre basis of the finished work

TECHNICAL SPECIFICATIONS

FOR

CONCRETE WORKS

SECTION - I: MATERIALS

PART - I: SPECIFICATIONS

2.0 Materials

2.1 Materials covered under this section of specifications are: -

- Cement
- Aggregates (Coarse and Fine)
- Water
- Admixtures

2.2 Cement

2.2.1 Cement used in the works shall conform to only the following types: -

a) Ordinary Portland cement of

- grade 33 conforming to I.S. - 269
- grade 43 conforming to I.S. - 8112
- grade 53 conforming to I.S. - 12269

b) Portland pozzolana cement (Fly ash based) - grade 43 conforming to I.S. 1489 (Part-I)

c) Super sulphate cement of grade 30 conforming to I.S. - 6909.

2.2.2 Compressive strength requirement of each type of cement for various grades, when Sample tested in accordance with I.S. 4031 (Part-6) shall be as under: - Strength in N/mm2 not less than for Age at

testing	Grade 30	Grade 33	Grade 43	Grade 53	
72 + 1 hour	15	16	23	27	
168 + 2 hours	22	22	33	37	

672 + 4 hours	30	33	43	53	

2.2.3 Setting time of cement of any type or any grade specified in these specifications, when tested by the Vicar apparatus method described in I.S. - 4031 shall conform to the following limits: -

a) Initial setting time: not less than 30 minutes

b) Final setting time: not more than 600 minutes

2.2.4 Cement to be used for the manufacture of concrete of different grades and for different purposes shall be as specified by the user/purchaser of such concrete and as approved by the Construction Manager.

2.3 Coarse Aggregate

2.3.1 Coarse aggregates for the manufacture of concrete shall conform to I.S. - 383.

2.3.2 Coarse aggregates shall consist of naturally occurring stones and gravels. They shall be hard, strong, dense, durable, and clear and be free from veins and adherent coatings. These should be free from injurious amounts of disintegrated pieces, alkali, vegetable matter and other deleterious substances. Flaky and elongated pieces should be avoided as far as practicable.

2.3.3 Limits of deleterious materials permissible in coarse aggregates, when tested in accordance with I.S. - 2386 shall be limited to the following: -

Deleterious substance	Maximum allowable percentage by weight of aggregates
I) Coal and lignite	1.0
ii) Clay	1.0
iii) Materials finer than 75 micron I.S. sieve	3.0

iv) Soft fragments Nil

v) Shale Nil

vi) Mica Nil

vii) Total of all items (I) to (vi) 5.0

2.3.4 Single sized coarse aggregates or graded coarse aggregates for manufacture of concrete shall have grading as given in table 3.4.1 and 3.4.2 respectively

Table 3.4.1

IS SIEVE SIZE	Percentage passing through for single sized coarse aggregates of nominal sizes:			
40mm	20mm	16mm	12.5mm	10mm
63mm	100	-	-	-
40mm	85-100	100	-	-
20mm	0-25	85-100	100	-
16mm	-	-	85-100	100
12.5mm	-	-	85-100	100
10mm	0-5	0-20	0-20	85-100
4.75mm	0-5	0-5	0-5	0-20
2.36	-	-	-	0-5

Table 3.4.2

Percentage passing through for graded aggregates I.S. Sieve of nominal sizes.

Size	40 mm	20 mm	16 mm	12.5mm
63 mm	100	-	-	-

40 mm	95 to 100	100	-	-
20 mm	30 to 70	95 to 100	100	-
16 mm	-	-	90 to 100	100
12.5 mm	-	-	-	90 to 100
10 mm	10 to 35	25 to 55	30 to 70	0 to 85
4.75 mm	0 to 5	0 to 10	0 to 10	0 to 10

2.3.5 Strength and other tests for coarse aggregates shall be done in accordance with I.S. 2386 as per instructions of Construction Manager and all such test reports shall be furnished to him for his approval before any aggregate is used in manufacture of concrete for the works.

2.3.6 Maximum nominal size of coarse aggregates to be used for the manufacture of concrete of different grades and different purposes shall be as specified by the user/purchaser of such concrete and as approved by the Construction Manager.

2.4.0 Fine aggregates

2.4.1 Fine aggregates for the manufacture of concrete shall conform to I.S. - 383.

2.4.2 Fine aggregates shall comprise of either naturally occurring sand or crushed and milled stone and gravels or a combination thereof. These shall be hard, strong, dense, durable, clear and free from adherent coatings, and shall be free from injurious amounts of alkali, vegetable matter, and other deleterious substances.

2.4.3 Limits of deleterious materials permissible in fine aggregates shall be as for coarse aggregates as given in para 3.3 above.

2.4.4 Grading of fine aggregates for manufacture of concrete shall be limited to the zones I to III of table 4.4.1, when determined as described in I.S. - 2386 (Part - I).

2.4.5 Tolerance for a particular grading zone shall be + 5% for all sizes of particles for that zone. This tolerance limit shall not be applicable to the following: -

a) For material passing 600-micron sieve for all zones.

b) For coarse limits of Zone - I.

c) For finer limits of Zone – IV

Table - 4.4.1

I.S. Sieve Percentage Passing for

Size	Zone-I	Zone-II	Zone-III	Zone-IV
10 mm	100	100	100	100
4.75 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 - 90	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 - 15

2.4.6 Strength and other tests for fine aggregates shall be done in accordance with I.S. - 2386 as per instructions of Construction Manager, and all such test reports shall be furnished to him for his approval before any of the fine aggregates is used in the manufacture of concrete for the works.

2.5.0 Water

2.5.1 Water used for mixing and curing shall be clean and shall be free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete and steel.

2.5.2 Water proposed to be used for manufacture of concrete and curing of concrete shall be tested as per recommendations of I.S. 3025. All such test reports shall be furnished to the Construction Manager for his approval.

2.5.3 Water for manufacture of concrete, when tested in accordance with I.S. 3025 for presence of solids shall have permissible limits as given in table 5.3.1

Table 5.3.1

Material	Maximum permissible limit
Organic	200 mg/litre
Inorganic	2000 mg/litre
Sulphates (as SO4)	300 mg/litre
Chloride (as CL)	500 mg/litre
Suspended matter	1000 mg/litre

2.5.4 The PH value of water to be used for manufacture of concrete shall not be less than 6.

2.5.5 Prior to testing of water sample, it shall not have any pre-treatment. Sample shall be stored in a clean container previously rinsed out with the same water.

2.6.0 **Admixtures**

2.6.1 Admixtures may be used in concrete subject to prior approval of Construction Managers. All admixtures shall conform to I.S. 9103.

2.6.2 Admixtures may be any one the following classes for use in concrete: -

a) Water - reducing Admixtures

b) Retarding Admixtures

c) Accelerating Admixtures

d) Water reducing and retarding Admixtures

e) Water reducing and accelerating Admixtures

f) Permeability reducing (waterproofing) Admixtures.

2.6.3 Liquid admixtures

2.6.3.1 Admixtures introduced into the concrete as liquids generally fall into the following categories: -

I) Air entraining

ii) Water reducing

iii) Water reducing retarders

iv) Retarders

v) Water reducing accelerators

vi) Accelerators

2.6.3.2 Dosage of these admixtures may vary from 4 cm to 2000 cm cube or more per 50 kg of cement. The dosing shall be done exactly as per specification of Admixture manufacturer.

2.6.3.3 Two or more admixtures may not be compatible in the same solution. It is therefore mandatory that when two admixtures manufactured by the same manufacturer is being used simultaneously, the manufacturer shall certify their compatibility. In case the two or more admixtures are produced by different manufacturers, then, before their use in concrete, test shall be performed by the manufacturer to establish their compatibility, all such test reports shall be furnished to the Construction Manager for his approval before their use in concrete.

2.6.4 Some admixtures may be in the form of powder, particle or high concentration liquids which may require mixing with water prior to dosing. Under these conditions, water in solution shall be considered as part of total water content in the batch in order to maintain the water - cement ratio.

2.6.5 Admixture manufacturer's recommendation shall be carefully followed so as to ensure complete solution of the product or to prepare a standard solution of uniform strength for easier use.

2.6.6 Certain admixtures may contain significant amounts of finely divided insoluble materials or active ingredients which may or may not be readily soluble. It is essential for such admixtures that precautions be taken to ensure that these constituents be kept in a state of uniform suspension before actual batching.

2.6.7 When relatively small amounts of powdered admixtures are to be used directly, these shall be pre - blended with cement.

2.6.8 Admixtures are sold under various trade names and may be in the form of liquids or powders. The proprietary name and the net quantity of content shall be clearly indicated in each package or container of admixtures. The admixtures shall be uniform within each batch and uniform between all batches.

2.6.9 No admixture shall be accepted for use in concrete unless these are tested in accordance with I.S. 9103 and the test results are approved by the Project Manager.

SECTION I: MATERIALS

PART-2: HANDLING AND STORAGE

2.7 Aggregates

2.7.1 Coarse and fine aggregates as delivered to weigh batchers shall be of good quality and uniform grading. Moisture content shall also be controlled.

2.7.2 Coarse Aggregates

2.7.2.1 Segregation in coarse aggregates shall be reduced to a minimum by separating the material into several fractions and batching these fractions separately.

2.7.2.2 Range of sizes in each fraction shall be reduced, and the number of separations shall be increased to control segregation. To maintain this the ratio of maximum to minimum size in each fraction shall be restricted to four for aggregates smaller than 25mm and the ratio shall be reduced to two for aggregates larger than 25mm.

2.7.2.3 When specification limits for grading cannot be met consistently, special handling methods shall be instituted, like rescreening of coarse aggregates at the batch plant to eliminate objectionable undersized material. Undersize materials in the smaller aggregate fractions shall be consistently reduced to 2% by rescreening immediately before storing in batch-plant bins.

2.7.3 Fine aggregates

2.7.3.1 Fine aggregates shall be controlled and stored to minimize variations in grading by keeping finer fractions uniform and exercising care to avoid excessive removal of fines during processing.

2.7.3.2 Variations in grading during production of concrete shall be minimized. Variation in fineness modulus of fine aggregate shall be maintained within + 0.20 of design value.

2.7.3.3 Amount and nature of material finer than the 75-micron sieve shall be given special attention. Excessive quantities of fines passing 75-micron sieve increases mixing water requirement, rate of slump loss, and increase of drying shrinkage and strength loss. Arrangements shall be made to store

coarse and fine fractions separately before loading then into batch - plant bins.

2.7.4 Storage

2.7.4.1 Stock piling of aggregates if required shall be kept to a minimum and in no case the height shall exceed 1.2 m. Stockpiles shall be built up in horizontal layers with gently sloping sides. Stockpiles shall not be created by end-dumping from trucks. Suitable arrangements to slide the aggregates down from truck bodies shall be made. Vehicular movement on stockpiles shall not be allowed.

Stockpiles shall be provided with a hard base (preferably concrete) with suitable drainage to prevent contamination. Overlap of different fraction piles

Shall be prevented by means of separator walls. Wind shall not be permitted to blow on dry fine aggregate causing separation/segregation.

2.7.4.2 Storage bins shall be kept as full as practicable to minimize changes in grading as material is withdrawn. Material shall be deposited in bins vertically and directly above the bin outlet.

2.7.5 Moisture Control

2.7.5.1 Effort shall be made to ensure uniform and stable moisture content in aggregates as batched. Use of aggregates having varying amounts of free water shall not be permitted. Sometimes it may be necessary to wet the coarse aggregates in stockpiles. Under such conditions the aggregates shall be dewatered on appropriate drying screens.

For fine aggregates, appropriate time shall be allowed for free water drainage before the aggregate is transferred to batch plant bins.

2.7.5.2 Moisture variation in fine aggregates shall be restricted to 0.5% per hour. To ensure stable moisture content in fine aggregate before loading in batch plant bin, use of moisture meter shall be made.

2.8.0 Cement

2.8.1 Handling

2.8.1.1 As far as practicable, cement of each type shall be obtained from one constant source throughout the works. Different brands of cements or cement of same brand from different sources shall not be used for the works without the written approval of Construction Manager.

2.8.1.2 Cement shall be received and stored either packed in approved quality bags or in silos. Damaged bags shall not be received in stores.

2.8.1.3 every delivery of cement shall be accompanied by a producer's certificate confirming that the supplied cement conforms to relevant specifications. These certificates shall be endorsed to the Construction Manager for his record.

2.8.1.4 every consignment of cement must have identification marks on packages indicating date of manufacture and grade and type of cement. Cement brought to works shall not be more than 6 weeks old from the date of manufacture.

2.8.2 Storage

2.8.2.1 Packaged cement shall be stored in weather tight but properly ventilated structures to prevent absorption of moisture.

These shall be stored on a raised floor/platform. Stacks shall be made with height not exceeding 10 bags. Adequate alleyways shall be provided between each stack. Stacks shall not be made against exterior walls.

2.8.2.2 Cement stored in bags during monsoon or cement in bags expected to be in storage for more than 8 weeks shall be completely wrapped with 700-micron thick polythene/polyethylene sheets so arranged that the flaps closes on the top of the stack with at least one-meter overlap. If during handling/use the covering sheets gets damaged or ruptured, these shall be replaced.

2.8.2.3 Storage facilities for bulk cement shall be in silos. Separate type of cement shall be stored in separate silos or in different compartments of the same silo. The interior of the silo shall be smooth. Bottom slopes for silos with respect to horizontal shall be a minimum of 50 degree for circular silos and 60 degree for rectangular/square silos. Non-circular storage silos

shall be equipped with non-clogging air diffuser flow pads through which small quantities of low-pressure air (approximately at 0.2 to 0.4 kg. /cm) shall be introduced intermittently to loosen cement which has settled tightly in the silo. Care shall be taken to use minimum airflow through cement, which in dry climates may change the set - characteristics of cement.

2.8.2.4 Cement storage silos shall be drawn down at intervals of one month to prevent cement caking.

2.8.2.5 Care shall be taken to prevent cement being transferred to the wrong silo, either by faulty procedures or equipment.

2.8.2.6 Effective precautionary measures shall be taken to eliminate dust - nuisance during loading or transferring cement.

2.8.2.7 Cement shall be used in the manufacture of concrete in order of the following preferences: -

a) Date of manufacture or age of cement.

b) Date of storage at works.

2.9.0 Admixtures

2.9.1 Handling

2.9.1.1 Admixtures, being manufactured ingredients for use in concrete, shall be handled

as packed by manufacturers. Damaged packings shall not be acceptable and contents of such packages shall not be used in the works.

2.9.2 Storage

2.9.2.1 Admixtures shall be stored in proper store - rooms and shall be kept in packages/containers as supplied by the manufacturer of the item.

2.9.2.2 When the seal of a package or container is broken for use care shall be taken that the balance quantity is stored such that these are protected from dampness. For liquid admixtures supplied in drums or cans, the lids shall be replaced tightly. For admixtures supplied in packages, the opened packs shall be carefully wrapped in 700-micron thick polythene sheets before putting these backs in storage.

2.9.2.3 Admixtures of different types and usages shall be stored in different groups (preferably in separate racks).

2.9.2.4 All packings of admixtures shall have the date of manufacture and/or date of expiry clearly stamped on them.

2.9.2.5 Admixtures of any type shall be used in order of the following preferences: -

a) Date of expiry.

b) Date of manufacture.

SECTION I: MATERIALS

PART - 3: MEASURING OR BATCHING

2.10.0 Objectives

2.10.1 During measurement all components of concrete shall be handled in a manner to maintain their desired grading and shall be weighed to the tolerances required to maintain the desired reproducibility of the concrete mix selected for use.

2.10.2 In addition to accurate weighing, another important objective of successful batching is the proper sequencing and blending of the ingredients during charging of the mixers. homogeneity and consistency of the concrete produced in respect of physical properties like unit weight, slump, air content, strength and air free mortar content in successive batches of the same mix proportion.

2.10.3 Tolerances

2.10.3.1 Batching Tolerances for different materials shall be as given in Table 2.1.1.

Table 2.1.1: Batching Tolerances

Ingredients	Batch weights greater than 30% of scale capacity.		Batch weights less than 30% of scale capacity.	
	Individual Batch	Cumulative Batch	Individual Batch	Cumulative Batch

Cement	+ 1% of batch or by weight whichever is greater.	+ 0.3% of scale capacity	Not less than required weight or 4% more than required weight.
Water (by volume or by weight)	Not + 1% recommended	Not + 1% recommended	
Aggregates	+ 2%	+ 1% + 2% or + 3% of re-quired cumulative weight, whicheverisles.	
Admixtures (by volume or by weight)	+ 3%	Not recommended	Not + 3% recommended.

2.10.3.2 Other requirements on measurement tolerances shall be: -

a) Beam or scale divisions of scales shall be 0.1 percent of total capacity.

b) Batching interlock of + 0.3 percent of total capacity at zero balance.

c) Quantity of admixtures measured shall never be so small that 0.4 percent of the full-scale capacity is greater than 3 percent of the required weight.

2.10.3.3 All batching equipment's shall be isolated from any kind of vibrations either from plant or otherwise. If required, proper vibration isolators shall be used.

2.10.3.4 All automatic controls shall be protected from dust and weather.

2.10.3.5 Frequent checks shall be made of the beam and scale pivot points for their correctness. All balances and scales shall be regularly cleaned.

2.11.0 Bins and Weigh Batchers

2.11.1 Batch plant bins shall be of adequate size to effectively accommodate the productive capacity of the plant. All compartments in bins shall be adequately separate for the various materials. Shape and arrangements of bins shall be conducive to the prevention of aggregate segregation and breakage.

2.11.2 Gates used to charge the batchers shall be power operated and shall be equipped with a suitable controlling device to obtain the desired weighing accuracy.

2.11.3 Batchers shall be capable of providing representative samples at any time during the process of batching. Batchers shall also be capable of proper sequencing and blending of aggregates during charging of mixer.

SECTION - II: CONCRETE

PART - I: SPECIFICATION FOR PORTLAND CEMENT CONCRETE

3.1.0 General

3.1.1 This section deals with the requirements of Portland Cement Concrete as manufactured from: -

- Cement
- Coarse aggregates
- Fine aggregates
- Water

Concrete may or may not contain permissible admixtures.

3.1.2 Specifications for ingredients to be used in manufacture/production of concrete shall be as stipulated in Section - I of these specifications.

3.2.0 Mix design and proportioning

3.2.1 Mix proportions shall be designed to ensure that the workability of fresh concrete is suitable for conditions of handling and placing, so that after compaction it surrounds all reinforcements and completely fills the

formwork. When concrete is hardened, it shall have the stipulated strength, durability and permeability.

3.2.2 Determination of the proportions by weight of cement, aggregates and water shall be based on design of the mix.

3.2.3 As a trial the manufacturer of concrete may prepare a preliminary mix according to provisions of S.P: 23-1982. Reference may also be made to ACI 211.1-77 for guidance.

3.2.4 Mix design shall be tried and the mix proportions checked on the basis of tests conducted at a recognized laboratory approved by the Construction Manager.

3.2.5 all concrete proportions for various grades of concretes shall be designed separately and the mix proportions established keeping in view the workability for various structural elements, methods of placing and compacting. Irrespective of the variables, each grade of concrete being produced for works shall meet the characteristic strength requirements as given in table 2.5.1, when tested in accordance with I.S. 516.

Table 2.5.1

Concrete grade Designation	Specified Characteristic Cube Compressive Strength at 28 days.
M - 20	20 N/mm2
M - 25	25 N/mm2
M - 30	30 N/mm2
M - 35	35 N/mm2
M - 40	40 N/mm2
M – 45	45 N/mm2
M – 50	50 N/mm2
M – 55	55 N/mm2

Strength values given in table 2.5.1 shall alone be the criterion for acceptance or rejection of the concrete.

3.2.6 In order to get a relatively quicker idea of the strengths gained by concrete, tests shall be conducted in accordance with I.S. 516, as per requirement and instructions of Construction Manager, for tests to determine modulus of rupture and compressive strengths. For such test results, with ordinary Portland cement, the guide line values shall be as given in table 2.6.1

Table 2.6.1

Concrete grade Designation	Cube Compressive Strength at (N/mm2) 7 days (N/mm2)	Modulus of rupture by beam test at 72 + 2 hrs. 7 days
M - 20	13.5	1.7 2.4
M - 25	17.0	1.9 2.7
M - 30	20.0	2.1 3.0
M - 35	23.5	2.3 3.2
M - 40	27.0	2.5 3.4
M - 45	30.0	2.7 3.6
M - 50	34.0	2.9 3.8
M - 55	37.0	3.1 4.0

3.2.7 Concrete compressive strength tests for preliminary works including trial mix design conducted in accordance with I.S. 516 under controlled laboratory conditions shall meet the requirements of values stipulated in table 2.7.1

Table 2.7.1

Concrete grade Designation	Compressive strength of cubes (N/mm2) at 7 days	at 28 days

M - 20	17.5	26
M - 25	22.0	33
M - 30	26.0	39
M - 35	31.0	46
M - 40	35.0	52
M - 45	40.0	59
M - 50	44.0	65
M - 55	48.0	71

3.3.0 Test Strength of Samples

3.3.1 Test strength of a sample shall be the average of three specimens from the same batch of concrete. Individual variations in strengths of the three specimens shall not be more than + 10 percent of the average.

3.4.0 Standard Deviation

3.4.1 Standard deviation calculations of test results based on tests conducted on the same mix design for a particular grade designation shall be done in accordance with clause 14.5 of I.S. 456.

3.5.0 Acceptance Criteria

Acceptance criteria of any concrete shall be as stipulated in clause 15 of I.S. 456.

3.6.0 Cement Content in Concrete

3.6.1 **For all grades of concrete manufactured/produced, minimum cement content in the concrete shall be 320 kg per cubic metre of concrete. Also, irrespective of the grade of concrete, the maximum cement content shall not be more than 500 kg per cubic metre of concrete. These limitations shall apply for all types of cements of all strengths.**

3.6.2 Actual cement content in each grade of concrete for various conditions of variables shall be established by design mixes within the limits specified in para 6.1 above.

3.7.0 Water cement ratio and slump

3.7.1 In proportioning a particular mix, the manufacturer/ producer shall give due consideration to the moisture content in the aggregates, and the mix shall be so designed as to restrict the maximum free water to cement ratio to less than 0.5.

3.7.2 Due consideration shall be given to the workability of the concrete thus produced. Slump shall be controlled on the basis of placement in different situations. For normal methods of placing concrete, maximum slump shall be restricted to 100 mm when measured in accordance with I.S. 1199.

3.8.0 Approval of Design Mix

3.8.1 The producer/manufacturer of concrete shall submit details of each trial mix of each grade of concrete designed for various workability conditions to the Consultant for his comment and approval.

Concrete of any particular design mix and grade shall be produced/manufactured for works only on obtaining written approval of the Construction Manager.

3.8.2 for any change in quality/quantity in the ingredients of a particular concrete, for which mix has been designed earlier and approved by the Construction Manager, the mix has to be redesigned and approval obtained again.

SECTION - II: CONCRETE

PART - 2: GUIDELINE SPECIFICATIONS FOR PUMPABLE CONCRETE

3.9 Basic Considerations

3.9.1 Ingredients of pumped concrete shall be same as those for concrete placed by other means. However, more emphasis shall be laid on quality control and proportioning of pumpable concrete.

3.10 Quality

3.10.1 Concrete mixes for pumping must be plastic and soft. Harsh mixes do not pump well. Particular attention shall be given to the mortar part (cement, fine aggregate and water) and also to the amount and sizes of coarse aggregates.

3.10.2 Particular reference shall be made to ACI - 211.1-77 covering the principles of proportioning of normal weight concrete. These specifications give details as they pertain to pumpable mixes.

3.11 Cement

3.11.1 There shall be no special requirements for cement to be used for pumpable mixes.

3.12 Coarse Aggregates

3.12.1 The maximum size of angular coarse aggregate shall be limited to one third of the smallest inside diameter of the hose or pipe on simple geometry of cubical shaped aggregates. For well-rounded aggregates, the maximum aggregate size shall be restricted to 40% of the pipe or hose diameter. Provision shall be made to totally eliminate oversized particles in the aggregates. Grading of different size aggregates shall be as per table 3.4.2 of Section - I, Part-I of these specifications and shall be as close to the middle range of each gradation limits. It may become necessary to combine and blend certain fractional sizes to produce proper gradation.

3.12.2 Uniformity of gradation throughout the period of the job from day to day is far more important than occasional perfect "down the middle gradation".

3.12.3 Shape of the coarse aggregate, whether angular or rounded, has an influence on the mix proportions. However, both types can be pumped satisfactorily. The maximum size of coarse aggregates has a significant effect on the volume or amount of coarse aggregates that may be efficiently used. Quantity of coarse aggregates must be suitably reduced as the maximum aggregate size become smaller.

3.13 Fine Aggregates

3.13.1 Properties of fine aggregate play a vital role in the proportioning of pumpable concrete. Together with cement and water, the fine aggregates provide the mortar or fluid, which conveys the coarse aggregates in suspension thus rendering the mix pumpable.

3.13.2 Gradation of fine aggregates which constitute the entire particle passing the 4.75 mm I.S. sieve shall conform to Table 4.4.1 of Section I, Part-I of these

specifications. For a pumpable mix, particular attention shall to given to the finer screen sizes. For small line systems (less than 150 mm diameter) 15 to 30 percent should pass the 300-micron sieve and 5 to 10 percent should pass the 150-micron sieve.

Fine aggregates which are deficient in either of these two gradings shall be blended with selected fines to produce the desired percentages.

Care shall be taken to restrict the finer gradings to the optimum. Otherwise the mix would require additional water which may cause excessive shrinkage and loss of strength.

3.13.3 Pumpability of mixes generally improves with decrease in fineness modulus values. Fineness modulus values between 2.40 and 3.00 are generally satisfactory. However, fineness modulus values above, without control on the finer grade may not produce satisfactory results. Limits given in para 5.2 above should therefore be kept in view while establishing fineness modulus of the fine aggregates.

3.13.4 it shall also be ensured that fineness modulus does not vary by more than 0.20 from the average value adopted in proportioning, to maintain uniformity of concrete.

3.14 Water and Slump

3.14.1 Water requirements and slump control for pumpable normal weight concrete mixes are interrelated and extremely important considerations.

3.14.2 Mixing water requirements vary for different maximum sizes of aggregates as well as for slumps. ACI - 211.1-77 table 5.3.3 gives guidelines for mixing water requirements for both non-air-entrained and air- entrained concrete. It is however emphasized that these values are only approximate and may require modifications due to:

- the amount and/or fineness of fine aggregates
- quantity or number of admixtures or additives
- cement replacements
- other materials being used in concrete

3.14.3 Experience indicates that slump below 50 mm are impractical for pumping jobs and slumps above 150 mm shall be avoided to prevent segregation of aggregates. Over-wet concrete will also exhibit excessive bleeding, and

increase shrinkage. It is much more important to obtain a truly "plastic" mix through proper proportioning than to try to overcome deficiencies by adding more water.

3.15 Cement

3.15.1 Determination of cement content in a pump mix shall follow the same basic principle used for conventionally placed concrete.

3.15.2 The exact cement requirement and water - cement ratio shall be established from: -

- strength requirements
- exposure conditions
- minimum cement factor.

Because of the slightly higher ranges of slump and ratios of fines to coarse aggregate, pump - mixes may require an increase in the amount of cement above those used in conventionally placed concretes

3.15.3 In establishing the cement content it is necessary to overstrength the concrete proportioning for laboratory testing to provide for field variations which produce lower strength.

However, use of extra quantities of cement as the only solution to rectify pumping difficulties shall not be practiced. It is far more essential to control and rectify deficiencies in aggregate proportioning. Well graded coarse and fine aggregates properly combined will give rise to cement factors for pump mixes which will closely resemble cement for conventionally placed concrete.

3.16 Admixtures

3.16.1 Any admixture that increases workability of concrete will usually improve pumpability. However, use of any admixtures shall be made only with the approval of Construction Manager.

3.16.2 Admixtures generally used to increase pumpability are: -

- Water reducing
- Air entraining
- finely divided minerals

3.16.3 Air entraining admixtures materially alter the properties of both fresh and hardened concrete. Air entrained concrete is considerably more plastic and work be pumped with less coarse - aggregate segregation and there is a lesser tendency of the concrete to bleed. However, to maintain durability

within specified limits, air content in an air entrained mix shall not be more than 3% by volume.

3.17 Testing for Pumpability

3.17.1 There is no recognized laboratory apparatus or precise piece of equipment available to test the pumpability of a concrete mix in the laboratory. Therefore, no mix shall be accepted on a pumping job unless an actual test under field conditions has been successfully tried.

3.17.2 Testing a mix for pumpability shall involve a duplication of anticipated job conditions from beginning to end, including batching, truck mixing, similar pumps and pipe lines installed to deliver concrete at heights and distances as on actual works. Guide lines for such mix proportions may however be obtained from another job with similar conditions but shall in no case be accepted as adequate for the job.

SECTION - III: CONCRETE

PART - I: MIXING AND READY-MIX CONCRETE

4.1.0 Mixing

4.1.1 Thorough mixing is essential for production of uniform concrete. Equipment's and methods used shall be capable of effectively mixing concrete materials to produce uniform mixes of the lowest slump practical for the work.

4.2.0 Charging of mixer

4.2.1 Mixers both stationary and truck mounted shall be so charged that there is a pre-blending of the ingredients as the stream flows into the mixer.

4.2.2 Water shall enter the mixer first, but must continue to flow while other ingredients are entering the mixer. Water charging pipes shall be of proper

design and of adequate size so that water enters at a point well inside the mixer. Water charging shall be complete within the first 25% of the mixing time.

4.2.3 Cement shall be charged along with other materials, but it shall be ensured that cement enters the stream after approximately 10% of the aggregates is in the mixer. When it is necessary to charge cement into truck mixers separately, additional mixing time shall be allowed to obtain desired uniformity of mix.

4.2.4 Admixtures shall be charged to the mixer at the sometime in the mixing sequence for every batch. Liquid admixtures shall be charged with the water. Powdered admixtures shall be rib boned into the mixer with other dry ingredients. When more than one admixture is used, they shall be batched separately and they shall not be premixed before entering the mixer.

4.3.0 Mixer Performance

4.3.1 Mixer performance checks shall be made at regular intervals to ensure uniformity of the concrete. Visual examination of the concrete shall be one of the aids for maintaining and checking mixer performance.

4.3.2 Results of tests on air content, slump, unit weight of air free mortar shall be guidelines on mixer performance.

4.4.0 Mixing Time

4.4.1 Mixing time shall be measured from the time all ingredients are in the mixer.

4.4.2 Mixing time shall be established from mixer performance tests conducted at frequent intervals throughout the period of the works. However, as an initial guide, mixer manufacturer's recommendation may be followed. Other guide line being: 1.33 mins. for 1 cum capacity of mixer and 0.33 min. for every additional 1 cum of mixer capacity.

4.4.3 Mixer shall be designed to have audible indicators and combination interlocks which prevent mixer discharge prior to completion of a present mixing time. Mixer shall also be designed to start and stop operation with full load.

4.5.0 Re-tempering

4.5.1 Provided that design water- cement ratio is not exceeded; small increments of re-tempering water may be added to mixed batches to obtain the desired slump.

4.5.2 Addition of water in excess of designed water - cement ratio to compensate for slump loss resulting from delays in delivery or placing of concrete shall not be permitted.

4.6.0 Mix Temperature

4.6.1 Batch to batch uniformity of concrete with regard to slump, water requirement and air content is dependent on temperature of concrete. It shall therefore be

ensured that the maximum and minimum temperatures of concrete throughout all seasons of the

year do not very beyond the limits given below: -

Maximum: 30* C

Minimum: 20* C

4.6.2 Necessary measures shall be taken to lower or raise the temperature of water to maintain the mixed concrete between the specified temperature limits.

4.7.0 Discharging of mixer

4.7.1 Mixer shall be capable of and handled properly so that concrete of lowest desired slump can be effectively discharged without causing segregation.

4.8.0 Ready - Mix Concrete

4.8.1 Ready - mix concrete may be: -

- mixed in a central plant and transported to the job in agitating or non-agitating truck bodies.
- mixed entirely in transit.
- mixed entirely after reaching the job site.
- mixed partially in a central plant and completed in transit or after reaching the job site (shrink mixing).

4.8.2 In ready mix concrete, special attention shall be given to the addition of mixing water quantity, which if incorrect, shall result in reduction of concrete quality.

4.8.3 Concrete consistency (slump) is also affected by: -

- amount and rate of mixing
- length of haul
- time period for unloading
- temperature conditions.

4.8.4 In cool weather, or short haul and with prompt delivery, concrete qualitymay not be significantly affected. But with reverse conditions, quality of concrete may be significantly affected.

Addition of water to compensate for slump loss shall not exceed that quantity necessary to compensate for a maximum 25mm slump loss. However, by this additional quantity of water, the design water cement ratio shall not be exceeded.

4.8.5 Loss in workability in warm weather shall be minimised by expediting delivery and placement, and by controlling the concrete temperature.

4.8.6 If it becomes necessary to use retarders to prolong the time the concrete will respond to vibrations after placement, prior approval shall be obtained from Construction Managers for their use.

4.8.7 In hot weather conditions or delays in delivery/placement, use may be made of the procedure of withholding some of the mixing water till the mixer arrives at the job site. In such cases, after addition of the balance (withheld) quantity of water, an additional30 revolutions of mixer at mixing speed shall be given to adequately incorporate the additional water into the mix.

4.8.8 When loss of slump or workability cannot be controlled by measures stated above, complete mixing shall be done at the job site using centrally dry batched ingredients.

4.9.0 Supply and placing of ready-mix concrete

4.9.1 Responsibility of in-place quality of ready-mix concrete shall be shared by the manufacturer/supplier of ready-mix concrete and the placing contractor.

4.9.2 They shall work in close coordination. The placing crew shall be in direct radio/telecommunication contact with the batch plant to ensure: -

- avoidance of delay in dispatching concrete from batch plant
- Inform batching plant delays in formwork, reinforcement work, handling or placing.

4.9.3 The placement contractor shall give in writing his requirement of a particular batch of concrete to the supplier. The Performa of this concrete order form shall be as given in Annexure `A' to these specifications. The contractor shall give copies of all such concrete order forms to the Construction Manager for his records. He shall get his duplicate order forms duly stamped and signed from the supplier/manufacturer.

4.9.4 The ready-mix concrete manufacturer/supplier shall, along with each batch of concrete delivered to the placement contractor, give him a concrete delivery ticket as per proforma given in Annexure `B' to these specifications. The supplier shall give copies of all such delivery tickets to the Construction Manager for his record and also shall get duplicate copies of all such delivery tickets duly received and signed from the placement contractor.

4.9.5 Ready mixed concrete as supplied by the manufacturer and as placed by the contractor shall in no way be different from the specifications of concrete given in Section II of these specifications.

SECTION - III: CONCRETE

PART - 2: TRANSPORTING READY MIX CONCRETE

4.10.0 General

4.10.1 Fresh concrete can be transported to the placement area by a variety of methods. Common among them are: -

- Mixer trucks
- Stationary truck bodies with or without agitators

- Buckets hauled by trucks
- Conveyor belts
- Hose or pipe line by pumping.

Each type of transportation has specific advantages and limitations depending on the condition of use, mix, accessibility and location of placing.

4.11.0 Transporting by mixer trucks

4.11.1 These are essentially revolving drums mounted on truck chassis. Truck mixers used in the job shall be labelled permanently to indicate the manufactures specifications for mixing like: -

- Capacity of drum
- Total number of drum revolutions required for complete mixing
- Mixing speed
- Maximum time limit before completion of discharge and after cement has entered the drum.
- Reduction in time period of discharge
- due to warm weather or other variables.

All above information's shall only form guidelines for the manufacturer/producer of concrete.

4.11.2 Fulfilment of the stipulated number of revolutions or elapsed time shall not be the acceptable criterion. As long as the mixing water limit is not exceeded, and the concrete has satisfactory plastic physical properties and is of satisfactory consistency and homogeneity for satisfactory placement and consolidation and is without initial set, the concrete shall be acceptable.

4.11.3 When the concrete is totally mixed in transporting trucks or in case of shrink-mix concrete, volume of concrete being transported shall not exceed 63% of threated capacity of the drum. In case the concrete is totally mixed in the central batching plant, the transporting truck may be loaded up to 80% of the rated capacity of the drum. In this case the drum shall be rotated at charging speed during loading and reduced to agitating speed after loading is complete.

4.11.4 When transporting concrete by truck mixers, delivery time shall be restricted to 1.50 hours from the time cement has entered the mixer to completion of discharge.

4.13.0 Transporting by agitating/non-agitating trucks

4.12.1 Transporting ready mix concrete by this method shall consist of truck chassis mounted with open top bodies. The metal body shall be smooth and streamlined for easy discharge. Discharge may be from the rear when the body is mechanically tilted. Body of the truck shall have a provision of discharge gate. Mechanical vibrators shall be installed at the discharge gate for control of discharge flow.

4.12.2 Agitators, if mounted, also aids in the discharging of concrete from the truck in addition to keeping the concrete alive.

4.12.3 Water shall not be added to concrete in transport through this system.

4.12.4 Bodies of trucks shall be provided with protective covers during period of inclement weather.

4.12.5 Delivery period, when adopting this systemof transporting, concrete shall be restricted to 30 minutes from the moment all ingredients including cement and water enters in mixer to completion of discharge.

4.13.0 Transporting by buckets

4.13.1 This method of transportation is very common for transportation of centrally mixed concrete. Buckets of suitable capacities may be filled with concrete which is totally mixed in central plant and hauled to the jobsite. Buckets then may be conveyed to the actual point of placement either with the help of crane/hoist or they may be carted.

4.13.2 As in the case of open truck transportation, water shall not be added to concrete transported in buckets. Concrete shall be protected from inclement weather by necessary covering arrangements. Also, maximum delivery period for this system of transportation from the time cement is introduced into the mixer to completion of discharge shall not exceed 30 minutes.

4.14.0 Cleaning

4.14.1 Before loading concrete in either truck mixer, open bodied trucks or buckets, the containers shall be thoroughly cleaned, washed and dried, so

that there is no water or moisture in the container which may affect the designed water content of the concrete.

4.15.0 Other methods of transportation

4.15.1 Transportation of concrete either by belt conveyors or by pumping is not envisaged in this work and therefore not specified.

4.15.2 If however, producer/manufacturer/purchaser of ready-mix concrete desires to use such methods of transportation, they may do so provided their scheme and complete specifications are submitted to the Construction Manager for his record and approval.

4.16.0 Objective

4.16.1 Method of transportation used shall ensure

4.16.2 efficient delivery of concrete

4.16.3 no significant alteration of properties with regard to water cement ratio, slump,

air content and homogeneity.

4.16.4 All variables in transportation, considering type and accessibility of placement locations, distance, time interval etc. shall be carefully studied before arriving at the method used.

SECTION - III: CONCRETE

PART - 3: PLACING CONCRETE IN POSITION

4.17.0 General

4.17.1 This section of specifications covers transfer of concrete from transporting vehicle discharge point to actual placement locations.

4.17.2 This may be accomplished by any of the usual methods like: -

- buckets, hoppers, manual or motor propelled buggies.

  chutes and drop pipes.
- use of conveyor bolts or compressed air
- Tremie concreting
- Placement by pumps

4.17.2.1 Use of compressed air and conveyor bolts are not envisaged and are not specified. If, however, these methods are intended to be used by the contractors, they shall have to submit complete detailed specifications and methodology to the Construction Manager for his approval before adopting these procedures. Tremix concreting is not anticipated in these works and therefore not specified. Placement of concrete by pumping methods is dealt with separately in section -III, Part-4 of these specifications.

4.18.0 Basic requirements

4.18.1 Basic requirements for placing equipment and methods, as for all other handling equipment's and methods shall be that the quality of concrete in terms of water- cement ratio, slump, air content and homogeneity is not affected significantly. Selection of all equipment and plant shall be based on their capability to handle efficiently concrete of the most advantageous quantities that can be readily consolidated in place with vibration. Equipment's which require adjustments in mix-proportions for placing of concrete shall not be used.

4.18.2 Sufficient placing capacity shall be arranged for so that concrete can be kept plastic and free of cold joints while placing.

4.18.3 Concrete shall be laid in layers not exceeding 300 mm, thick. Inclined layers and cold joints shall be avoided. For monolithic construction, each layer shall be placed while the underlying layer is still responsive to vibrations and compactions. Shallow layers permit knitting the layers together by proper vibration.

4.18.4 Concrete shall be deposited as near to the actual position of placement to prevent segregation by lateral flow into place.

4.18.5 On sloping surfaces, concrete shall be placed on the lower end of the slope first and progressing upwards, thereby increasing natural compaction.

4.18.6 High velocity discharge/dumping of concrete, causing segregation, shall not be permitted.

4.18.7 Finished surfaces of placed concrete shall be protected by planned walkways and the surface kept covered till these are strong enough to resist damage from traffic to which these may be exposed.

4.19.0 Placing equipment's

4.19.1 Buckets: -Properly designed bottom dump buckets permit placement of concrete at lowest practical slump values. Discharge gates for such buckets shall have a clear opening size not less than one third of the interior horizontal area, nor less than five times the maximum aggregate size. The bottom shall be sloping and the slopes shall not be less than 60* to the horizontal. Discharge gates of the buckets shall be such that the placement crew can open and close then at any stage of discharge without any difficulties.

4.19.2 Discharge hoppers: These shall have provisions of discharge similar to those of the buckets mentioned in Para 3.1 above. These shall also have same side slopes as for the buckets to prevent segregation during discharge.

4.19.3 Spilled concrete shall not be refilled into buckets/hoppers for reuse and these shall be wasted.

4.19.4 Manual or motor propelled buggies - Rigid and smooth runways shall be laid if concrete is intended to be carried to placement locations by these buggies. This is essential to prevent segregation of concrete.

Recommended maximum delivery distance for power buggies shall be 120 metres and for hand drawn buggies (wheel barrows) the recommended maximum delivery distance shall be 60 metres.

4.20.0 Chutes and Drop Pipes

4.20.1 When chutes are intended to be used for transferring concrete of higher to lower elevations, these shall be made of mild steel or be lined with mild steel plates. The chutes shall have a rounded bottom and shall have sufficient capacity to avoid overflow. The slope of the chute shall be constant and steep enough to permit concrete of the slump required in place to flow continuously down the chute without segregation. Chutes longer than 6 metres shall be covered to prevent drying and slump loss.

4.20.2 Drop pipes shall be used for transferring concrete vertically downwards or near vertical slopes. pipes shall be made of mild steel with seamless joints having circular cross section. Pipes shall have diameters of at least 8 times the maximum aggregate size for the top two metre length. The size

may be gradually reduced to not less than 6 times the maximum aggregate size. The pipe shall be positioned and secured in place. Arrangements shall be made at the bottom of the pipe to dissipate the free fall energy of the concrete by providing a cushion. Suggestive methods are to use a reinforced sack-type boot to receive the dropped concrete, discharge arrangements being made just above the sack.

SECTION - III: CONCRETE

PART - 4: SPECIAL REQUIREMENT FOR PLACING CONCRETE BY PUMPING METHODS

4.21.0 General

4.21.1 Concrete conveyed by pressure through either rigid pipes or flexible hoses and discharged directly into the desired area is termed as pumped concrete. The method of conveying the concrete through pipe lines is dealt with in these specifications.

4.21.2 Method of applying pressure to concrete is by pumps. Pumps to be used shall be either of the two types as mentioned below: -

a) Piston type pumps

b) Squeeze pressure type pumps.

Compressed air pressure pumps shall not be used in the works.

4.22.0 Pumping Equipment's

4.22.1 Piston Pumps

4.22.1.1 Piston pump to be used in the works shall consist of a receiving hopper for mixed concrete, an inlet valve, an outlet valve, and the pump shall be a twin - piston pump.

The two pistons shall be so arranged that one piston retracts when the other is moving forward and pushing concertino the pipe line to maintain a reasonably

steady flow of concrete single - piston pumps shall not be acceptable.

Inlet and outlet valves shall be any one of the following types: -

- rotating plug type
- sliding plate type
- guided plunger type

- swing type
- flapper type
- or any combination of the above.

The pistons shall be mechanically driven using a crank or chain or hydraulically driven using oil or water.

The receiving hopper shall have a minimum capacity of 1.0 cum and the hopper shall be fitted with re-mixing rotating blades capable of maintaining consistency and uniformity of concrete.

Primary power for pumps may be supplied by - gasoline, diesel, or electric motors.

The primary power unit and the pump unit may be truck, trailer or skid mounted.

4.22.2 Squeeze Pressure Pumps

4.22.2.1 Squeeze pressure pumps shall consist of a receiving hopper fitted with remixing blades. Remixing blades shall be such that these can push the concrete into the flexible hose connected at the bottom of the hopper.

The flexible hose shall pass through a metal drum around the inside periphery of the drum and come out through the top part of the drum.

The drum shall be maintained under a very high degree of vacuum during operation. The drum shall be so fitted with hydraulically operated metal rollers, which when rotating, create a squeeze pressure on the flexible hose carrying concrete and forces the concrete out into the pipe line.

4.22.3 Effective Rangeland Discharge of Pumps

4.22.3.1 Effective range of pumps to be used in the work shall be decided by the contractors after studying the site conditions. However, the minimum horizontal range shall not be less than 150 metres and minimum vertical range shall not be less than 50 metres.

4.22.3.2 Selection of pumps based on discharge capacity shall be decided by the contractors after studying the requirements for the project. Discharge capacity shall be worked out by the contractors and approval obtained from

the Construction Manager. As a guide line figure the contractors may assume a discharge capacity of 15 cubic metre/hour/pump.

4.23.0 Pipe Lines

4.23.1 All concrete carrying pipe lines shall generally be rigid pipe lines. Flexible pipe lines may only be used at bend - curves in lines or at discharge ends if required. Placements of flexible units shall be done judiciously and connected to the pipe lines only when it meets the approval of the Construction Manager.

4.23.2 Rigid Line/Hard Line/Slick Line

Such lines shall be made either of steel or plastic. Aluminium alloy pipes shall not be used. Minimum pipe line diameter shall be 100 milli-metres and shall have normal maximum length of 3 metre in each section connected through couplers.

4.23.3 Flexible pipe line

Flexible lines shall be made out of rubber or spiral wound flexible metal or plastic. The pipe shall again be such that they are in sections of 3 metre length each and connected through couplers. These pipes shall be such that they are interchangeable with rigid lines. While installing flexible units, care shall be taken that there are no kinks in the pipe line, which is abnormal tendency with these pipes having diameters 100 mm and above.

4.24.0 Couplers

4.24.1 Couplers to be used for connecting pipeline sections (either hard or flexible) shall have adequate strength to withstand stresses due to handling, misalignments, poor support to pipe lines etc. For horizontal runs of pipes and for vertical runs up to30 metre height the couplers shall be rated for a minimum pressure of 35 kg/cm square. Couplers used for rising runs between 30 metre and 50 metre heights shall have a minimum pressure rating of 50 kg/cm square. Couplers shall be designed to allow for replacement of any pipe section without displacing other sections. These shall provide for the full internal cross section with no constrictions or crevices which may disrupt the smooth flow of concrete. For pipe lines of size 150 mm and above, double toggle type coupler with a thick rubber

gasket and secondary wedge-take-up is recommended. Types of couplers that may be used shall be any of the following: -

- grooved end couplers
- one-piece extended lever swing type couplers
- and full flow oil line type couplers.

4.25.0 Other Accessories

4.25.1 Other accessories which shall be catered for are standards as under: -

- Rigid and flexible pipes of varying lengths
- Curved sections of rigid pipes
- Swivel joints and rotary distributors
- Pin and gate valves to prevent back flow in pipe lines
- Switch valves to direct the flow into another pipe line
- Connection devices to fill forms from the bottom up.
- Splints, rollers, and other devices for protection of conduit over rock, concrete reinforcing steel and forms and to provide lifting and lashing points in the pipe line.
- Transitions for connecting different sizes of pipe sections.
- Air vents for down-ward pumping.
- Clean out equipment.

4.25.2 For concreting of columns, walls and scattered small placements, recommendation is made for special cranes or power-controlled booms carrying pipe lines with a pendant type concrete delivery hose.

4.26.0 Lubrication of Pipe Line

4.26.1 Before pumping concrete into the pipe line, the line shall be lubricated with a properly designed mortar/grout lubricant. This shall be ensured by starting the pumping operation with a properly designed mortar, or with a batch of regular concrete with the coarse aggregate omitted. The quantity of mortar required as lubricant is dependent on the smoothness and cleanliness of the pipe line. As a guide line, for a 100 mm diameter pipe line of 100 metre length, 0.08 cum to 0.10 cum of mortar should normally be adequate, but this shall not be taken as specified, and the contractor shall establish his requirement.

The quantity of mortar that comes out of the delivery end of the pipe line shall not be used in place of the concrete work. However, with approval of the Construction Manager. This mortar may be used as bedding mortar against construction joints. The rest of the mortar shall be wasted. Lubrication shall be maintained as long as the pumping of concrete continues.

4.27.0 Guide Lines of Field Practice

4.27.1 Proper planning of concrete supply, pump locations, line layout, placing sequence and the entire pumping operation will result in savings of time and expense.

4.27.2 The pump shall be placed as near the placement area as practicable. The surrounding area of the pump shall be free of obstructions to allow for movement of concrete delivery trucks. The surface must be strong enough to withstand the loaded trucks operating on it. If the surface is a suspended slab, the truck route shall be adequately supported in consultation with the Construction Manager.

4.27.3 Pipe-lines from the pump to the placing area shall be laid with minimum number of bends. For large placement areas, alternate lines shall be installed for rapid connection when required. A flexible pipe at the discharge end will permit placing over a large area directly without remanding of pipe lines. The pipeline shall be firmly supported.

It more than one size of pipe must be used; the smaller diameter pipe shall be placed at the pump end and the larger diameter at the discharge end.

4.27.4 When pumping downwards, an air release valve shall be provided at the middle of the top bend to prevent vacuum or air build-up. Similarly, while pumping upwards, a no-return valve shall be provided near the pump to prevent the reverse flow of concrete during the fitting of clean up equipment's or when working on the pump.

4.27.5 It is essential that direct radio/telecommunication be maintained between the pump operator and the concrete placing crew. Good communication between the pump operator and the batching-plant, is also essential. The placing rate shall be estimated by the pump operator so that concrete can be ordered at an appropriate delivery rate.

4.27.6 The pump shall be started for a check run and operated without concrete to ensure that all moving parts are operating properly. Before placing concrete, the pump shall be run with some grout/mortar for lubricating the line.

4.27.7 When concrete is received in the hopper, the pump shall be run slowly until the lines are completely full and the concrete is steadily moving. A continuous pumping must be ensured, because, if the pump is stopped, concrete in the line may be difficult to move again.

4.27.8 When a delay occurs because of concrete delivery, or some form repair works or for any other reason, the pump shall be slowed down to maintain some movement of concrete in the pipe line. For longer delays, concrete in the receiving hopper shall be made to last as long as possible by moving the concrete in the lines occasionally with intermittent strokes of the pump. It is sometimes essential to run a return line back to the pump so that concrete can be recirculated during long delays.

4.27.9 If after a long delay, concrete cannot be moved in the line, it may be necessary to clean out the entire line. However, quite often only a small section of pipe line may be plugged and require cleaning. The pump operator who knows such details as the length of line, age of concrete in the line etc., should be depended upon to aid in deciding the appropriate section to be cleaned.

4.27.10 When the form is nearly full, and there is enough concrete in the line to complete the placement, the pump shall be stopped and a "go-devil" inserted at the appropriate time so that concrete ahead of the go-devil is adequate for the completion of the work. The go-devil shall be forced through the pipe line to clean it out. Use of water pressure is a safer method. The go-devil shall be stopped about a from the discharge end to ensure that water does not spill on the placement area. If air pressure is used, extreme care shall be taken and the pressure must be very carefully regulated. A trap shall be installed at the end of the line to prevent the go-devil being ejected as a dangerous projectile. An air release valve shall also be installed in the line to prevent air pressure build up.

4.27.11 It is essential to clean the line after concrete placing operation is complete. Cleaning shall be done in the reverse direction from the form work end to

the pump-end where the concrete in the line can be dumped in a bucket.

After removal of all concrete, all pipe lines and other equipment's shall be cleaned thoroughly and made ready for the next use.

4.28.0 Submittals

4.28.1 Along with their bid the contractors shall be required to submit the following information's regarding the equipment's proposed to be used by them: -

- Type, number, capacity, range, mounting, nature of primary power used and the operating weights of pump and mounting.
- Manufacturer's specifications for pipe lines giving pressure ratings, sizes and material for straight and curved sections
- Manufacturer's certificates.

SECTION - III: CONCRETE

PART - 5: VIBRATING - COMPACTING AND CURING OF CONCRETE

4.29.0 Compacting Concrete

4.29.1 Concrete shall be thoroughly compacted and fully worked around all the reinforcements, around embedded fixtures and into corners of the formwork so as not to leave any voids/air spaces.

4.29.2 Internal vibration when properly applied is the most effectivemethod of consolidating/compacting plastic concrete and is generally best suited for normal construction.

4.29.3 Use of mechanical vibrators complying with relevant specifications shall be made as under: -

- Immersion type vibrators (I.S.2505)
- Screed board concrete vibrators (I.S.2506)
- Concrete vibrating tables (I.S.2514)
- Concrete Form vibrators (I.S.4656)

4.29.4 Vibrators shall not be used for moving concrete laterally, and shall be inserted into concrete vertically at close intervals.

4.29.5 The largest and most powerful vibrator that can be used effectively shall be used to ensure that all concrete is adequately consolidated. Care shall be taken to prevent over vibration resulting in segregation and bleeding.

4.29.6 A systematic and patterned vibration shall be used to ensure proper consolidation of the full mass of concrete deposited.

4.29.7 Remigration of concrete may be done provided that the running vibrator sinks into the concrete by its own weight. Till such time it is not too late for the concrete to be benefited from remigration. However, remigration shall not be done to concrete where initial set has taken place.

4.29.8 In unusually difficult and obstructed places supplemental form vibrators shall be used. However, care shall be taken to avoid over vibration, causing segregation, bleeding, paste formation on the surface.

4.29.9 For unusually thin and repetitive precast units, calibratorsshall be used for compaction of concrete.

4.29.10 Use of vacuum dewatering processes and use of absorptive form liners have shown successful results in preventing formation of air void holes in concrete. Specialist agencies and technicians shall be employed when such processes are proposed to be used.

4.29.11 Experienced and competent vibrator operators shall be used for compaction of concrete.

4.29.12 Adequate number of stands by vibrators shall be kept ready while placement and compaction of concrete is in progress.

4.30.0 Curing Concrete

4.30.1 Curing of concrete shall commence from the day of placing concrete and as soon as the surface is finished, and shall continue for a minimum period of 10 days.

4.30.2 Exposed surfaces of concrete shall be continuously kept in state of damp or wet condition throughout the period of curing specified.

4.30.2.1 Moist curing shall be done either by ponding (overlarge horizontal areas) or by spraying of water at intervals so that the surface is never dry.

4.30.2.2 For vertical faces and soffits of slabs and beams, moist curing shall be done either by spraying or sprinkling water at intervals directly on the surfaces

to keep them wet continuously, or, by covering the surfaces with suitable absorbent membrane completely hugging the surfaces and keeping the membrane wet.

4.30.2.3 As an alternative to moist curing, membrane curing may be permitted with prior written approval obtained from the Construction Manager on the curing compound proposed to be used.

4.30.2.3.1 Such curing compound shall be applied to all exposed surfaces of concrete as soon as initial set of concrete has taken place.

4.30.2.3.2 Rate of coverage of curing compound shall be as per specification of manufacturer of the compound. The contractor shall have to provide a written guarantee on the performance of such curing compounds proposed to be used by him.

4.30.3.0 In addition to methods of curing specified in paras1.0 and 2.0 above, when the relative humidity is less than 50% and the wind speed exceeds 4 metres per second, sheltering of concrete during casting and for a period of 24 hours after casting shall be provided.

Such sheltering shall be in the form of heavy-dutypolythene sheets forming an enclosure for the area under operation keeping adequate headroom clearances for concreting operations.

Similar protective cover to freshly laid concrete shall be provided during inclement weather conditions, so that rain water does not come in contact with freshly laid concrete for a period of 10 hours.

4.30.4.0 Cost of all works specified in this section including tools, plants, equipment's and accessories required to carry out the works shall be borne by the contractors.

SECTION - III: CONCRETE

PART - 6: CONCRETING UNDER EXTREME WEATHER CONDITIONS

4.31.0 Hot weather concreting

4.31.1 When the shade temperature is 40* C or above the contractor shall employ all necessary precautions for proper concrete placement and curing as laid

down below, or else, decide for concreting during evening and night hours, subject to approval of Construction Manager.

4.31.2 Adequate advance preparation shall be made to meet requirements of hot weather concreting in terms of equipment and material as under: -

- ensure ample supply of curing water and cooling surfaces of formwork, reinforcing steel and aggregates.
- ensure provisions of adequate quantities of canvas or heavy-duty polythene sheets and lumber for erecting temporary sheds and wind - breaks.

4.31.3 For hot weather concreting, a detailed schedule shall be drawn up such that concrete is placed in position and compacted properly with the least delay in operations.

4.31.4 Temperature of fresh concrete shall not be allowed Togo above the specified limit of 30*C. This may be achieved by: -

- use of ice in mixing water keeping the water - cement ratio to design value.
- cooling of aggregates by wetting with proper control of free water content.

4.31.5 As necessary, formwork and reinforcing steel shall be sprayed with cold water to bring down the temperature taking adequate precaution that there is no standing water in the formwork.

4.31.6 During hot weather due to rapid loss in slump, strain and demand on vibrating equipment is larger. Therefore, adequate number of stands by vibrators shall be kept ready for use as required.

4.31.7 The area under concreting operation shall be enclosed with heavy duty polythene sheet or canvas sheets to protect direct sun and to bring down the temperature to below 40* C in the area. Immediately after the concrete is placed, it shall be covered with material such as burlap which shall be kept wet continuously. When ready for floating/final finish, the cover shall be removed in parts, work completed and once again covered.

4.31.8 All equipment's, tools, plants, mixers, transport trucks etc shall be kept under shade and their temperature shall not be allowed to rise above 40*C.

4.31.9 Special care shall be taken for curing in hot weather conditions. Curing shall be done with water having temperature less than 30* C. Where curing by ponding is to be done, checks shall be made on the temperature of ponding water such that the temperature does not rise above 35* C.

4.32.0 Cold weather concreting

4.32.1 For the purpose of cold weather concreting, the cold weather shall be defined as a period when for more than three successive days the mean daily temperature drops to 5* C or below. When temperatures above, 10* C occurs during more than 12 hours in any 24-hour period, the concrete shall no longer be regarded as cold weather or winter concrete.

4.32.2 Plans to protect fresh concrete from freezing and to maintain temperatures above the designated minimum for the required time after placing shall be made well in advance of expected freezing temperatures.

4.32.3 In moderately cold weather when heavy frost or freezing is forecast, all unformed concrete surfaces shall be protected from freezing for at least the first 24-hourperiod after placing. For periods of prolonged cold weather, protection and curing shall be continued for a minimum of 10 days after placement of concrete.

4.32.4 During cold weather when daily temperatures are generally below 5*C, concrete shall be placed and maintained at temperatures not lower than those shown in line - 1 of table 2.4.1. Minimum concrete temperatures as mixed for various atmospheric temperatures shall be as given in lines 2 and 3 of table 2.4.1.

Table 2.4.1

Line	Air Temperature	Minimum Section Size (p.m.)		
	300	300 to 900	900 to 1800	1800
1. -	13*C	10*C	7*C	5*C

2. above - 1*C 16*C 13*C 0*C 7*C
3. -18*C to 1*C 18*C 16*C 13*C 10*C

4.32.5 Actual temperatures of concrete surface determines the effectiveness of protection regardless of air temperatures. Corners and edges of concrete are most vulnerable to freezing and usually are more difficult to maintain at the required temperature. Therefore, special measures shall be taken to monitor the temperatures at edges and corners and evaluate the effectiveness of the protective measures taken.

4.32.6 Heated enclosures, if used, shall be strong, windproof and weatherproof. Heating units shall be vented and not be permitted to dry the concrete locally. Heating systems shall not be used where CO2 formation and emissions are high, which when in contact with fresh concrete result in concrete carbonation. Wherever practicable steam heating procedure should be employed.

4.32.7 Lower slump than normal is particularly desirable in cold weather. This minimises bleeding and set occurs earlier.

4.32.8 Concrete should be placed at the lowest possible temperature given in table 2.4.1. Temperatures exceeding those shown in table by more than 5*C should be avoided.

4.32.9 Control of concrete temperatures may be achieved by: -

- heating of aggregates
- heating of mixing water

4.32.10 Cost of all work specified in this part of specification including all tools, plants, equipment's and material shall be borne by the contractor.

4.32.10.1 Decision to continue concreting operations in Hot or Cold weather as per specifications shall rest entirely on the Construction Manager.

SECTION - IV: SAMPLING AND TESTING FOR QUALITY CONTROL

PART - I: MATERIALS

5.0 Aggregates

5.1.1 Supplier of aggregates shall furnish the following information's before the material is delivered to site: -

- Precise location of source from who's the material is to be supplied.
- Trade group of principal rock type as per table 1.1.1
- Physical characteristics as per I.S. 383
- Presence or reactive minerals

Table - 1.1.1

Trade group names of aggregates to be used for concrete: Granite, Gabbro, Dolerite, Rhyolite, Basalt, Quartzite, Gneiss.

5.1.2 The supplier shall also furnish reports on test results giving the following information's for approval to Construction Manager before delivery of material at site: -

- Specific gravity
- Bulk density
- Moisture content
- Absorption value
- Aggregate crushing strength
- Aggregate impact value
- Abrasion value
- Flakiness index
- Elongation index
- Limits of deleterious substances in the aggregate
- Soundness of aggregate
- Potential reactivity of aggregates.

All tests shall be conducted in accordance with I.S. 2386 (Part - I to VIII).

5.1.3 Change in quality of aggregates as per trade group name shall not be acceptable in the work. Change in source of aggregates shall also not be acceptable under normal circumstances, even if the aggregates belong to the same trade group.

Construction Manager, may with his discretion allow a change in the source. But, in that case, all tests mentioned in para 1.2 above shall have to be repeated for the aggregates from the changed source and the test results submitted to Construction Manager for his approval before the delivery of material at site.

5.1.4 In addition to provisions in paras 1.1, 1.2 and 1.3above, the following tests have to be performed unrepresentative samples from every lot of aggregates

after delivery at site. These test results are to be submitted to the Construction Manager for his approval. Acceptance criteria for aggregates shall be based on the results of this set of tests only. If in the opinion of the Construction Manager, the test results are not within permissible limits, the lot of aggregates from which the samples have been obtained for testing shall stand rejected and the material shall be removed from the site.

Mandatory tests on Aggregates at Site

Tests	No. of tests on each 10 cum of material or part there of
1. Specific gravity	3
2. Bulk density	3
3. Aggregate crushing strength	3
4. Limits of deleterious substances	3
5. Aggregate impact value	3

Mean value of the results from above tests shall be taken as the representative value and the acceptance criteria shall be based on these. All test procedures and computations for test results shall be as per I.S. 2386.

5.1.5 All other tests in para 1.4 following requirements set in specifications, if only the limits of deleterious substances do not meet the requirements stipulated in Section - I, Part - I of specifications, an attempt may be made to wash the aggregates to bring the limits within permissible values. Under such circumstances, moisture content check shall be made and allowance made before batching as per stipulations given in Section - I, Part - 2 of these specifications.

5.1.6 Apart from mandatory tests specified in para 1.4 above, the Construction Manager may at his discretion, call for any additional tests that he may consider necessary. Sampling, procedure and computations for such tests shall be done in accordance with I.S. 2430 and I.S. 2386 as applicable.

5.2.0 Cement

5.2.1 Supplier of cement shall furnish the following

5.2.1.1 Certificate confirming that chemical composition and physical characteristics are within the stipulated values for types of cement supplied as per relevant codes.

5.2.1.2 Certificate confirming that the chloride content in the cement is not in excess of 0.05 percent by mass of cement.

5.2.2 If during subsequent testing of cement supplied in lots any of the properties are found to be outside the acceptable limits, the lot of cement shall be rejected.

5.2.3 Each 1000 bags or part thereof of cement, or each wagon load of cement shall constitute one lot of cement for the purpose of conducting tests at site before cement is accepted.

5.2.4 Samples for testing at site shall be taken at random from 2% of the total quantity supplied in one lot. For cement supplied in bags, samples shall be drawn from minimum of 5 bags and the 2% value shall be rounded off to the next higher integer.

For bulk cement, sampling shall be done with the help of slotted sampler to be as per I.S. 3535.

5.2.5 Results of tests conducted on samples drawn as mentioned in para 2.4, shall be submitted to the Construction Manager for his approval. If in the opinion of the Construction Manager, the test results are not within permissible limits, the lot of cement from which samples have been obtained for testing shall stand rejected and the material shall be removed from site.

5.2.6 Following tests shall be conducted at site on each lot of cement delivered: -

Mandatory tests	Number of test/lots
1. Consistency of standard cement paste	5

2. Initial and final setting time 5 each
3. Compressive strength test 10

Mean values of the results from the above results shall be taken as the representative value and the acceptance criteria shall be based on these tests. All test procedures and computation of test results shall be as per I.S. 4031.

5.2.7 Apart from mandatory tests specified in para 2.6 above, the Construction Manager may at his discretion, call for any additional tests that he may consider necessary. All such tests shall be done on representative samples taken from each lot described Para 2.4 and testing and computation of test results shall be done as per I.S. 4031.

5.3.0 Water

5.3.1 Water to be used in manufacturing and caring of concrete shall be tested before use. All such test results shall be submitted to the Construction Manager for his approval before water is used.

5.3.2 Manufacturer/Contractor responsible for caring concrete, shall identify and inform the Construction Manager, precisely the location of source of water intended to be used. Each such source of water shall be separately tested. In the event of a change in the source of water all tests specified herein shall have to be repeated.

5.3.3 In the event water is drawn from tube wells or open - wells, water samples shall be tested for seasonal fluctuations in water table or at intervals to be directed by the Construction Manager.

5.3.4 Water samples from each source shall be tested as under: -

Test	Number of tests each source
Acidity	3
Alkalinity	3
Presence of Solids	3

Mean values of the above tests shall be taken as the representative value and the acceptance criteria shall be based on these test results. All testing procedures and computation of test results shall conform to I.S. 3025.

5.4.0 Admixtures

5.4.1 Suppliers of Admixtures for concrete shall supply the following before any admixtures approved by the Construction Manager for their use: -

a) Certificate confirming that the use of a particular brand of admixture shall not be harmful to concrete in any way.

b) Certificate confirming the exact dosage of admixture of a particular brand.

c) Certificate stating the specific purpose for which the admixture is to be used.

d) Special precautionary measures tube taken in the manufacture of concrete when using the particular brand of admixture.

e) Certificate confirming that the admixture conforms to specifications of I.S.9103 or to ASTM - C 260, ASTM - C 10, ASTM - C 141, ASTM - C 595 or to ASTM - C 618.

5.4.2 Construction Manager at his discretion may require tests to be performed to reconfirm the characteristics properties of any admixture. All such tests shall be done in accordance with I.S. 9103.

5.5.0 All tests described in paras 1.0 to 4.0 above shall be done at the site laboratory or at a laboratory to be identified by the Construction Manager depending on the test to be conducted.

5.6.0 All tests shall be done in the presence of a representative nominated by the Construction Manager and a representative of the concrete Manufacturer when tests are performed at the site laboratory. All observation and reports of tests shall be jointly signed by the two representatives before the test results are submitted to the Construction Manager for his approval.

5.7.0 Expenses for all materials used for testing, sampling procedures and testing including preparing reports shall be borne by the Concrete Manufacturer.

SECTION - IV: SAMPLING AND TESTING FOR QUALITY CONTROL

PART - 2: CONCRETE

5.8.0 Fresh Concrete

5.8.1 Fresh concrete shall be tested for

- Slump
- Compacting Factor/Workability
- Consistency
- Weight per cubic metre, cement factory and air content

5.8.1.2 Slump

5.8.1.2.1 For concrete totally mixed in a central plant, slump shall be checked at: -

a) Immediately during loading of trucks

b) Point of discharge from the delivery truck

c) Final placement location

At placement location the slump measured shall conform to the design slump. Manufacturer of concrete shall adjust for loss of slump in transit and establish the requirements of design mix. All slump measurements shall be done within a period of 20 minutes from the time cement is added to the mixer. Placement contractor shall transport concrete from truck discharge point to actual placement location within 10 minutes of delivery, before the final slump reading is taken at placement location.

5.8.1.2.2 For concrete entirely mixed in transit or for shrink mix concrete, slump readings shall be taken at: -

a) Point of discharge from delivery trucks

b) Final placement location

In this case also, the slump measured at the final placement location shall conform to the design slump. The placement contractor shall be responsible for transporting concrete from delivery truck discharge point to final placement location within 10 minutes. However, in this case, the truck shall discharge the concrete within 1 hour and 30 minutes from the time cement is added in the mixer and slump measured at point of discharge immediately on delivery. Manufacturer of concrete shall ensure that the final slump measurement corresponds to the ordered slump.

5.8.1.2.3 For measuring concrete slump at point of discharge from delivery trucks, samples shall be taken from concrete omitting the first and the last

15% of the load. For concrete delivered or placed by pumping, sampling shall be similar to those specified for delivery trucks.

5.8.1.2.4 Slump measurement of ready-mix concrete transported by buckets shall be at locations specified in para 1.2.1 with same limits on time. Sampling from buckets shall be such that the buckets containing discharge from mixer for the and last 15% are omitted.

5.8.1.2.5 At placement location, samples for checking slump shall be collected from every 20 cum of concrete or part thereof placed at location for each type of concrete.

5.8.1.2.6 For all slump checks in the field at least two recordings shall be made and the average value taken as the recorded slump.

5.8.1.2.7 Slump checks for concrete in the laboratory shall be carried out as and when required by the manufacturer of concrete during the mix design stage and during the progress of work for control on field results.

5.8.1.2.8 Slump readings shall only be a guideline for concrete consistency and shall not be taken as the acceptability criteria for concrete placed at location. All slump tests shall be carried out in accordance with I.S. 1199.

5.8.1.3 Compacting factor

5.8.1.3.1 For concrete whose ordered slump is 50 mm or less, compacting factor test shall be conducted at both field and central batch plant in addition to slump tests mentioned in para 1.2.

5.8.1.3.2 Compacting factor check shall be done in field only at placement location, and shall also be conducted at central batch plant if concrete is totally mixed in plant.

5.8.1.3.3 For this test sampling shall be done as for slump measurements infield and within the same time frame as for slump test.

5.8.1.3.4 Only one compaction factor test shall be conducted for every 20 cum of concrete or part thereof placed at location for each type of concrete. Since the test is sensitive, every care shall be taken to conduct this test totally in compliance with procedure mentioned in I.S. 1199.

5.8.1.3.5 Laboratory tests for determining compacting factor of concrete shall be done as per manufacturer's requirement for establishing and controlling the design mix of concrete.

5.8.1.3.6 Compacting factor test shall not be taken as an acceptance criterion and shall be treated only as a guide line to workability of concrete.

5.1.4 Consistency of Concrete

5.1.4.1 This test shall be performed only at the batching plant laboratory using a Vee-Bee Consist meter, for determining and predicting the slump of concrete. Number and frequency of these tests shall be based on requirements of the manufacturer of concrete. Care shall be taken in producing mix design of required characteristic strengths of concrete within limits of Vee-Bee - Degrees between 1.6 and 4.5 for concrete transported and placed by normal methods and between0.8 and 3.5 for concrete transported and placed by pumping methods.

5.8.1.5 Weight, Cement Factor and Air Content Test

5.8.1.5.1 Freshly mixed concrete for every type shall be tested in the batch plant laboratory for each batch of concrete produced to determine weight per cubic metre of freshly mixed concrete, cement factor in concrete and the air content of the concrete. Frequency and number of tests shall be finalized by the manufacturer of concrete in consultation with the Construction Manager for his requirement on the mode of measurement of concrete produced.

5.8.1.6 The Construction Manager may at his discretion require further tests over and above those specified above in Para 1.1to be conducted on fresh concrete. The manufacturer and the placement contractor shall have to comply with all such requirements.

5.9.0 Hardened Concrete

5.9.1.1 For quality control a strict check on the strength of concrete shall be maintained along with other field requirements such as workability, consistency, slump etc., mentioned in para 1.1 above.

5.9.1.2 Acceptability criterion for concrete as specified in Para 2.5 of Section - I, Part - I, shall only be applicable.

5.9.2 Tests on cube crushing strength of concrete in accordance and compliance with I.S. 456 and I.S. 516 shall be done as under: -

5.9.2.1 Samples of fresh concrete shall be taken from concrete at central batch plant mixer while loading delivery trucks or other transport and also from concrete transported to placement location.

5.9.2.2 Test on specimens made from samples collected at placement location shall be considered as field test specimens and results therefrom shall be the criterion of concrete strength. Test on specimens made from samples at the batch plant shall only be taken as guide lines tests. Only in the case of doubtful results, the Construction Manager may refer to such guide line results for deciding on the quality of concrete.

5.9.2.3 For truck mix concrete and shrink mix concrete guide line test specimens shall be made from samples collected at discharge location from mixing trucks. For this purpose, first and last 15% of the load shall be omitted while collecting samples.

5.9.2.4 Frequency of sampling shall be as given in table2.3.4.1 for each grade of concrete of different work abilities and for each type of specimens (field test specimens and guideline test specimens) for conducting 28-day crushing strength tests.

Table 2.3.4.1

Quantity of concrete Delivered (cum)	Number of samples
Less than 5	1
6 to 15	2
16 to 30	3
31 to 50	4
51 and above	4 Plus one additional sample for each additional 15 cum part thereof.

Each sample shall be of adequate quantity so that a minimum of 3 specimen cubes can be made test of the sample in accordance with I.S. 516.

5.9.2.5 All test specimens shall be made compacted cured and tested in compliance with I.S. 516, and the test results interpreted in accordance with I.S. 456. For

acceptance of concrete strength, field specimens test results shall not be less than values given in Table 2.5.1 of Section - II, Part - I.

5.9.2.6 In addition to 28-day crushing strength test on specimens made at frequencies specified in para 2.3.4 above, early strength tests at 7 days shall also be conducted on field specimens as well as guide line test specimens. Frequency of sampling for this set of tests shall also be same as those specified in Table 2.3.4.1 above. 7-day strengths shall conform to values given in Table 2.6.1 of Section - II, Part - I. But these test results even if conforming to specified values shall only be taken as guide line values for projecting concrete strength and shall not be construed as conforming to specifications.

5.9.2.7 For each grade of concrete and for all workability conditions with different water - cement ratios and compositions of admixtures, Preliminary tests shall be conducted for crushing strengths on finalization for design mix for each type of concrete. Such tests shall be conducted both at 7 days and 28 days under laboratory conditions. Six test specimens shall be made for 7-day test and six test specimens shall be made of 28-day test.

Average of the six tests results of different periods shall not be less than those specified in Table 2.7.1 of Section - II, Part - I.

5.9.2.8 Crushing strengths on cubes shall also be conducted during the process of finalizing concrete design mix. Frequency and number of such tests shall be as per requirements of concrete manufacturer.

5.9.2.9 All test specimens for conducting crushing strength shall be properly labelled for identification indicating: -

- date of making specimen
- grade of concrete
- Placement location exact
- Purchasers order number

5.9.2.10 In addition to crushing strength test on concrete, the Construction Manager may call for other tests on hardened concrete. The placement contractor and the manufacturer of concrete shall comply with all such instructions.

5.10 Non-destructive tests

5.10.1 When the 28-day crushing strength values on field specimens and/or specimens made for guide line tests fall short of specified values, or in case of doubtful placement of concrete, the Construction Manager shall call for non - destruction tests on the structure. Such tests may be any one or a combination of the following: -

- Rebound hammer test
- Windsor Penetration Probe test
- Pulse velocity (Sonic or Ultrasonic) tests
- Core test
- Load test

5.10.2 Interpretation of rebound hammer, Windsor Probe and Pulse velocity test results shall rest with the Construction Manager.

5.10.3 Core tests, if ordered by the Construction Manager, shall be done in accordance with I.S. 516. Samples for such test shall be taken from locations to be identifiedby the Construction Manager and such samples shall be collected in compliance with I.S. 1199.

5.10.4 If felt necessary, the Construction Manager may instruct load testing for any part of the structure based on doubtful concrete strengths. Such tests shall be carried out as per details to be provided by the Construction Manager in consultation with the structural consultants.

5.11 The concrete manufacturer/concrete placement contractor shall arrange for all tests to be conducted in accordance with these specifications, including all necessary tools, plants, equipment's and material, and shall be responsible for conducting all tests at his cost.

5.12 All tests conducted at the field laboratory shall be carried out by qualified technicians employed by the concrete manufacturer/concrete placement contractor, in presence of authorised representative of the Construction Manager. All test reports and observation reports shall be jointly signed by

the Construction Manager's authorised representative and the technician conducting such tests.

5.13 Construction Manager shall alone decide where such tests are to be conducted. He may instruct tests to be conducted at laboratories other than the field laboratory and such instructions shall be followed without claiming any extra charges on this account.

5.14 The Concrete Manufacturer/Placement Contractor shall set up a laboratory at his own expense which shall have facilities for conducting all necessary field tests on materials and field and laboratory tests on concrete. The laboratory shall be staffed by the Concrete Manufacturer/Placement Contractor with qualified and experienced scientists and technicians.

C. SPECIFICATIONS FOR REINFORCING STEEL

Sloe. Contents

1. General
2. Binding Wires
3. Cover Blocks
4. Storage of Steel
5. Fabrication
6. Placement
7. Cover to Reinforcements
8. Splicing
9. Welded Splice
10. Unit weights.

6.0 GENERAL

6.1 This section covers the requirements for providing fabricating, delivering and placing in position and securing at location by binding or welding, of

reinforcements for in situ and precast non-prestressed reinforced concrete work.

6.1.2 Reinforcements for concrete may be from any of the "Grades" of steel indicated below, conforming to the relevant Indian standards mentioned against each: -

Grade	Description	Conforming to
Fe 250	Mild Steel	IS 432 (Part I)
Fe 490	Hard drawn steel wire	IS 432 (Part II)
Fe 415	High strength Deformed/	
	Ribbed steel	IS 1786
Fe 500	High strength Deformed/	
	Ribbed steel	IS 1786
Fe 550	High strength Deformed/	
	Ribbed steel	IS 1786

6.1.3 Reinforcing steel may be any of the following types: -

Type - I: Plain Round Bars (PR)

Type - II: Welded Wire Fabrics (WWF)

Type - III: Cold Twisted Deformed Bars (CTD)

Type - IV: Thermo Mechanically Treated Ribbed Bars (TMT)

Type - V: Thermo Mechanically Treated Ribbed Corrosion Resistant bars (Copper Bearing) (TMT-CR)

Type – VI: Corrosion resistant CTD bars (CTD – CR)

6.1.4 Unless specifically shown in drawings or instructions issued in writing by the Construction Manager, Steel of any Grader Type other than those specified in clauses 1.2 and 1.3above shall not be used for the purpose of concrete reinforcements.

6.1.5 Type and grade of steel to be used in a work shall be verified from the Construction Manager and relevant contract Documents before procuring such steel.

6.1.6 All steel shall be procured only from original producers. Rerolled steel shall not be procured for the purpose of using these as reinforcement in concrete work.

6.1.7 Every consignment of steel brought to the site of works for use in reinforced concrete work, shall be accompanied by a certificate from the manufacturer giving the following details: -

a) Process of Manufacture

b) Grade and Type of Steel

c) Chemical composition of steel

d) Identification mark on steel

e) Results of tests giving yield strength, ultimate

Tensile strength, Elongation percentage on gauge length of five times the diameter of bar, bend and rebind on minimum mandrel diameter, bond strength values, corrosion test results and fatigue test results. All such certificates shall be deposited with the Construction Manager for his record and reference.

6.1.8 Steels of grade Fe 415, Fe 500 and Fe 550 may be of type III (CTD bars), or Type IV TMT bars), or Type V (TMT-CR bars) or Type VI (CTD-CR) depending on the process employed by the manufacturer. Depending on the process the chemical composition of steel may vary from manufacturer to manufacturer. However, the manufacturer shall give a guarantee that when combinations of different grades and different types of steel are used in conjunction and are placed in contact, there is no bimetallic action-causing enhancement of the process of corrosion.

6.1.9 Some tests to reconfirm the mechanical properties of steel shall have to be conducted on every consignment of steel received at site. Frequency of such tests shall be as under: -

For every consignment of steel up to 100 tonnes or part thereof: -

Tests to be conducted	Number of tests
I) Tensile strength test	1 No. for each size with a min. of 2 tests
ii) Bend test for: -	

Bars smaller than a .	and 1 No. for each size with including 20 mm dia.
Bars larger than 20 mm dia min.	1 No. for each size with a
	of 5 tests.
iii) Elongation test choosing one number from any two different sizes if applicable	Minimum 2 Nos
iv) Mass tolerance test from one number different sizes if applicable	Minimum 3 tests with

All such field tests shall be conducted at a laboratory to be decided by the Construction Manager. Contractors shall be obliged to conduct all such tests and cost of such tests have to be borne by the Contractors.

6.1.10 Steel brought to site shall be free from mill scales, rust, grease, oil, paint or any other coatings which have deleterious effects on the performance. Bars and wires shall be cleanly rolled and shall be free from all surface defects detrimental to its use.

However, rust, seams, mill scales or minor surface irregularities shall not be the cause for rejection. Such bars shall be properly cleaned and retested as directed by the construction Manager. Tests shall be conducted in accordance with relevant Indian Standard specifications.

6.1.11 Based on test results of field tests specified in clauses1.9 and 1.10 above, the construction Manager will be the sole authority to accept or reject the consignment of steel, and such decision shall not be influenced by the results of tests as per manufacturer's certificate mentioned in clause 1.7 above.

6.1.12 For acceptability of steel, test results shall comply with the values given below.

Steel Grade (Clause 1.2)	Fe250	Fe490	Fe415	Fe500	Fe550
1. Yield Strength/ 0.2% Proof stress (Min)	250	490	415	500	550
2. Ultimate Tensile strength (Min)	410	580	485	550	585
3. Elongation on gauge length 5 Día (Min)	23%	10%	14.5%	14%	12%
4. Mandrel dia. for Bend test (Max) a) For bars up to & including 20mm	2 Día	2 Día	3 Día	4 Día	5 Día
b) For bars above 20 mm	3 Día	2 Día	4 Día	5 Día	6 Día
5. Mandrel dia. for Rebind test (Max.) a) For bars up to & including 20mm	(Not Applicable)	5 Día	5 Día	7 Día	
b) For bars above 20 mm	(Not Applicable)	7 Día		7 Día	8 Día
6. Tolerance on Nominal mass of 7.85 gems/cc	+2%	+2%	+2%	+2%	+2%

6.1.13 Steels of all grades and all types shall have maximum Carbon content of less than 0.25% by mass for guaranteed weldability.

6.1.14 Steels of Type V shall have a minimum Copper content of 0.30% by mass.

6.1.15 Steel of Type II shall be manufactured in conformity with provisions of I.S. 1566 and shall be certified by the manufacturer as such.

6.2.0 BINDING WIRES

6.2.1 Binding wire for steels of all grades and types shall normally be black neared steel wire conforming to 1. S.280.

6.2.2 When reinforcing bars are galvanised for corrosion protection, the binding wires to be seed in conjunction with such steel shall also be galvanized as per relevant specifications given elsewhere.

6.2.3 Binding wires to be used in conjunction with fusion bonded epoxy-coated reinforcing bars shall be plastic coated as per specifications given elsewhere.

6.2.4 Nominal size of binding wires shall be as under: -

a) For bars of size less than and including 20 mm: 20 Gauge

b) For bars of size over 20 mm: 18 Gauge

6.3.0 COVER BLOCKS

6.3.1 Cover blocks for reinforcements shall be made out of cement mortar. Crushing strength of such cover blocks shall be one grade richer than the concrete in the member where such cover blocks are to be used. OR PVC cover blocks shall be procured of adequate strength for all types as specified.

6.3.2 Cover to reinforcements may also be provided with reinforcing bars forming 'Chairs" for seating of bars. Such chairs shall be fabricated out of scrap-steel of lengths which cannot be efficiently used as reinforcements. Unless specifically shown on drawings or permitted by Construction Manager, Type V bars or bars treated for corrosion resistance shall not be used for fabricating such "Chairs".

6.3.3 Cover blocks made out of Neoprene or High strength Plastic may be used subject to written approval being obtained from the Construction Manager.

6.4.0 STORAGE OF STEEL

6.4.1 Reinforcing steel shall be handled and stored in a manner such that bending and distortion of the bars is avoided.

6.4.2 All reinforcing steel shall be stored horizontally above ground level on platforms or other approved supports, clear of any running or standing water. Contact with soil shall be avoided. Proper drainage and protection from elements shall be provided.

6.4.3 Bars of different grades, types and sizes shall be stored separately.

6.4.4 Reinforcing bars treated with a corrosion resistant protective coating of any kind shall be handled and stored with utmost care so as not to cause any damage to the protective coating. Such bars shall be stored separately from others.

6.4.5 Every stack of reinforcement stored shall be provided with a distinctively displayed identification board carrying the following information: -

a) Grade of Steel as per clause 1.2

b) Type of Steel as per clause 1.3

c) Nominal size of steel

d) Type of corrosion treatment to steel - if provided

e) Delivery batch number and date.

6.5.0 Fabrication

6.5.1 Contractor shall prepare Bar bending schedules for all structural components based on drawings issued for construction. Such schedules shall be submitted to the Construction Manager for his approval. Fabrication of reinforcements shall be commenced only on receiving approval on bar bending schedule from the Construction Manager.

6.5.2 Reinforcement steel shall be carefully cut bent and formed to the dimensions and configurations shown on drawings and bar bending schedules.

6.5.3 All cutting, bending, fixing, binding etc shall be done generally in accordance with IS 2502 unless otherwise specified herein.

6.5.4 Bending dimension tolerances shall be as specified in IS 2502. However, cutting tolerance for all sizes of bars and for all lengths shall be limited to +10mm.

6.5.5 All bars shall be bent cold using appropriate mandrel sizes. Dimensions of bends and hooks shall be as indicated in schedules.

6.5.6 It shall be ensured that bars are not bent or straightened in any manner that will injure the material. Any incorrectly bent bar shall be used only when the bends are set right, provided that during straightening and re-bending the bare is not damaged in any way including formation of twisted necks.

6.5.7 No bar shall be bent or straightened when in position on the works without approval of the Construction Manager, whether or not such bar is partially embedded in hardened concrete.

6.5.8 Reinforcing steel having a reduced section, visible cracks, peels or any other defects shall not be used for the purpose of reinforcing of concrete.

6.6.0 Placement

6.6.1 All reinforcements shall be placed accurately and secured in position as indicated on drawings.

6.6.2 Tolerance on placing of reinforcements shall be as under: -

(I)	Overall thickness of member	Tolerance in spacing of bars
(a)	Members of thickness 300mm or less	+ 5mm
(b)	Members of thickness more than 300mm	+ 10mm
(c)	Beams and column elements	+ 2 mm

(ii) Tolerance to clear concrete cover dimensions Shall be + one third the specified cover or 5 mm whichever is less

6.6.3 Contractor shall provide approved type of supports to reinforcing bars for maintaining the bars in position and to ensure required spacing and correct cover as called for in the drawings. Precast cement mortar cover blocks, chairs and spacer bars shall be used as appropriate for this purpose. For fair faced concrete.

6.6.4 All intersections of reinforcements shall be securely tied with strands of binding wire as required, and twisted tight to make the skeleton or network of steel a rigid frame so that the bars do not get displaced during transportation, placement or vibration of concrete.

Tack welding of reinforcements in place of binding with wire may be permitted by the Construction Manager after ensuring the weldability of steel.

6.6.5 Contractor shall take all necessary precautions to ensure that during handling and erecting of steel, no damage is done to the finished concrete.

6.6.6 Temporary walk ways and galleries shall be placed across reinforcements laid in position for purpose of movement of men and material. Such walkways and galleries shall be independent of the reinforcements. No movements of men and material shall be permitted on reinforcements laid and secured in position.

6.6.7 Without relieving the contractor of the responsibilities for the correctness of placing of reinforcements in accordance with drawings, the reinforcements as placed and secured in position shall be got inspected and approval obtained from the Construction Manager in writing before any concrete is placed in the form. Contractor shall allow for sufficient time to get the reinforcement work inspected and any subsequent remedial measures to be carried out.

6.7.0 Cover to Reinforcements

6.7.1 Unless shown on drawings or otherwise specified or instructed, minimum clear concrete cover to reinforcements shall be maintained as per IS 456 for normal structures, and as per IS 3370 for water retaining structures.

6.7.2 Care shall be taken to maintain the covers to tolerance limits specified earlier in clause 6.2 above.

6.8.0 Splicing

6.8.1 As far as practicable, bars of maximum available lengths shall be used. All bars shall preferably be in single lengths. Where such arrangements are not possible, bars shall be spliced together.

6.8.2 Splices may be lapped splices or welded splices. Unless specifically shown on drawings or conveyed in writing by the Construction Manager, welded splice shall not be provided.

6.8.3 Where welded splices are indicated on drawings or instructed by the Construction Manager, such welding shall be provided as specified in clause 9.0.

6.8.4 Where details and specific locations of splicing's are not shown on drawings, lap splices shall be so provided that: -

6.8.4.1 At any section not more than 50% of total number of bars are spliced together at any face of the member.

6.8.4.2.1.1 From the end of one splice to the beginning of the next splice in two contiguous bars, there is a clear distance of 300mm or 12 times bar diameter whichever is greater.

6.8.5 Lengths of such lap splices shall be as given in table 6.5.1 below: -

Table 6.5.1

Steel Grade	Steel Type	Splice lengths for grades of Concrete in multiples of nominal bar diameter					
		M-20	M-25	M-30	M-35	M-40	
Fe 250	I	45	40	36	32	30	
Fe 490	II	89	76	71	63	56	
Fe 415	III/IV/V		47	40	38	33	30
Fe 500	III/IV/V		57	50	45	40	36
Fe 550	III/IV/V		62	53	50	44	40

6.8.6 Splice lengths given in Table 6.5.1 are for steels which do not have any coating on the surface affecting its bond strength

6.8.7 Irrespective of values obtained from Table 6.5.1, minimum splice length shall be 300mm

6.8.8 When bars of two different diameters are spliced, the splice length shall be based on the smaller of the two diameters, unless otherwise shown in drawings.

6.9.0 Welded Splice

6.9.1 Wherever specified on drawings or instructed by Construction Manager, welded laps shall be provided and such welding's shall be paid for separately unless specifically included in the item of work described in bill of quantities.

6.9.2 Welding of reinforcements shall be done in accordance with: -

IS 2751 for mild steel bars of grade Fe 250

IS 9417 for type III (CTD bars) steel conforming to grades Fe 415, Fe 500 and Fe 550.

For types IV and V (TMT and TMT CR bars) of grades Fe 415, Fe 500 and Fe 550, welding procedures shall be confirmed from Manufacturer of such steel and shall be strictly followed as recommended by manufacturer.

6.9.3 Size of weld, throat thickness, length of lap welds and details of butt welds shall all be as per details shown in relevant drawings.

6.9.4 In all cases of welded splice, at least 2% of the welded connections made shall be tested to ensure the joints are of full strength of the bars connected. Also 100% of all such welds shall be subjected to radiographic tests to ensure proper welding. Cost of all such tests to be conducted on welded joints shall have to be borne by the contractor and all such tests shall be conducted at a laboratory to be identified by the Construction Manager.

6.9.5 For manual metal arc welding and oxy-acetylene welding, only welders of proven ability shall be employed and such welders shall have to pass qualifying tests as stipulated in Appendix - C and Appendix – D of IS 2751.

6.10 Unit Weights:

Unit weights of payable per meter shall be as follows:

6mm die	0.222 kg / m
8mm die	0.395 kg / m
10mm die	0.616 kg / m
12mm die	0.888 kg / m
16mm die	1.578 kg / m
20mm die	2.466 kg / m
25mm die	3.853 kg / m
32mm die	6.313 kg / m
36mm die	7.990 kg / m

D. SPECIFICATION FOR FORMWORK

7.0 General

7.1 This section covers the requirements for providing, fabricating and erecting formwork including propping, bracing, shoring, strutting, tying, bolting, wedging, and all other supports to the concrete during the process of setting and subsequent removal of forms.

7.2 Design of Forms

7.2.1 Before fabricating forms, the Contractor shall submit design calculations and drawings for proposed formwork to the Engineer-in-Charge for his approval. The approval of the Engineer-in-Charge shall not in any manner reduce the responsibility of the Contractor as far as structural safety and stability of the formwork is concerned.

7.2.2 Samples of Forms

7.2.2.1 If expressly directed by the Engineer-in-Charge, prior to start of delivery of material for formwork, the Contractor shall prepare samples of types of formwork as may be directed (about 10 sqm) and obtain approval of the Engineer-in-Charge.

7.3.0 Tie Bolts

7.3.1 In case the Contractor proposes to use tie bolts running through the concrete, the location and size of such tie bolts shall be submitted to the Engineer-in-Charge for his approval. However no through bolts /tie bolts shall be used for water retaining structures and basement walls.

7.4.0 Materials

7.4.1 General

7.4.1.1 Formwork shall be of timber, plywood (including marine plywood), steel or any other material capable of resisting damage to the contact faces under normal conditions of erecting forms, fixing steel and placing concrete. The selection of materials suitable for formwork shall be made by the Contractor based on the quality consistent with the specified finishes and safety. For designated areas prominently in public view the choice of material shall be decided by the Engineer-in-Charge.

7.4.1.2 All formwork supports (cantering, props, scaffolds etc.) shall only be in structural steel and preferably of pipes conforming to IS:806, IS:1161, IS:1239, IS:2750. In particular, IRC:87 shall be applicable for details.

7.4.2 Timber

7.4.2.1 Timber used for formwork shall be easily workable with nails without splitting. It shall be stable and not liable to warp when exposed to sun and rain or wetted during concreting.

7.4.3 Plywood

7.4.3.1 Plywood used for formwork shall be minimum 12 mm thick. Shuttering quality plywood complying with IS:4990 and of make approved by the Engineer-in-Charge. Suitable stiffeners and walkers shall be provided depending on the shuttering design.

7.4.4 Steel

7.4.4.1 Steel formwork shall be made of minimum 4 mm thick black sheets stiffened with angle iron frame.

7.5.0 Design Criteria

7.5.1 Formwork shall be designed for the loads and lateral pressures due to dead weight of concrete, superimposed live loads of workmen, materials and plants and for any other loads. Reference shall be made to IRC:87 for details. The designs and detailed drawings shall be submitted by the Contractor for the comments/approval of the Engineer-in-Charge.

7.5.2 Forms shall be designed to have sufficient strength to carry the hydrostatic head of concrete as a liquid without exceeding the acceptable limits of deflection tolerances.

7.5.3 Where necessary to maintain the tolerances indicated on the drawings, the formwork shall be cambered to compensate for anticipated deflections due to weight and pressure of the fresh concrete, and also due to any other construction loads. Unless otherwise shown or specified, the camber shall be provided as indicated in Table-5.3.

TABLE-5.3

Type of Member Compression Steel as % of Tension Steel Camber Coefficient Simple span 0%0.666 Continuous or restrained span50%0.037 Cantilever0%0.086 Cantilever50%0.046

Camber in CMS = K * L * 2.54 D

Where, K = Camber Coefficient

L = Length of the Member in Metre

D = Depth of the Member in Metre

Tolerances for formed surfaces of cast-in-situ concrete shall comply with clause 5.9 and subclauses there under.

7.6.0 Erection of Formwork

7.6.1 Forms shall be used wherever necessary to confine the concrete during vibration and to shape it to the required lines. The formwork shall conform to shapes, lines, levels, and dimensions of the concrete shown on the drawings.

7.6.2 Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of concrete and shall be maintained rigidly in position. Formwork shall be effectively supported by adequate number and size of struts, braces, ties and props to ensure rigidity of forms during concreting.

7.6.3 Where props rest on natural or filled up ground, to avoid any settlement, the soil shall be thoroughly compacted and bases of props shall be of sufficient size as to restrict the bearing pressure as approved by the Engineer-in-Charge.

7.6.4 Forms shall be tight enough to prevent loss of mortar from concrete and to produce a dense, homogeneous and uniformly coloured concrete completely free from honeycombing or surface roughness. Joints in formwork shall be designed to prevent leakage, not only between individual elements forming the panels but also from the horizontal and vertical junction between the panels themselves. At all joints of panels, the Contractor shall provide foam rubber strips of suitable width and thickness to avoid leakage.

7.6.5 If formwork is held together by bolts or wires, these shall be so fixed that no steel shall be exposed on surface against which concrete is to be laid. The Engineer-in-Charge may at his discretion allow the Contractor to use tie bolts running through the concrete at Contractors cost. Holes if permitted

to be left, in the concrete by these tie bolts shall be filled as specified by the Engineer-in-Charge at the Contractor's expense.

7.6.6 Formwork shall be constructed so as to facilitate loosening and permit removal without jarring the concrete. Wedges, clamps and bolts shall be used wherever practicable instead of nails.

7.6.7 All formwork erected shall be approved by the Engineer-in-Charge before concreting is started.

7.6.8.1.1.1 Dowels shall be provided at the proper locations and in the required alignment, if necessary by providing holes in the shuttering. Providing dowels by bending them within the concrete and later chipping the concrete and straightening the dowels shall not be permitted. Nothing extra shall be payable for provision of such dowels even if it results in lower number of reuses of the shuttering material.

7.7.0 Cleaning and Coating of Forms

7.7.1 At the time concrete is placed in the forms, the surface of the forms in contact with the concrete shall be free from encrustations of mortar, grout or other foreign material. Temporary openings shall be left at the bottom of formwork to enable sawdust, shavings, wire cutting and other foreign material to be worked out from the interior of the forms before the concrete is placed. Compressed air blasts shall be used for cleaning forms just prior to concreting.

7.7.2 The surface of the forms to be in contact with the concrete shall be coated with an approved coating that will effectively prevent sticking and will not stain the concrete surface. The coating shall be FOSROC's "REEBOL" or SikkaQuileute's "SEPARAOL" or approved equivalent. The coating shall be applied before reinforcement has been placed and care shall be taken that it does not come into contact with the reinforcement while it is being placed in position.

7.7.3 After each use the surface of forms in contact with concrete shall be cleaned and treated with form oil approved by the Engineer-in-Charge. Lubrication (machine) oils shall be prohibited for this application.

7.7.4 Immediately before concreting is commenced the formwork shall be carefully examined to see that all dirt, shavings, sawdust and other refuse have been removed.

7.8.0 Removal of Formwork

7.8.1 Formwork shall be removed carefully so as to prevent damage to the concrete. Wooden wedges only shall be used between the concrete surface and the form if necessary while removal. Metal wedges, bars or tools shall not be used for this purpose. Any concrete damaged in the process of removing the forms shall be repaired in accordance with the provisions of concrete specifications.

7.8.2 All non-supporting forms shall be loosened and removed during regular working hours, and as soon as the concrete has hardened sufficiently to prevent damage by the removal of the forms. All falsework and forms supporting concrete beams and slabs, or other members subject to direct bending stress, shall not be removed or released until the concrete has attained sufficient strength to ensure structural stability and to carry both the dead and live loads including any construction loads which may be placed upon it.

7.8.3 Unless otherwise permitted in writing by the Engineer-in-Charge, the forms shall not be stripped in less than the minimum periods specified in IS:456, clause 10.3. However, the Engineer-in-Charge may increase the above period if he considers it necessary for structural stability.

7.8.4 No construction loads exceeding the combination of superimposed dead loads plus specified live load shall be supported on any unshared portion of the structure under construction, unless analysis indicates adequate strength to support such additional loads.

7.8.5 Formwork shall be removed in such a manner so as not to impair safety and serviceability of the structure. It shall be removed gradually to prevent sudden application of loads to the concrete. All concrete to be exposed by form removal shall have sufficient strength so as not to be damaged thereby.

7.9.0 Reuse of Forms

7.9.1 Immediately after the forms are removed, they shall be cleaned with jet of water and a soft brush before they are reused.

7.9.2 The Contractor shall not be permitted to reuse any forms which in the opinion of the Engineer-in-Charge have become unfit for reuse. The Engineer-in-Charge may in his absolute discretion order rejection of any forms he considers unfit for use in the works, and order their removal from the site.

7.10.0 Formwork for Sloped Surfaces

7.10.1 Forms for sloped surfaces shall be built so that the formwork can be placed shutter-by-shutter immediately ahead of concrete placement so as to enable ready access for placement, vibration inspection and repair of the concrete.

7.10.2 The formwork shall also be built so that the shutters can be removed one by one from the bottom up as soon as the concrete has attained sufficient stiffness to prevent sagging.

7.10.3 Formwork needs to be placed on both sides for sloped surfaces with slope angle with horizontal being greater than 30□.

7.11.0 Formwork for Curved Surfaces

7.11.1 The Contractor shall interpolate intermediate sections as necessary and shall construct the forms so that the curvature will be continuous between sections. Where necessary to meet requirements for curvature, the form lumber shall be built up of laminated splices cut to make tight, smooth form surfaces.

7.11.2 After the forms have been constructed, all surface imperfections shall be corrected and all surface irregularities at matching faces of form material shall be dressed to the specified curvature.

7.12.0 Shuttering for Waffle Slab

Shuttering for Waffle Slab/ Coffered Slab shall be with Fibre Glass moulds of approved design. The moulds shall be of uniform shape and dimension to give the desired shape of Coffered slab. They shall be as manufactured by M/s Krishnan and Associated Engineers or approved equivalent.

7.13.1 Measurement shall be taken for evaluating the area of shuttering in contact with the concrete surface. Dimensions of formwork shall be measured correct to one cm and the areas calculated in sqm to the second decimal place.

7.13.2 No deductions from the shuttering due to the openings or obstructions shall be made if area each of such openings or obstructions does not exceed 0.4sqm. Nothing extra shall be paid for forming such openings.

7.13.3 The rate of formwork shall include the cost of labour and materials required for all the operations described above.

7.13.4 No payment for formwork shall be made for providing construction joints and pour strips. In case of expansion/ separation joints form work shall be measured on both faces of the joint where the concrete is now being laid irrespective of the manner in which the joint has been made. (In case the joint is made using Polystyrene stuck to the face of concrete cast first, the polystyrene shall not be measured). In case the expansion/ separation joints are being formed with an existing structure where the concrete has already been cast on one side the measurement for the formwork shall be taken only for one side.

7.13.5 All form work shall be measured under one item irrespective of its use at different locations, different heights, in different floors, of different shapes, sizes, orientation and inclination. and in different elements like raft, isolated footings, for walls, ramps, bases, suspended floors and roofs, landings, mezzanines, beams, lintels etc. Nothing extra shall be payable for providing grooves, niches etc. (Clause 4.29.1 of the Additional Conditions of the Contract also refers)

7.13.6 Formwork for Waffle Slab shall be measured separately in sqm. Measurement shall be taken for evaluating the area of fibre glass mound shuttering in contact with the concrete surface. Dimensions of formwork shall be measured correct to one cm and the areas calculated in sqm to the second decimal place.

8.0 Tolerances

Tolerance is a specified permissible variation from lines, grades or dimensions given in drawings. No tolerances are specified for horizontal or vertical encroachments beyond the legal boundaries. Unless otherwise

specified, tolerances given in the following sections shall be permitted.

8.1 Tolerance for RCC Buildings

Variation from plumb should be as follows:

a) In the lines and surface of columns, walls, and other vertical members, viz inside face of lift shaft, etc. 3 mm per 3.0 metre but not exceeding 10mm for the full height of the building.

b) For exposed comer column and other conspicuous lines

In any bay up to 5 m maximum	3mm
In 10m or more bays	5mm

c) Soffits of slabs, ceilings and beams

2.5 m bays	3mm
5.0 m bays	3mm
10.0 m or more	10mm

d) Lintels, sills, parapets, grooves and other conspicuous lines

In any bay up to 5 m maximum	3mm
In 10 m or more	5mm

e) Variation of the linear building lines from established positions in plan and related position of columns, wall and partitions

In bay up to 5 m maximum	5mm
In 10 m or more	10mm

f) Deviation from dimensions of footing I foundation:

- Dimension in plan (+) 50mm
- Eccentricity in plan: 0.02 times the width of the footings in the direction of deviation but not more than 50mm
- Thickness: (+) 0.05 times the specified thickness.
- Surface of foundation against ground: -5mm, +10mm
- Top surface of foundations, bases, piers: +5mm, -20mm

g) Variation in sizes and location of sleeves, opening in walls and floors to

be 5 mm (except for anchor bolts)

h) Variation in cross-sectional dimension of columns and beams and thickness of slabs and walls 5 mm, +10 mm

I) Variation in steps

In a flight of stairs	Risers	Treads
In flight of stairs	3mm	5mm
In consecutive steps	1.5mm	3mm

All the tolerances mentioned above shall apply to concrete dimensions only, and not to positioning of vertical steel or dowels.

E. SPECIFICATION FOR STRUCTURAL STEEL

9.1 General

Description

Extent and Intent

The contractor shall furnish all materials, labour operation, equipment, tools and plant and incidentals necessary and required for the completion of all metal work in connection items of metal work as called for in the drawings. The drawings and specifications cover the major requirements only. The supplying of additional fastenings, accessory features and other items not mentioned specifically herein but which are necessary to make a complete installation shall be a part of the contract.

Works Include anchorages in cast-in-situ concrete.

Related Work

a) Grouting base plates and bearing plates

b) Metal fabricators

c) Roofing sheets

Applicable Standards

IS-226-1975	Structural Steel (standard quality) (fifth revision)
IS-456-1978	Code of practice for plain and reinforced concrete (third revision)
IS-696-1972	Code of practice for general engineering drawings (second revision)
IS-786-1967	(Supplement) SI supplement to Indian Standard conversion factors and conversion tables (first revision)
IS-812-1957	Glossary of terms relating to welding and cutting of Metals
IS-813-1961	Scheme of symbols for welding
IS-814	Covered electrodes for metal arc welding of structural steels: 814 (Part 1)-1974 Part 1 for welding products other than sheets (fourth revision)
IS-816-1969	Code of practice for use of metal arc welding for general construction in mild steel (first revision)
IS-817-1966	Code of practice for training and testing of metal arc welders (revised)
IS-819-1957	Code of practice for resistance spot welding for light assemblies in mild steel
IS-875-1964	Code of practice for structural safety of buildings:

	Loading standards (revised)
IS-919-1963	Recommendations for limits and fits for engineering (revised)
IS-961-1975	Structural steel (high tensile) (second revision)
IS-962-1967	Code of practice for architectural and building drawings (first revision)
IS-1024-1979	Code of practice for use of welding in bridges and structures subject to dynamic loading (first revision)
IS-1030-1982	Carbon steel castings for general engineering purposes (second revision)
IS-1148-1973	Hot-rolled steel rivet bars (up to 40 mm diameter) for structural purposes (second revision)
IS-1149-1982	High tensile steel rivet bars for structural purposes
IS-1261-1959	Code of practice for seam welding in mild steel
IS-1278-1972	Filler rods and wires for gas welding (second revision)
IS-1323-1962	Code of practice for oxy- acetylene welding for structural work in mild steel (revised)
IS-1363-1967	Black hexagon bolts, nuts and lock nuts (diameter 6 to 39 mm) and black hexagon screws (diameter 6 to 24 mm) (first revision)
IS-1364-1967	Precision and semi-precision hexagon bolts, screws, nuts and lock nuts (diameter range 6 to 39 mm) (first revision)
IS-1367-1967	Technical supply conditions for threaded fasteners (first revision)
IS-1393-1961	Code of practice for training and testing of oxy-

	acetylene welders
IS-1395-1982	Molybdenum and chromium molybdenum vanadium low alloy steel electrodes for metal arc welding (second revision)
IS-1477	Code of practice for painting of ferrous metals in buildings: 1477 (Part 1)-1971 Part 1 Pre-treatment (first revision) (Part 2)-1971 Part 2 Painting
IS-1929-1961	Rivets for general purposes (12 to 48 mm diameter)
IS-1977-1975	Structural steel (ordinary quality) (second revision)
IS-2062-1984	Weldable structural steel (third revision)
IS-2155-1962	Rivets for general purposes (below 12 mm diameter)
IS-3613-1974	Acceptance tests for wire-flux combinations for submerged-arc welding of structural steels (first revision)
IS-3757-1972	High-tensile friction grip bolts (first revision)
IS-4000-1967	Code of practice for assembly of structural joints using high tensile friction grip fasteners
IS-5369-1975	General requirements for plain washers and lock washers (first revision)
IS-5370-1969	Plain washers with outside diameter 3 x inside diameter
IS-6419-1971	Welding rods and bare electrodes for gas shielded arc welding of structural steel
IS-6623-1972	High tensile friction grip nuts
IS-6649-1972	High tensile friction grip washers
IS-7205-1974	Safety code for erection of structural steel work
IS-7215-1974	Tolerances for fabrication of steel structures

IS-7280-1974	Bare wire electrodes for submerged arc welding of structural steels
IS-8500-1977	Weld able structural steel (medium and high strength qualities)

9.2 **Shop Drawings**

Include

a) Shop drawings for trusses, bracings, purlins, columns, ties, base plates, crane girders, etc.

b) Indicate profiles, sizes, spacing and locations of structural members, connections, attachments, fasteners, cambers, loads and designs of joints.

c) Indicate welded connections using standard welding symbols and net weld lengths. Indicate the method of erection, shop and field joints.

d) Indicate and identify all transportable parts and sub-assemblies, associates with special erection instructions, if any.

e) Provide design calculations for splices, joints, other details not specifically detailed in design drawings on fabrication drawings considering standard detailing practices and developing full member strengths.

f) Submit 3 sets of shop drawings to Project Manager for approval.

g) Allow three weeks for Project Manager to approve Shop Drawings.

Products

Materials

a) Structural steel members.

b) Structural tubing.

c) Bolts, nuts and washers.

d) Welding materials.

e) Primer.

f) Shear studs.

All metal materials shall be free from defects impairing strength, durability and appearance and they shall have structural properties that comply fully with the standards set out in Clause 2.6.1.1.3, which follows. All ferrous metal shall be free from rust, scale and other defects. All non-ferrous metal shall have uniform finished surfaces, machined and buffed, free from defects. All sections shall conform accurately to sizes and shapes required.

Fabrication

a) Fabricate structural steel members in accordance with IS Specifications 800 Section V and approved shop drawings.

b) Defective material used shall be replaced by the Contractor.

c) Fabricated items delivered at site shall be suitably protected from any damages.

Finish

a) Clean, prepare and shop rime structural steel members. Do not prime surfaces to be field welded or bolted or in contact with concrete.

Execution

a) Erect structural steel in accordance with IS Specifications.

b) Make provision for erection loads and for sufficient temporary bracing to maintain the structure in proper plumb and in true alignment until completion of erection and installation of permanent bracing.

c) Do not field cut or alter structural members without approval of Project

Manager.

d) After erection, prime welds, abrasions and surfaces not shop primed, except surfaces to be in contact with concrete.

e) Members shall be cut mechanically by saw or shear or by oxy acetylene flame and not by electric metal arc.

f) Cut edges shall be ground as per IS 823.

g) Cutting tolerances shall be

- Members connected at bolt ends: + or - 1 mm.
- Other members: + or - 3 mm.

h) All bolt holes shall be drilled and to the sizes specified in drawings.

- Tolerance for spacing between two holes: + or - 1 mm.
- Tolerance between two perpendiculars of any oval hole: + or - 1 mm.
- Bolt holes for field joints shall be drilled in the shop to the required diameters and tested.

I) Drilling holes for standard sizes if varies can be reamed to next higher sizes. The tolerance for hole reaming shall not exceed 15% of the total number of holes for one joint.

Preparation of members for welding

a) Proper jigs and fixtures shall be used to ensure correct positioning of structural members during assembly.

b) Sharp edges, rusting of cutting edges, notches, irregularities, and fissures due to faulty cutting shall be chipped and ground.

c) Edge preparation for welding shall be done properly taking care of cleaning, providing dry surface, removing grease, dust or dirt, foreign matter, etc.

c) Finished dimensions of structure shall be ensured after considering the shrinkage and distortions during welding.

9.3 **Welding**

Personnel:

a) Welders shall be fully trained, experienced and certified by the recognized welding institutes.

b) Welders' qualification tests shall be as per IS 823 and approved by Project Manager.

Execution:

a) Welding shall be done in accordance with IS 823.

b) Welded parts shall be marked with welders' identification.

c) Protect the welded parts, electrode wires against wind and rain.

d) Discontinued seams shall be melted before resuming welding operation.

e) Welding seams shall be cooled slowly and not by any other quick methods.

f) Before welding a second layer over the existing layer of weld, the layer shall be cleaned metal bright by light chipping and wire brushing.

g) Execution shall proceed in strict compliance with Section 2/7 Safety Procedures.

Approval:

a) Welded parts shall not have any deformations.

b) Welded joints should compensate for contractions due to welding.

c) Defective welds must be rectified.

d) Weld seams shall correspond to design shapes and dimensions.

e) Weld seams shall not have cracks, fusion, under cuts, rough surfaces, bums, blowholes, and incomplete penetration.

f) Approval of finished elements, inspections and tests shall be as per Annexure

9.4 **Bolting**

Material

a) Bolts, nuts shall be in accordance with IS 1367 and tested as per IS 1608.

b) Washers shall be as per IS 2016.

Preparation

a) Members shall be assembled for bolting with proper jigs and fixtures to sustain the assemblies without deformation and bending.

b) All sharp edges, shavings, rust, dirt, etc. shall be removed before assembly.

c) Before assembly the contacting surfaces of the members shall be cleaned and given a coat of primer.

d) Temporarily the assembly shall be done and checked for co-axiality of the holes after which the assembly shall be finally bolted.

Execution

a) Bolts shall be fixed after all the defects have been rectified and approved by Project Manager.

b) Bolts shall be tightened from the centre of joint towards the edge.

Identification

a) Structural members prior to dispatch for erection shall be marked with a weather-proof light-coloured paint. The size and thickness of members shall be so chosen as to facilitate easy identification.

b) Structural members small in size shall be bundled or crated and shall ~ marked with metal tags for bundles and painted on crates for identification with particulars of the bundle / crate size, weight, etc.

Shop - approvals

Pre-Assembly

a) Pre-assembly of bolted structures shall be done for all elements as well as for the entire structure in conformity with the 'holes for field joints'.

b) Steel structures having same type of welding the shop test pre-assembly shall be performed at least one member out of ten members.

Inspection

a) Contractor to provide facilities for Project Manager to inspect the steel assembly, welding, bolting, painting etc. at any time during fabrication of members.

b) Project Manager shall have the access to the fabrication shop at all times for regarding the fabrication of steel items to the drawings and specifications.

c) Shop approval by the Engineer is only mandatory.

d) Contractor to bear all the expenses for testing required by the Engineer for satisfying regarding the quality of workmanship.

e) Contractor to furnish necessary tools, gauges, instruments, technical and non-technical personnel for shop tests at his own cost.

Approvals

Intermediate approvals

a) For part of the work that cannot be inspected later.

b) For part of the work that will be difficult to perform inspection and even if done results are not satisfactory.

Partial approvals

a) To the structural steel members and assemblies before the primer coat is applied.

b) of materials used for fabrication.

c) of test erection.

d) of markings.

e) of fillet joints.

f) of plain surfaces.

g) of special features such as rollers, etc.

Final approval

a) To all elements and assemblies of steel structures after having a shop primer coat and ready for delivery.

b) Includes partial approval

c) of shop primer coat.

d) of mode of loading and transport.

e) of storage of materials.

9.5 Approved Fabricators

All metal work fabricated shall be approved by the Structural Consultant *I* Project Manager. The entire work shall be carried out by workmen skilled in this kind of work in a shop fully equipped to carry out all phases of fabrication in accordance with the best-accepted trade practices.

10.0 Painting

10.1.1 Preparation:

a) Surface to receive primer coat shall be sand blasted / wire brushed, free of dust, oil, rust, etc.

b) Surfaces not accessible to painting shall be filled with approved type of oil and putty.

c) Surface shall be completely dry.

d) Surfaces where water or aggressive agents may collect during transportation, storage, erection and operation shall be filled with putty and provided with drainage holes.

e) Structural steel members are inspected and approved.

f) Welds are approved.

g) After satisfying the above criteria the surfaces are to be provided with one coat of red oxide / zinc chromate primer to the satisfaction of Project Manager before the material is dispatched for erection.

10.1.2 **Do not prime the following areas:**

a) Surfaces to receive weld at site.

b) Surfaces bearing markings.

c) Surfaces as indicated in drawings.

d) Planned surfaces shall receive a coat of hot oil or any approved resistant lubricant only.

e) To coat the surfaces with hot oil to holes for links.

f) To give a coat of cement wash for any members either embedded or in contact with concrete.

g) To give a bituminous coal for members in contact with ground gravel, brickwork and moisture.

h) Contractor to give a further coat of red oxide paint after erection and placing in position of the assembly if called for by the Project Manager.

10.1.3 **Packing, Transportation, Delivery:**

a) Structural steel members shall be marked and approved in shop before packing and loading for transportation.

b) Adequate packing must be done for all the steel members to protect them against warping during loading and unloading.

c) Suitable lifting devises to be used for loading and unloading.

d) Additional steel bracing to be provided for all slender projecting members to prevent any warping during transportation loading and unloading.

e) Loading and transportation shall be done as per the transportation rules.

f) To provide additional splice joints where required in consultation with

Engineer in case the members to be transported are beyond the limitations of transporting system.

g) To secure all small parts including gusset plates fish plates by securing them with wire to their respective parts.

h) To crate all bolts, nuts and washers.

I) All structural parts to be delivered in the order required for construction and as per instructions of Project Manager and shall accompany the following documents.

- Quality and quantity of structure or members.
- Location of members in the structure
- Description of structure
- Identification number
- Building / job symbol

10.1.4 Storage and Preparation of Members Prior to Erection

a) Place for storage of steel member shall be prepared in advance and got approved by the Project Manager.

b) To provide concrete platform at the site for preliminary erection work.

c) To verify the quality of material obtained at site and for workmanship to the specifications and drawings.

d) To verify whether the parts obtained at site is free from defects due to loading, unloading transportation.

e) To avoid warping of members during unloading by taking sufficient precautionary measures.

f) To store the members as per the symbol and markings and in order of erection.

g) To place the steel members at least 150mm above the platform on

wooden or steel locks for protection against direct contact with ground and to permit drainage of water.

h) To equip for rectification of members like straightening at site and to provide sufficient space for the same.

I) To see that the parts are clean before erection.

10.1.5 Field Erection

a) To get approvals of foundation, columns, column pedestals or other related structure on which the structural steel members are to be erected.

b) To get approvals of the members receiving structural steel members regarding their levels, dimensions, alignments and verticality well in advance.

c) To carry out any minor discrepancies at no additional cost.

d) To get approvals of pockets, bolt locations, levels of base plates before erection.

e) Erection to commence after satisfying the above conditions.

f) Erection to be done in an organised way so that any individual member is not subjected to instability during the erection time.

g) Precautionary measures to be taken during erection of trusses, purlins and other steel members by providing proper bracing.

h) Faulty erections done without caring for safety of members and of personal shall be made good at no additional cost.

I) Contractor is not relieved of his responsibilities, guarantees even after the Project Manager approves the fabrication, erection, etc., at any stage of work.

j) Contractor is solely responsible for the correctness accuracy and quality of the fabrication, erection and final approvals to be obtained by the Project Manager.

10.1.6 Erection and Tolerance

a) To check and inspect before, during and after erection.

   i. Damage during transportation.
   ii. Alignment of structure.
   iii. Erection sequence
   iv. Progress
   v. Workmanship

b) To erect members as per the predetermined plan approved by the Project Manager.

c) To position and level the structure including aligning and to plumb the stanchion and fixing every member in position with bolts, erection bolts, weld as per design and drawings.

d) To inform the Project Manager of any variation, deviation in location of foundations, anchor bolts which shall deviate the prefabricated members.

e) Structural Engineer to give suitable solutions in case of above deviations well in advance for the contractor to proceed with the fabrication of members including any modifications necessary.

f) Contractor to rectify any minor deviations in foundations, location of steel bolts and orientation of bolt hole positions at no extra cost.

g) To erect structural steel members ensuring that the system is stable against inherent weight, wind and any erection trusses.

h) To anchor and fasten the erection joints after duly checking the plan, elevation positions of the, members with reference to the drawings after the approval of Project Manager.

I) To fasten bolts to the final position with bolt heads and nuts resting on the member and on tapered washers with members having a sloping surface.

10.1.7 Final Acceptance and Handing Over the Structure

a) Contractor to submit As-built shop drawings for the approval of the Structural Consultant / Project Manager, as per the stipulation given in Conditions of Contract.

b) Documents to be submitted for final acceptance are as follows:

- Shop acceptance drawings
- Quality certificate for structural members, plates, flats, bolts.
- Quality certificate for material used for fabrication including electrodes, welding wire, bolts, nuts, washers, etc.,
- List of welders who welded the structures and their certificates for having undergone welding course.
- Acceptance and intermediate control procedure adopted during the process of fabrication, assembly, transportation, delivery and erection or structure.

10.1.8 **Measurements**

a) Payment of structural steel members including bolts, nuts, washers, gusset plates, etc., will be done on weight basis.

b) The weight of members will be assessed from the final fabricated and approved drawings and the respective Bill of Materials prepared by the Contractor and approved the Structural Consultant / Project Manager.

c) The weight of members shall be as per IS 1200 part 8 IS 800 handbooks.

d) Sections different than mentioned in IS handbook shall be taken as per manufacturers' information.

e) No rolling tolerance will be allowed.

f) Built up of members will be paid as per the actual weight of the members.

g) Gusset plates shall be paid to the nearest rectangle enclosing the shape and no deduction shall be made for any skew cuts.

h) Welds, bolts, anchors, washers, etc will not be measured and paid for separately.

I) Payment do not include any other related temporary works connected with this work including welds, shims, wedge plates, etc.

j) Rates to include any trimming, straightening, edge preparation, preparation and approval of shop drawings, and one coat of red oxide / zinc chromate primer and also including any handling, remanding, loading and unloading, transportation to the site of work and returning surplus material to the Project Manager at the place requested by him.

k) Rate to include necessary scaffolding, temporary support, tool and tackles, touching up primer coat grouting etc.

10.1.9 **Grouting**

a) To level, align and plumb the structural steel work and the base of stanchions by providing steel shim plates.

b) To align anchor bolts in foundation to the required level, location and orientation by using templates.

c) To clean the underside of base plates, pockets to receive grout by using compressed air.

d) To use cement mortar 1:2, 1 of cement and 2 of sand, non-shrink grout under base plates.

e) To use grade M 30 concrete to fill up the grout pockets left for fit to anchor bolts.

f) To pour the grout under a sufficient head and tam until the voids are thoroughly filled and the grout overflows.

10.2.1 **Tolerances**

a) Steel work for line and level ± 3mm

b) For structural steel for plumb 3.5mm for 10M and not more than

7mm for 30M

c) To follow any tolerance criteria provided on the drawings.

d) To provide tolerances for all structural steel members as per IS code other than what is mentioned in a, b and c.

ANNEXURE – A

Inspection of test	**Coverage**	**Procedure**	**Evaluation findings & remedy of Defect**
Inspection of weld seam	All welds	Naked Eye or Lens	All faulty welds shall be rectified
Checking of Sizes	At least one for each weld	Ordinary measuring instruments (rule, templates)	Should faulty weld be found all welds shall be checked & all defects shall be rectified
Mechanical tests for welding procedure performance & electrodes		As per IS: 823	

ANNEXURE-B

INADMISSIBLE WELD DEFECTS AND TOLERANCE ALLOWED FOR WELDS

Defects	**Detailing of sketching of defect**	**Allowed tolerances & remedy of defects**	**Cause of defects**	**Mode of finding defects**

Unsatisfactory appearance	Uneven width rugged seam	At discretion cut weld & reweld	Uneven welding progress, voltage fluctuations, varying arc length, negligence inexperienced welded	External (visual inspection)
Unsatisfactory shape	Shallow or jutting welds	No variance from design shape shall be allowed	Negligence	Visual inspection template checking
Incomplete weld		Not allowed fill in weld		Template checking
Molten metal flow		Not allowed fill in weld wrong	Excessive melting, ions handling of electrodes	Visual inspection
Pits	Not allowed cut & reweld	-	Wrong welding technique	Visual inspection
Surface cracks		Not allowed cut & reweld	Great stresses, sudden cooling, wrong type of electrodes	Visual inspection
Incorrect sectional dimensions a) Depth of weld		B1 = ±2mm B2 = ±2mm B = ±1mm C = ±1mm Chisel &	Negligence	Template checking

		Grid		
Insufficient	For weld lengths 11+5mm, for 12+10mm for shorter seams cur &reweld or complete to length		Negligence	Rule checking
Back cuts	If 0.5mm for 10mm & C1mm for 10mm replace relevant members		Burnt material, excessive melting	Visual inspection
Surface porosities	Max. 5% of seam area cut &reweld		Frequent interruptions or welding electrodes inadequately covered	Visual inspection

Testing: The following tests shall be carried out on the materials andconcrete usedinRCCwork.

Material	Test	Field/Latest	Test Procedure	Frequency of concrete	Quantity No Samples
Reinforced Cement Concrete	a) Slumptest b) Cubetest	Field Lab	Standard Standard	Regularintervals design. AsperIS456:2000	Regular intervals Duringconcreting as,pre-mixdesign as perIS456:2000

(I)Slump tests: The tests shall be carried out from time to time directed by the engineer on concrete actually being placed in the works at the commencement of each period of concrete placing in accordance with the procedure laid down in the latest Indian Standards Specifications

ii) Cube tests: Whenever required by the Architect but subject to the minimum Requirement given in the table above, cubes shall be made in a manner as laid down in the latest Indian Standards Code of Practice (IS:456) and sent to an approved laboratory for testing and the results submitted to the Architect immediately on receipt. The cost of all such tests made shall be borne by the contractor. At least 6 cubes will be taken on each day of concreting when a minimum of 5cum of concrete is laid or as instructed by the. The contractor shall keep a record at site of all such tests identifying them with the portion of the work to which they relate. This record will be checked by the engineer from time to time.

Acceptance criteria; As specified in IS 456:2000

5.07 Inserts and pipes: Insert so fan kind like fan hooks, sleeves, pipes, bolts and nuts, anchor, bolts etc., are to be accurately placed in the concrete (and/or brick work) and concreted over, as and when required and directed. The word "insert" will mean article like anchors beams, sleeves, pipes, bolts, nuts etc.

Pipes: All electric conduits and junction boxes and all sanitary pipes, water supply pipe s and down pipe shall tie with in concrete slabs, beams or columns shall be laid I n place and the Architects approval shall be obtained before the casting of concrete. No cutting of structural concrete will be permitted. All care shall be taken to ensure that conduit pipes are not damaged.

PRE-CAST CONCRETE JALI

a) The jail shall be of specified grade reinforced with 1.6mm mild steel wire unless otherwise specified.
b) Fixing: The jail shall be set in position true to plumb and level before joints sills and soffits of the openings are plastered. It shall then be properly grouted with cement mortar 1:3 (1 cement :3 coarse sand) and rechecked for levels. Finally, the jambs, sills and soffits shall be plastered embedding the jail uniformly on all sides.
c) Measurements: the jail shall be measured for its gross superficial area. The length and breadth shall not be less than that specified.
d) Rate: the rate shall be inclusive of materials and labour involved in all the operations described above except plastering of jambs, sills and soffits, which will be paid for under relevant items of plastering

PRECAST CONCRETE

Precast concrete shall comply with IS 456 and with the following requirements:

a. All precast units shall be cast on suitable bed or platform with firm foundation and free from wind. 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.
b. Side shutters shall not be struck in less than 24 hours after depositing concrete and no precast unit shall be lifted until the concrete reaches a strength of at least twice the stress to which the concrete may be subjected to at the time of lifting.
c. The lifting and removal of precast units shall be undertaken without causing shock, vibration or undue bending stresses to or in the units. Before lifting and removal takes place contractor shall satisfy Engineer or his representative that the methods he proposes to adopt for these operations shall not over stress or otherwise affect seriously the strength of the precast units. The reinforced side of the units shall be distinctly marked.
d. All precast work shall be protected from the direct rays of the sun for at least 7 days after casting and during; that period each unit shall be kept constantly watered or preferably be completely immersed in water if the size of the unit so permits, otherwise curing practice shall be followed
e. Slots, openings or holes, pockets etc. shall be provided in the concrete work in the drawings or as directed by Engineer. Any deviation from the approved drawings shall be made good by contractor at his own expense. Without damaging any other work sleeves, bolts, inserts, etc. shall also be provided in concrete work where so specified.

Mode of Measurement

It shall be measured as per the item schedule. The unit rate for precast concrete members shall include formwork, mouldings, finishing, hoisting and setting in position including mortar, provision of lifting arrangement, exposed concrete finish etc. complete. Only if reinforcement is used, it shall be measured and paid for separately under item rate.

TECHNICAL SPECIFICATION

FOR

MASONRY WORKS

3. MASONRY WORKS

3.1 BRICK MASONRY WORKS

3.1.1 SCOPE

This specification establishes the materials, dressing, laying, joining. Curing, workmanship etc. for brick masonry works. Brick masonry shall also comply with all the requirements of IS:2212.

3.1.2 GENERAL REQUIREMENTS

3.1.2.1 Materials: Refer materials specification no 2.9

3.1.2.2 Cement Mortar

Cement mortar shall meet the requirements of IS:2250 and shall be prepared by mixing cement and sand by volume. Proportion of cement and sand shall be 1:6 (1 part of cement and 6 parts of sand), or as directed by the Engineer-in-Charge / shown on the drawing, for brick masonry of one brick thickness or more, while 1:4 cement mortar (1 part of cement and 4 parts of sand) shall be used for brick masonry of half brick thickness. The sand being used for mortar shall be sieved. The mortar shall be used as soon as possible after mixing and before it has begun to set and in any case within initial setting time of cement after water is added to the dry mixture. Mortar unused for more than initial setting of cement, shall be rejected and removed from the site of work.

3.1.2.3 Proportioning

The unit of measurement for cement shall be a bag of cement weighing 50 kgs and this shall be taken as 0.035 cubic metres. Sand shall be measured

in boxes of suitable size on the basis of its dry volume. In case of damp sand, its quantity shall be increased suitably to allow for bulkage.

3.1.2.4 Mixing

The mixing of mortar shall be done in a mechanical mixer operated manually or by power. The Engineer-in-Charge may, however, permit hand-mixing as a special case, considering the magnitude nature and location of work. The Contractor shall take the prior permission of Engineer-in-Charge, in writing, for using hand-mixing before the commencement of work.

3.1.2.5 Mixing in Mechanical Mixer

Cement and Sand in specified proportions, by volume, shall be thoroughly mixed dry in a mixer. Water shall then be added gradually and wet mixing continued for at least one minute. Care shall be taken not to add more water than that which shall bring the mortar to the consistency of stiff paste. Wet mix from the mixer shall be unloaded on water-tight masonry platform, made adjacent to the mixer. Platform shall be at least 150 mm above the levelled ground to avoid contact of surrounding earth with the mix. Size of the platform shall be such that it shall extend at least 300 mm around the loaded wet mix area. Wet mix, so prepared, shall be utilised within initial setting time (thirty (30) minutes for ordinary Portland cement conforming to IS: 269 after addition of water. Mixer shall be cleaned with water each time before suspending the work.

3.1.2.6 Hand Mixing

The measured quantity of sand shall be levelled on a clean water-tight masonry platform and cement bags emptied on top. The cement and sand shall be thoroughly mixed dry up being turned over and over, backward and forward, several times till the mix is of uniform colour. The quantity of dry mix which can be consumed within initial setting time of cement shall

then be mixed with just sufficient quantity of water to bring the mortar to the consistency of stiff paste.

3.1.3 CONSTRUCTION PROCEDURE

3.1.3.1 Soaking of Bricks

3.1.3.1.1 Bricks shall be soaked in water before use for a period that is sufficient for the water to just penetrate the whole depth of bricks as well as to remove dirt, dust and sand. Proper soaking of bricks shall prevent the suction of water from the wet mortar as otherwise mortar will dry out soon and crumble before attaining any strength. The bricks shall not be too wet at the time of use as they are likely to slip on mortar bed and there will be difficulty in achieving the plumbness of wall as well as proper adhesion of bricks to mortar.

The period of soaking shall be determined at site by a field test by immersing the bricks in water for different periods and then breaking the bricks to find the extent of water penetration. The least period that corresponds to complete soaking, will be the one, to be allowed for in the construction work.

3.1.3.1.2 The soaked bricks shall be removed from the tank, sufficient early, so that at the time of laying, they are skin dry. The soaked bricks shall be stacked over a clean place, wooden planks or masonry platforms to avoid earth, dirt being smeared on them.

3.1.4 Laying

3.1.4.1 Brick Work (One or more brick thickness)

3.1.4.1.1 Brick work (One or more brick thickness) shall be laid in English Bond unless otherwise specified. Half or cut bricks shall not be used except when needed to complete the bond. In no case the defective bricks shall be used.

3.1.4.1.2 A layer of average thickness of 10mm of cement mortar shall be spread on full width over a suitable length of lower course or the concrete surface. In order to check and achieve uniformity in masonry, the thickness of bed joints shall be such that four courses and three joints taken consecutively shall measure equal to four times the actual thickness of the brick plus 30 mm. Each brick with frog upward, shall be properly bedded and set in position by gently tapping with handle of trowel or wooden mallet. Its inside faces shall be buttered with mortar before the next brick is laid and pressed against it. After completion of the course, all vertical joints shall be filled from top with mortar.

3.1.4.1.3 All brick courses shall be taken up truly plumb; if battered is to be truly maintained. All courses shall be laid truly horizontal and vertical joints shall be truly vertical. The level and vertically of work in walls shall be checked up at every one metre interval.

3.1.4.1.4 The masonry walls of structures shall be carried up progressively, leaving no part one metre lower than the other. If this cannot be adhered to, the brick work shall be raked back according to bond (and not left toothed) at an angle not more than 45 degrees but racking back shall not start within 60 centimetres of a corner. In all cases returns, buttresses, counter forts, pillars etc. shall be built up carefully course by course, and properly bonded with the main walls.

The brick work shall not be raised more than fourteen (14) courses per day.

3.1.4.1.5 At the junction of any two walls, the bricks shall at each alternate course, he carried into each of the respective walls so as to thoroughly unite the work.

3.1.4.1.6 The courses at the top of plinth and sills, at the top of the wall just below the soffit of the roof beam and at the top of the parapet, shall be laid with bricks on edge. Brick on edge course shall be so arranged as to tightly fit under the soffit of the roof beam or roof slab, restricting the mortar layer thickness up to 12 mm, however, any gap between the finished brick work and soffit of roof slab / beam shall be suitably sealed with manhole of 13 cm wide of approved quality leaving the equal gap on either side and

then sealed with the mortar over chicken mesh as instructed by Engineer-in-charge.

3.1.4.2 **Brick Work (Half brick thickness)**

3.1.4.2.1 For brick walls of half brick thickness, all courses shall be laid with stretches. Wall shall be reinforced with 2 nos.- 6mm diameter mild steel reinforcement bars, shall be straightened and thoroughly cleaned. Half the mortar thickness for the bedding joint shall be laid first and mild steel reinforcement, one on each face of the wall, shall be embedded, keeping a side cover of 12mm mortar. Subsequently, the other half of the mortar thickness shall be laid over the reinforcement covering it fully.

3.1.4.2.2 The reinforcement bars shall be carried at least 150 mm into the adjoining walls or RCC columns. In case the adjoining wall being of half brick thickness, the length of bars shall be achieved by bending the bars in plan. During casting of reinforced concrete columns, 6mm die M.S. reinforcing bar shall be placed at every fourth course of brick masonry. At the junction of two walls, the brick shall, at each alternate course, be carried into each of the respective walls so as to thoroughly unite the work. The brick masonry work shall not be raised more than 14 courses per day.

3.1.4.2.3 Brick course under the soffit of beam or slab, shall be laid by restricting the mortar thickness to 12 mm. However, any gap between the finished brick work and soffits of slab / beam, shall be suitably sealed with the thermoscope of 8cm wide of approved quality leaving the equal gap on either side and then sealed with the mortar over chicken mesh as instructed by Engineer-in-charge.

3.1.5 **Circular Brick Work**

3.1.5.1 The detailed specification for brick work covered under 3.1.4.1 and 3.1.4.2 shall apply, in so far as these are applicable. Bricks forming skew backs, shall be dressed or cut so as to give proper radical bearing. Defects in dressing of brick shall not be covered up by extravagant use of mortar, nor shall the use of chips etc., be permitted.

3.1.5.2 The circular brick work shall be carried up from both ends simultaneously and keyed in the centre. The bricks shall be flushed with mortar and well pressed into their positions so as to squeeze out a part of their mortar and leave the joints thin and compact. All joints shall be full or mortar and thickness of joints shall be between 5 mm and 15 mm.

3.1.6 **Jointing**

3.1.6.1 Joints shall be restricted to a width of 10mm with brickwork of any classification. All bed joints shall be normal to the pressure upon them i.e. horizontal in vertical walls, radial in circular brick masonry and at right angles to the face in the battered retaining walls. The vertical joints in alternate courses shall come directly one over the other and shall be truly vertical. Care shall be taken that all the joints are full of mortar, well flushed up. In case no pointing is to be done, cement mortar shall be neatly struck as the work proceeds. The joints in face which are to be plastered or pointed shall be squarely raked out to a depth of 12mm while the mortar is still green. The rake joints shall be brushed to remove loose particles. After the day's work, the faces of brick work shall be cleaned on the same day with wire brush and all mortar droppings removed.

3.1.7 **Curing**

Green work shall be protected from rain or any other running water or accumulated water from any source, by suitable means. Masonry work, as it progresses, shall be kept thoroughly wet by sprinkling water at regular intervals, on all faces. Curing shall be done after 24 hours of completion of day's work and shall be done for at least 10 days after completion. Proper watering cans with spray nozzles, rubber or PVC pipes shall be used for this purpose.

3.1.8 **Staging / Scaffolding**

3.1.8.1 Staging / Scaffolding shall be properly planned and designed by the Contractor. Use of only steel tubes is permitted for staging / scaffolding. Design of staging / scaffolding shall be submitted for approval of the Engineer-in-Charge, before commencement of work.

3.1.8.2 Single scaffolding having one set of vertical support, shall be used and other end of the horizontal scaffolding member shall rest in a hole provided in the headed course. The support shall be sound and strongly clamped with the horizontal pieces over which the scaffolding planks shall be fixed. The holes left in the masonry work for supporting the scaffolding shall be filled and made good with plain cement concrete of grade 1:3:6 during plastering. Suitable access shall be provided to the working platform area. The scaffolding shall be strong enough to withstand all loads likely to come upon it and shall also meet the requirements specified in IS:2750.

3.1.8.3 Double scaffolding shall be provided for pillars less than one metre in width or for the first-class masonry or for a building having more than two storeys.

3.1.8.4 The following measures shall also be considered during erection of the scaffolding / staging.

a) Sufficient sills or underpinnings, in addition to base plates, shall be provided, particularly, where scaffoldings are erected on soft grounds.

b) Adjustable bases to compensate for uneven ground shall be used.

c) Proper anchoring of the scaffolding / staging at reasonable intervals shall be provided in each direction with the main structure wherever available.

d) Horizontal braces shall be provided to prevent the scaffolding from rocking.

e) Diagonal braces shall be provided continuously from bottom to top between two adjacent rows of uprights.

f) The scaffolding / staging shall be checked at every stage for plumb line.

g) Wherever the scaffolding / staging is found to be out of plumb line, it shall be dismantled and re-erected afresh. Efforts shall not be made to bring it in line with a physical force.

h) All nuts and bolts shall be the clamps / couplings are firmly tightened to avoid slippage.

i) Erection work of a scaffolding / staging, under no circumstance shall be left totally to semiskilled or skilled workmen and shall be carried out under the supervision of Contractor's technically qualified civil engineer.

3.1.8.5 For smaller works or works in remote areas wooden bellies may be permitted for scaffolding / staging by the Engineer-in-Charge at his sole discretion. The contractor must ensure the safety and suitability of such works as described under clause 3.1.6 above.

3.19 Embedment of Fixtures

All fixtures, pipes, conduits, holdfasts of doors and windows etc. required to be built in walls, shall be embedded in plain cement concrete block of grade 1:3:6, at the required positions, as the work proceeds, unless otherwise specified.

3.19.1 PAYMENT / MEASUREMENT

The payment of brick masonry shall be inclusive of all labour, material, scaffolding / staging sampling and testing, soaking of bricks, laying of bricks, raking of joints, cutting of bricks, provided recesses and making

rectangular or round openings, with the manhole of 7 cm wide of approved quality leaving the equal gap on either side and then sealed with the mortar over chicken mesh as instructed by Engineer-in-Charge, curing, making of masonry platform for unloading the wet mix, embedding the fittings / fixtures including providing PCC (1:3:6) etc. all as specified for all heights and depths. Deduction for rectangular or circular openings, shall be done as per relevant IS codes.

3.19.1.1.1 Payment for brick work shall be made on cubic meter (cum) basis on the volume of actual work done, the thickness of wall being calculated on the basis of nominal brick length and breadth only as the case may be for brick work of one (1) or more brick thickness.

Payment for walls of less than 1 brick thick shall be made on square metre basis of the net area of brick work and shall include labour cost of providing and fixing reinforcement wherever specified.

Use of different size of brick less than specified size of 21 cm and 10 cm will not be normally allowed. However, if the specified bricks are not locally available, use of other size of bricks shall be permitted only with prior sanction. No extra payment shall be paid for the additional quantity due to extra thickness beyond specification.

Deduction for voids shall be as per IS: 1200. The rate of brick work shall include scaffolding and all items mentioned above and no extra payment shall be made for cutting bricks, if required, either for openings or for rounding or for insertions or for recesses at the time of brick wall construction. No extra payment shall be made for raking of joints.

HONEY COMB BRICK WORK

The brick honeycomb work shall be done with specified class of brick, laid in specified mortar. All joints and edges shall be struck flush to give an even surface.

The thickness of the brick honeycomb work shall be half-brick only, unless otherwise specified. Openings shall be equal and alternate with half brick laid with a bearing of 2cm on either side.

MEASUREMENTS

The length and height shall be measured correct to a cm. Area shall be calculated in square metres correct to two places of decimal. Honey comb openings shall not be deducted.

3.20 STONE MASONRY

3.2.1 Scope

Stone masonry work shall comply with all the requirements of IS:1597 Part I (Rubble Stone Masonry) IS:3620 (Laterite Stone Masonry) IS;2185 Part I and IS:2572 (Concrete Block Masonry)

3.2.2 Rubble stone masonry

3.2.3. Materials

Refer specification for Materials vide specification no.2.10

3.2.4 Cement Mortar

Refer 3.1.2.2 under Brick Masonry Works

3.2.5 Construction Procedure

3.2.5.1 All stones shall be wetted before use. Each stone shall be placed close to the stones already laid so that the thickness of the mortar joints at the face

is not more than 20mm. Face stones shall be arranged suitably to stagger the vertical joints and long vertical joints shall be avoided. Stones for hearting or interior filling shall be hammered down with wooden mallet into the position firmly bedded in mortar. Chips or sprawls of stones may be used for filing of interstices between the adjacent stones in heartening and these shall not exceed 20% of the quantity of stone masonry. To form a bond between successive courses plum stones projecting vertically by about 15 to 20cm shall be firmly embedded in the heartening at the interval of about one metre in every course. No hollow space shall be left anywhere in the masonry.

The masonry work in wall shall be carried up true to plumb or to specified batter.

Random rubble masonry shall be brought to the level courses at plinth, window sills, lintel and roof levels. Levelling shall be done with concrete comprising of one part of the mortar as used for masonry and two parts of graded stone aggregate of 20mm nominal size.

The masonry in structure shall be carried uniformly. Where the masonry of one part is to be delayed, the work shall be raked back at an angle not steeper than 45^{o}.

3.2.5.2 Bond stones

Bond or through stones running right through the thickness of walls, shall be provided in walls up to 60cm thick and incise of walls above 60cm thickness, a set of two or more bond stones overlapping each other by at least 15cm shall be provided in a line from face of the wall to the back.

For all thickness of such walls, a set of two or more bond stones overlapping each other by at least 15cm shall be provided.

Length of each such bond stone shall not be less than two-third of the thickness of the wall.

Where bond stones of suitable lengths are not available precast cement concrete block of 1:3:6 mix (1 cement: 3 coarse sand: 6 graded stone aggregate 20mm nominal size) of cross section not less than 225 square centimetres and length equal to the thickness of wall shall be used in lieu of bond stones. (This shall be applicable only in masonry below ground

level and where masonry above ground level is finally required to be plastered).

At least one bond stone or a set of bond stones shall be provided for every 0.5 sqm of the area of wall surface. All bond stones shall be marked suitably with paint as directed by the Engineer-in-Charge.

3.2.5.3 Quoin and Jamb stones

The quoin and jamb stones shall be of selected stones neatly dressed with hammer or chisel to form the required angle. Quoin stones shall not be less than 0.01 cum in volume. Height of quoins and jamb stones shall not be less than 15cm. Quoins shall be laid header and stretcher alternatively.

3.2.5.4 Joints

Stones shall be so laid that all joints are fully packed with mortar and chips. Face joints shall not be more than 20mm thick.

The joints shall be struck flush and finished at the time of laying when plastering or pointing is not to be done. For the surfaces to be plastered or pointed, the joints shall be raked to a minimum depth of 20mm when the mortar is still green.

3.2.5.5. Scaffolding

Single scaffolding having one set of vertical support shall be allowed. The supports shall be sound and strong, tied together by horizontal pieces, over which the scaffolding planks shall be fixed. The inner end of the horizontal scaffolding member may rest in a hole provided in the masonry. Such holes, however, shall not be allowed in pillars under one metre in width or near the skew back of arches. The holes left in masonry work for supporting scaffolding shall be filled and made good with cement concrete 1:3:6 (1 cement: 3 coarse sand: 6 stone aggregate 20mm nominal size).

3.2.5.6 Curing

Masonry work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. Incise of masonry with fat lime mortar curing shall commence two days after laying of masonry and shall continue for at least seven days thereafter.

3.2.5.7 Protection

Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damages, mortar dropping and rain during construction.

3.2.5.8 Measurements

a) The length, height and thickness shall be measured correct to a cm. The thickness of wall shall be measured at joints excluding the bushing. Only specified dimension shall be allowed; anything extra shall be ignored. Quantity shall be calculated in cubic metre nearest to two places of decimal.

b) The work under the following categories shall be measured separately.

(I) From foundation to plinth level (level one)

(a) work in or under water and or liquid mud.

(b) work in or under foul positions

(ii) From plinth level (level one) to top level of Compound wall.

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

(I) Ends of dissimilar materials (that is posts, girders, rafters' purlins, trusses, corbels, steps etc.,) up to 0.1 sqm in section.

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

(iii) Wall plates and bed plates and bearing of hajjes and the like, where the thickness does not exceed 10cm and the bearing does not extend over the full thickness of the wall.

Note: The bearing of floor and roof shall be deducted from wall masonry.

(i) Drain holes and recesses for cement concrete blocks to embed hold fasts for doors, windows, etc.,

(ii) Building in masonry, iron fixture, pipes up to 300mm die, hold fasts of doors and windows etc.,

(iii) Forming chases in masonry each up to section of 350 sq.cm Masonry (excluding fixing brick work) in chimney breasts with smoke of air flues not exceeding 20 sq.dm (0.20 sqm) in sectional area shall be measured as solid and no extra payment shall be made for pargetting and coring such flues. Where flues exceed 20 sq.dm (0.20 sqm) sectional area, deduction shall be made for the same and pargetting and coring flues shall be measured in running metres stating size of flues and paid for separately. Aperture for fireplace shall be deducted and no extra payment made for splaying of jambs and throating.

d) Apertures for fire places shall not be deducted and extra labour shall not be measured for splaying of jambs, throttling and making arch to support the opening.

e) Square or Rectangular Pillars

These shall be measured as walls, but extra payment shall be allowed for stone work in square or rectangular pillars over the rate for stone work in walls. Rectangular pillar shall mean a detached masonry support rectangular in section, such that its breadth does not exceed two and a half times the thickness.

f) Tapered walls shall be measured net, as per actual dimensions and paid for as other walls.

g) Curved masonry

Stone masonry curved on plan to a mean radius exceeding 6metres shall be measured and included with general stone work. Stone work circular on plan to a mean radius not exceeding 6 metres shall be measured separately

and shall include all cuttings and waste and templates. It shall be measured as the mean length of the wall.

3.2.5.9 Rate

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

a) Raking out joints for plastering or pointing done as a separate item, or finishing flush as the work proceeds.

b) Preparing tops and sides of existing walls for raising and extending.

c) Rough cutting and waste for forming gables, cores, skew backs or spandrels of arches, splays at eaves and all rough cutting in the body of walling unless otherwise specified.

d) Bond stones or cement concrete bond blocks.

e) Leading and making holes for pipes etc.,

f) Bedding and pointing wall plates, lintels, sills etc., in or on walls, bedding roof tiles and corrugated sheets in or on walls.

g) Building in ends of joists, beams, lintels etc.,

3.2.6 LATERITE STONE MASONRY

3.2.6.1 Dressing

Literate stones shall be hammer dressed into rectangular blocks so that all faces are free from waviness and unevenness, and the edges are true and square. The least thickness/ breadth shall be not less than height. The length shall generally be equal to twice the breadth, unless otherwise specified.

3.2.6.2 Laying

The dressed stones shall be laid in regular courses of not less than 15cm height. All courses in the masonry shall be of the same height unless otherwise directed. The stones shall be laid in alternate header stretcher fashion, alternative courses of header and stretchers or in any other

suitable fashion as directed. The vertical joints shall break by at least 65mm. No specific corner stones are necessary. Quoin may be provided, where so indicated.

3.2.6.3 Joints

All bed joints shall be truly vertical, the thickness of joints shall not exceed 15mm. Each stone shall be carefully laid in place with joints completely filled with mortar. On faces, whereon plastering or pointing is required to be done, the joints shall be struck flush as the work proceeds. In other cases, joints shall be raked square to a minimum depth of 13mm by a racking tool during the progress of work while the mortar is still green.

3.2.6.4 Scaffolding, Curing and Protection

3.2.6.4.1 Scaffolding

Double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

3.2.6.4.2 Protection

Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

3.2.6.4.3 Curing

Masonry work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. Incise of masonry with fat lime mortar, curing shall commence two days after laying of masonry and shall continue for at least seven days thereafter.

3.2.6.5 Measurements

The finished work shall be measured correct to a centimetre in respect of length, breadth and height. The cubical contents shall be calculated in cubic metre nearest to two places of decimal.

3.2.6.5.1 No deduction not any extra payment shall be made for the following:

(i) Ends of dissimilar materials (that is joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps etc.,) up to 0.1 sqm in section

(ii) Openings up to 0.1 sqm in area. In calculating the area of opening, any separate lintels or sills shall be included along with the size of the opening but the end portion of the lintels shall be excluded and extra width of rebated reveals, if any, shall also be excluded.

(iii) Wall plates and bed plates and bearing of Khaja and the like, where the thickness does not exceed 10cm and the bearing does not extend over the full thickness of the wall.

Note: The bearing of floor and roof slabs shall be deducted from wall masonry.

(iv) Drainage holes and recesses left for cement concrete blocks to embed hold-fasts for doors and windows, building in the masonry iron fixture and pipes up to 300mm diameter.

(v) Stone walling in chimney breasts, chimney stacks, smoke or air flues not exceeding 0.20 sqm in sectional area shall be measured as solid and no extra measurement shall be made for pargetting and coring such flues. Where flues exceed 0.20 sqm in sectional area, deduction shall be made for the same and pargetting and coring flues paid for separately.

3.2.7 Hollow and solid concrete block masonry

Hollow and Solid concrete blocks - shall conform to the requirements of IS:2185-1979. Specification for hollow and solid concrete blocks except with regard to the mix of cement concrete and sizes of aggregates which shall be as indicated. Hollow blocks shall be sound, free from cracks, broken edges, honey combing and other defects that would interfere with the proper placing of block or impair the strength or performance of construction.

3.2.7.1 Dimensions and Tolerances

Concrete masonry building units shall be made in sizes and shapes to fit different construction needs. They include stretcher, corner, double corner or pier, jamb, header, bull nose, and partition block and concrete floor units.

3.2.7.2 Concrete block-hollow (open or closed cavity) or solid shall be referred to by its nominal dimensions.

The nominal dimensions of concrete block shall be as follows:

Length 400, 500 or 600mm
Height 200 or 100mm
Width 50,75,100,150,200,250 or 300mm

In addition, block shall be manufactured in half lengths of 200, 250 or 300mm to correspond to the full lengths.

The maximum variation in the length of the units shall be not more than +5mm and maximum variation in height and width of unit, not more than +33mm.

3.2.7.3 Classification

Hollow (open and closed cavity) concrete blocks.

The hollow (open and closed cavity) concrete blocks shall conform to the following three grades:

a) Grade 'A' - These are used as load bearing units and shall have a minimum block-density of 1500 kg/cum. These shall be manufactured for minimum average compressive strengths of 3.5, 4.5, 5.5 and 7.0 N/sq.mm respectively at 28 days (See Table 3).

b) Grade 'B' - These are also used as load bearing units and shall have a block density less than 1500 kg/cum but not less than 1000 kg/cum. These shall be manufactured for minimum average compressive strengths of 2.0, 3.0 and 5.0N/sq.mm respectively at 28 days (See Table 3).

c) Grade 'C' - These are used as non-load bearings units and shall have a block density less than 1500 kg/cum but knotless than 1000

kg/cum. These shall be manufactured for minimum average compressive strength of 1.5 N/ sq.mm at 28 days (see Table 3).

d) Grade 'D' - The solid concrete blocks are used as loadbearing units and shall have a block density not less than1800 kg/cum. These shall be manufactured for minimum average compressive strengths of 4.0 and 5.0 N/sq.mm respectively (See Table 3).

3.2.7.4 Physical requirements

a) Compressive strength - The average crushing strength of eight blocks, when determined in accordance with IS:2185 - 1979 shall be not less than as specified in table given below:

TABLE 3
PHYSICAL REQUIREMENTS

Type	Grade	Density of Block Kg/mm³	Minimum Average Compressive Strength of Units N / mm²	Minimum strength of individual units N / mm²
(1)	(2)	(3)	(4)	(5)
Hallow (Open and closed cavity) Load bearing unit	A (3.5) A (4.5) A (5.5) A (7.0) B (2.0) B (3.0) B (5.0)	Not Less Than 1500 Note Less Than 1500 But Not Less Than 1000	3.5 4.5 5.5 7.0 2.0 3.0 5.0	2.8 3.6 4.4 5.6 1.6 2.4 4.0
Hallow (Open and closed cavity non-load bearing units.	C (1.5)	Less Than 1500 But Not Less than 1000	1.5	1.2
Solid Load Bearing	D (5.0) D (4.0)	Not Less Than 1800	5.0 4.0	4.0 3.2

Units				

b) Drying Shrinkage - The drying shrinkage of the blocks average of three blocks), when unrestrained, shall be determined in accordance with IS:2185-1979 and shall not be exceed 0.1 per cent.

c) Moisture movement - The moisture movement (average ofthree blocks) when determined in the manner described in IS:2185-1979, shall not exceed 0.09 per cent.

d) Water Absorption - The water absorption (average ofthree blocks) when determined in the manner described in IS:2185-1979 shall be not more than 10 percent by mass.

e) Face shells and webs shall increase in thickness from the bottom to the top of the unit. Depending upon the coremoulds used, the face shells and webs shall be flared andtapered orstraight tapered, the former providing a wider surface for mortar. The thickness of the face shell and web shall be not less than the values given in Table below:

TABLE 4
Minimum face shell and web thickness

Nominal Block Width	**Face Shell Thickness Minimum**	**Thickness of Web Minimum**	**Total Web Thickness per course in any 200 mm length of walling min.**
(1)	**(2)**	**(3)**	**(4)**
100 or Less	**25**	**25**	**25**
Over 100 to 150	**25**	**25**	**30**
Over 150 to 200	**30**	**25**	**30**
Over 200	**35**	**30**	**38**

f) Subject to the tolerances specified in 3.2.7.2 and the provisions of (g) The face of masonry units shall beflat and rectangular, opposite face shall be parallel andall arises shall be square. The bedding surfaces shall be at right angles to the faces of the blocks.

g) Blocks with special faces shall be manufactured and supplied as directed by the Engineer-in-Charge.

3.2.7.5 Curing and Drying

The blocks shall be cured in an immersion tank or in a curing yard and shall be kept continuously moist for at least14 days. When the blocks are cured in an immersion tank, the water of tank shall be changed at least every four days.

After curing, the blocks shall be dried in shade before being used on the work. They shall be stacked with voids horizontal to facilitate through passage of air. The blocks shall be allowed to complete their initial shrinkage before they are laid in wall.

3.2.7.6 Construction of masonry

For single storeyed buildings, the hollows of blocks in foundation and basement masonry shall be filled up with sand and only the top foundation course shall be of solid blocks. But for two or more storeyed buildings, solid concrete blocks shall be used in foundation courses, plinth and basement walls, unless otherwise indicated. If hollow blocks are used, their hollows shall be filled up with cement concrete 1:3:6 using 12.5mm nominal size aggregates.

3.2.7.7 Wetting of blocks

Blocks need not be wetted before or during laying in the walls. Incise the climate condition so require, the top and the sides of the blocks may only be slightly moistened so as to prevent absorption of water from the mortar and ensure the development of the required bond with the mortar.

3.2.7.8 Laying

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

All courses shall be laid truly horizontal and all vertical joints made truly vertical. Blocks shall break joints with those above and below for not less than quarter of their length. Precast half-length closers (and not cut from full-size blocks) shall be used. For battered faces, bedding shall be at right angles to the face unless otherwise directed. Care shall be taken during construction to see that edges of blocks are not damaged.

a) Provision for door and window frames

A course of solid concrete block masonry shall be provided under door and window openings (or a 10cm thick precast concrete sill block under windows). the solid course shall extendfor at least 20cm beyond the opening on either side. For jambs of very large doors and windows either solid units are used, or the hollows shall be filled in with concrete of mix 1:3:6, using 12.5mm nominal size aggregates.

b) Provisions for roof

The course immediately below the roof slab shall be built with solid blocks. The top of the roof course shall be finished smooth with a layer of cement and coarse sand mortar 1:3, 10mm thick and covered with a thick coat of white wash or crude oil, to ensure free movement of slab.

c) Intersecting Walls

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

d) Piers

The top course of block in the pier shall be built in solid blocks. Hollow concrete block shall not be used for isolated piers, unless their hollows are specified to be filled with cement concrete.

e) Fixtures, fitting, etc., shall be built into the masonry in cement and coarse sand mortar 1:3 while laying the blocks where possible. Holdfasts shall be built into the joints of the masonry during laying.

Holes, chases, sleeves, openings, etc., of the required size and shape shall be formed in the masonry with special blocks while laying, for fixing pipes, service lines, passage of water etc., After service lines, pipes etc., are fixed, voids left, in any shall be filled up with cement concrete 1:3:6 (1 cement, 3 coarse sand: 6 stone aggregate 20mm nominal size) and neatly finished.

f) Finishes

Rendering shall not be done to the walls when walls are wet. Joints for plastering or pointing as specified shall be raked to a depth of 12mm. Joints on internal faces, unless otherwise indicated, shall be raked for plastering. If the internal faces of masonry are not to be plastered the joints shall be finished flush as the work proceeds or pointed flush where so indicated.

SAMPLING&T ESTS

a.	**Dimensional Tolerance**	
b.	**WaterAbsorption}**	
C.	**Efflorescence}**	**PHYSICALCHARACTERISTICS**
d.	**CompressiveStrength**	

Dimensions and Tolerances: The no mina size of the blocks shall be as specified. The maximumvariationinthelengthoftheunitsshallbenotmorethan+5mmand maximum variationinheightandwidthofunit, notmorethan+3mm.

Compressive Strength: TheMinimumcompressivestrengthforsolidconcreteblocks shouldbe40kg/sq.cm.

DryingShrinkage: Thedryingshrinkageoftheblocks(averageofthreeblocks),when unrestrained, shallbedeterminedinaccordancewithIS:2185-1979andshallnotbe exceed 0.1 per cent.

Moisture Movement: The moisture movement (average of three blocks), when determined inthemannerdescribedinIS:2185-1979, shallnotexceed0.09 percent.

Water Absorption:Thewaterabsorption(averageofthreeblocks),whendeterminedinthe manner describedinIS:2185-1979shall be not more than 10per cent by mass.

SPECIFICATION

FOR

WOOD WORKS

4.0 Wood work

4.1 General:

Reference shall be made to the following Indian standards:

IS 2202 Part-I	:	Specifications for wooden flush door shutters (solid core type) plywood face panels.
IS 2202 Part _ II	:	Specification for wooden flush door shutters (Solid core type) practice board and hard board face panels.
IS 1003 Part – I	:	Specification for Timber panelled and glazed shutters – Door shutters
IS 3087	:	Specification for wooden particles boards (medium density) for general purposes.
IS 3097	:	Specification for veneered particles board
IS 848		Specification for synthetic Resin Adhesives for plywood (Phenolic and cements plastic)
IS 205	:	Specification for nonferrous metal butt hinges
IS 2338	:	Code of Patrice for finishing of wood and wood-basedmaterials (Part I & Part II)
IS 1341	:	Specification for steel butt hinges
IS 4021	:	Specification for timber door, window and ventilator frames
IS 303	:	Specification for plywood for general purposes
IS 281	:	Specification for AL drops

IS 204	:	Specification for Tower bolt
IS 208	:	Specification for door handles
IS 1823	:	Specification for door stoppers
IS 2209	:	Specification for Mortice locks
IS 3847	:	Specification for mortice night latches
IS 5899	:	Specification for bathroom latches
IS 7196	:	Specification for hold fasts
IS 3564	:	Specification for door closers

4.2 Material

4.2.1 Timber

4.2.1.2 Hard Wood

Hard wood shall be first class wood conforming to IS 4021 of good quality, well-seasoned and free from defects suchas dead knots, cracks, sapwood etc. No individual hardand sound knot shall exceed 6 sq.cm. in size with nodimension more than 50mm and the aggregate area of such knots shall not be more than 1% of the area of the piece.

There shall not be less than 5 growth rings per cm. Width in cross-sections.

A) Sal wood

Sal is heavier, harder, stronger, more shock resistance thanteak. Its heart wood is a naturally durable wood, and usually remains immune to attack by white ants and fungi for a long period, while its sapwood is very perishable and should not be used. Well dried sale is not a really easy wood to saw and work. It is a rough constructional wood than a carpentry timber. No individual hard and sound knot shall exceed 25mm in diameter and the aggregate area of all the knots shall not exceed 1% of the area of the piece

It can be used for a variety of purposes, such as for beams, rafters, flooring, piles, bridging, tool handles, picker arms and tent pegs, etc.

4.2.1.3 Moisture content in timber

The maximum permissible percentage of moisture content for well-seasoned timber shall be as per IS 287

4.2.1.4 Workmanship of wood work

Workmanship for wood and joinery shall be as per IS 1200 and IS 4021

4.2.1.5 Painting / Polishing of wood work

Painting / Polishing of wood work shall be in accordance with material specification no.10

4.3 Wooden door / window frame

Wooden door / window frame shall be made of specified wood as per item description and shall be in accordance with detailed drawings.

The wooden members of the frame shall be planed smooth and accurate to the full dimension. Rebates, rounding, moulding etc. shall be done before the members are jointed into frames.

Joints in the frame work shall be perfect with square edges and shall be pinned with hard wood / bamboo pins of 10 to 15mm dia.

Wood work shall be painted / polished or otherwise treated as specified. All exposed portions shall be coated with wood primer and concealed surface by bituminous paints as per material specification no. 10.

Before any surface treatment is applied, the wood workshall be got approved by the Engineer-in-Charge. The frames shall be fixed only after acceptance by the Engineer-in-Charge.

4.4 Shutters

4.4.1.1 Hinges

Hinges shall be as provided in Bill of Quantities.

4.4.1.2 Workmanship

All the four edged of the door shutters shall be square. The shutter shall be free from twist or warp in its plane. In case of double shutters, the meeting of the shutters shall be rebated by one third the thickness of shutter. The rebating shall be splayed.

The shutter then shall be veneered whenever required by gluing approved shade and textured commercial type 0.5mm thick veneering conforming to class IS: of IS 303.

The veneering shall be done by gluing the veneer with BWP type, phenol formaldehyde synthetic resin conforming to IS :848 by hot press process on the shutter. Workmanship and finished of the veneering sail conform to IS :303

The exposed surfaces of the lipping of the edges shall be as directed by Engineer-in-Charge.

The shutter shall be fixed to the door frame, by means of hinges @ minimum three hinges per lead, maximum spacing of hinges being 600 mm or as per drawing with suitable sized screws.

The shutter when fitted to the frame shall satisfy all operational aspects of the door like smooth movement, proper closing against the door frame, etc.,

4.4.2 Flush Shutters

4.4.2.1 Flush door shutters shall have to be specified make door / or equivalent to conform manufactures specifications. Thickness and type of shutters shall be as specified. The shutters shall have a solid core and may be of decorative or non-decorative (paintable) as per IS 2202 (Part IS:) 1991. Thickness and type of shutter shall be specified. Lipping shall be done with battens of first-class hard wood or as specified and of depth not less than 25mm and provided internally on all edges of shutters. Hinges shall be as specified in Bill of quantities.

Workmanship shall be as in 4.4.5.2

In the alternative, flush door of country wood frame treated with chemical impregnation and mechanical kiln dried to 10-12% moisture content and core filled with web form of hexagonal cells made out of composite material of Lingo cellulose fibres (for internal use); filled with water-resistant low-density fibre board (for external use) and provided with rails and styles of not less than 50mm in suitable locations for fixing locks, etc.

4.4.3 Panelled Shutters

4.4.3.1 Materials shall be as specified in 4.2.1.1 to 4.2.1.3

Panelled or glazed shutters for doors, windows, ventilators and cupboards shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, veneered particle board, fibre board wire gauge or sheet glass, the shutters, single or multi-panelled as shown in the drawings or as directed by the project thickness of shutters shall be as specified. All members of the shutter shall be straight without any wrap or bow and shall have smooth well-planned face at right angles to each other.

Any wrap or bow shall not exceed 1.5mm. the right angle for the shutter shall be checked by measuring the diagonals and the difference between the two diagonals should not be more than ± 3mm.

4.4.3.2 Frame work

Timber for stiles and rails shall be of the same species and shall be sawn in the directions of grains sawing shall be truly straight and square. The timber shall be planned smooth and accurate to the required dimensions. The stiles and rails shall be joined to each other by plain or hunched mortice and tenon joints and the rails shall be inserted 25mm short of the width of stiles. The bottom rails shall have double tenon joints and for other rails single tenon joints shall be provided. The lock rails of door shutter shall have its centre line at a height of 800mm form the bottom of the shutters unless otherwise specified. The thickness of each tenon shall be approximately one-third the finished thickness of the members and the width of each tenon shall not exceed three times its thickness.

4.4.3.3 Panelling

The panel inserts shall be either framed into the grooved or housed in the rebate of stiles and rails. Timber, plywood, hardboard and particle board panels shall be fixed only with grooves. The depth of the groove shall be 12mm and its width shall accommodate the panel inserts such that the faces are closely fitted to the sides of the groove. Panel inserts shall be framed into the grooves of stiles and rails to the full depth of the groove leaving on space of 1.5 mm. Width and depth of the rebate shall be equal to half of the thickness of stiles and rails. Glass panels, asbestos panels wire gauge panels and penal inserts of cupboards shutters shall be housed in the rebates of stiles and rails. For all panelled door, I.S. 1003 / 1991 to be followed.

4.4.3.4 Timber panels:

Timber panels shall be preferably made of timber of large width, the minimum width and thickness of the panel shall be 150mm and 15mm respectively, unless otherwise specified. When made from more than one piece, the pieces shall be jointed with a continues tongued and grooves joint glued together and reinforced with headless nails at regular intervals not exceeding 100mm. Depth and thickness of such joint shall be equal to one-third of thickness of panel. The panels shall be designed such that no single panel exceeds 0.5 square metre in area. The grains of timber panels shall run along the longer dimensions of the panels. All panels shall be of the same species of timber unless otherwise specified.

4.4.5 Particle Board flush shutter

Particle board flush shutter shall in general conform to IS 2202

4.4.5.1. Materials

4.4.5.1.1. FLUSH DOORS

The flush doors shall be of solid core single leaf rigid composite polymer laminated Flush door shuttles of required thickness, manufactured out of solid core door confirming to IS 2202 (part -1)1991, laminated with 0.8 mm thick polymer, termite, water resistant and with various pre moulded design on both faces confirming to IS 6307-19585, using adhesive confirming to IS 4835-1979 and door shutters tested in confirmation to IS 4020-1994.The finish of shutters will be TEADK /OAK/ CEDER/ ROSE WOOD /WALNUT plain colours WHITE /IVORY/ BEIGE/ LIGHT GREY including cost of fixtures and inclusive of Providing, Supply of shutters to respective work spot 35 mm thick door shutters including cost of fixtures and hardware's like handle ,Locks and hinges, tower bots ,latches and stoppers etc complete

4.4.5.1.2. Veneers

Veneers shall conform to class-1 of IS 303 and (BS 476 Part-7)

4.4.6.1.3. Synthetic enamel paint and primer

Specification of synthetic enamel paint and primer shall be same as specified in material specification no.10.

4.4.6.1.4. Hinges

Specification of hinges shall be same as specified in clause 4.4.1.2

4.4.6.2. Workmanship

Teakwood stiles top rail and bottom rail of specified thickness and size shall be provided with suitable rebate.

The MDF board shall be fitted in by means of teakwoodmoulded beading of appropriate cross section. The beading shall be fixed by means of approved make neoprene based adhesive and nailing.

All the four edges of the door shutter shall be square. The shutter shall be free from twist or warp in its plane. In case of double leaf shutters, the meeting of the stiles shall be rebated by one third the thickness of shutter. The rebating shall be splayed. The surface of the teakwood stiles and rails shall be coated with 2 layers of approved quality polyurethane transparent coat with strainer to achieve the desired shade.

The shutter shall be fixed to the door frame by means ofhinges @ minimum 3 hinges per leaf, maximum spacing ofhinges being 600 mm or as per drug. with suitable sized screws.

The shutter when fitted to the frame shall satisfy alloperational aspects of door like smooth movement, proper closing against the door frame etc.

The joints between stiles / rails and the panel shall beproperly finished. Extra neoprene adhesive shall be removed and no gap between panel and stiles / rails shallbe permitted. Any stain of paint on the panel surface shall be properly removed.

4.4.7 Glazed wooden door shutter

4.4.7.1 Materials

4.4.7.1.2 Glazing

Glass sheets for glazing shall be (I) 4mm thick plain glass (wt. 7.2 kg. / sqm) conforming IS 2835. or ii) 5.5mm thick wired glass conforming to IS 5437 or (iii) 6.3mm thick laminated glass conforming to IS 2553 as the casemaybe as per items description or iv) 5.5m thick toughened glass.

Glass sheets shall be free from flaws, scratches, cracks, bubbles etc.

4.4.7.1.3. Hinges

Hinges shall be a specified in clause 4.4.5.1.4

4.5 Measurement and Rate

Wood work in door / window frames shall be measured in cum.

Door / Window shutters shall be measured in Sq.

Hardware's and fitting like locks, kick/push plates, towerbolts, door closer etc. shall be paid on actual numbers provided. Length and width shall be measured to thenearest 0.01m area and volume shall be worked out to the nearest 0.01 sq. and 0.001 cum.

Rate shall include all materials, labour, erection, protective measures, transport, conveyance, storage andother incidental expenditures as required for completion of the items.

4.6 ALUMINUMDOORS, WINDOWS AND VENTILATORS MATERIAL

Aluminum alloy used in the manufacture of extruded doors and window sections shall correspond to IS designation HE9WPofIS 733.Hollow aluminium alloy sections used shall conform to IS designation HV9-WPof IS1285. Machine screws used shall confirm other requirements of IS1362. Also cadmium plated screw, outwashes, bolts lugs of steel shall be used on direction of the OWNER/CONSULTANT.

Specially designed and extruded sections may be permitted if supporting design calculations for wind load are submitted to the OWNER/CONSULTANT for approval.

All aluminium material used shall be anodized for protection against corrosion in marine atmospheres. A thick coating of 15microns from a sulfuric acid bath shall improve its corrosion resistance. Further, anodized sections should be double sealed or alternatively sealed by exposure to steam. Anodized material received at site shall be with a certificate confirming anodic coating of 15micron.OWNER/CONSULTANT may get the same tested from outside at the cost of the Contractor as per IS1868.

FABRICATION

:

Frames shall be square and flat,with the corners fabricated to a true right-angle.

The fixed as well as openable frames shall be constructed by cutting sections to exact length, with corners mitred and welded. Mitred shutter frame joints must be fitted mechanically with aluminium clits if approved by the OWNER/CONSULTANT.

Where hollow sections are used with welded joints, argon-arc welding or fleshpot welding shall be employed or if approved mechanical connection assembly.

Subdividing bars of units shall be tenoned and riveted into the frame. Sections used shall conform to IS1948 for respective location or as approved by the Employer Similarly, the specifications of 12mmthick pre-laminated particle board flat pressed three layers or graded wood particle board confirming to IS:12823 Grade I Type II, in panels and glazing (glass panes) including all other allied material required to be provided in the aluminium doors and windows shall be as per latest Indian Standard and as described in the respective item of the BOQ.

MEASUREMENTS:

Measurements shall be in square meter. Glass shall be measured as part of aluminum window and doors.

4.7 Rolling shutters:

Shall be of approved manufacture suitable for fixing in the position ordered i.e. outside, inside on or below lintel or between jambs. Shutters up to 12

sq. (130 sq. Ft) in areashall be manually operated, of 'Push up' type while bigger sizes shall be of reduction gear typemechanically operated by chain or handles unless otherwise provided in the schedule of quantities.

These shall consist of 8 gauge or as specified with 75mm (3") M.S. laths of best quality mild steel strip, machine rolled andstraightened with an effective bridgedepth of 16mm (5/8") and shall have convex corrugations. These shall be inter-locked together throughout their entirelength with end locks. These shall be mounted on specially designed pipe shaft.

Springs shall be of approved make, coiled type. These shall be manufactured from tested high tensile spring steel wire or strip of adequate strength to balance theshutters in position. The spring pile shaft etc., shall be supported on strong MS or malleable cast iron brackets.

Both the side guides and bottom rail shall be jointless and of single pieces of pressed steel.

Top cover of shaft, spring etc., shall be of the same material as that of lath.

For rolling shutter with wicket-gate night latch shall be provided free of cost.

The shutter and cover etc., shall be painted with one coat of Anticorrosive paint before fixing and two coats of synthetic enamel Paint of approved quality and shade, after fixing in position. All metal rolling shutters must be as per I.S. 6248 / 1979 (first revision)

4.8 Collapsible steel gate:

It shall consist of vertical double channels at 10cm centres. The sizes of channels/T-sections for top and bottom shall be as approved by the Engineer-in-charge. The gate shall be provided with necessary bolts, nuts, locking arrangements, stoppers and brass handles, on both sides. The gate shall be painted with one coat of anticorrosive paintbefore erection and two coats of synthetic enamel paint of approved quality and shade after erection.

4.11 Glazing

Glazing shall be glass of approved specially selected quality and thickness as specified and unless otherwise directed it shall be provided on the exterior with metal beading.

4.12 Precast reinforced concrete door and window frames

Manufacture of precast reinforced concrete door and window frames is described here. These will conform to IS:6523 in all respects unless otherwise specified. Frames shall be manufactured in an approved factory with all necessary arrangements for fixing hinges or hinges fixed at position as specified with hole for receiving tower bolt, sliding bolt etc., as specified.

4.12.1 Shape and dimensions

Precast reinforced concrete door and window frames shall be 60 x 100mm or 70m x 75mm in cross section for single shutter and 60 x 120mm for double shutter door, cross section general conforming to architects' drawings. Where specified, suitable groove for receiving wall plaster shall be provided.

The overall sizes (width and height) shall be as per drawing or as specified.

4.12.2 Materials

The materials used for manufacturing of the frames shall comply with standards given in Table I of IS:6523

4.12.3 Aggregate

The aggregate used shall be of well graded mixture of clean coarse and fine aggregates. The nominal size of coarse aggregate shall not exceed 10mm.

4.12.4 Concrete

Mix of concrete shall be as specified or as directed by the Engineer-in-Charge. But the mix shall not be weaker than M 20 controlled mix and shall be suitable for producing a dense concrete without voids after proper vibration.

There shall be a minimum of three bars of 6mm. The longitudinal reinforcement for each vertical or horizontal member shall be one piece

and shall be firmly held by 3mm die ties spaced at not more than 300mm centre to centre.

The longitudinal reinforcement shall have a maximum cover of 12mm or twice the diameter of main bar, whichever is higher.

4.12.5 Casting

The entire frame may be cast complete in one piece or each of the vertical and horizontal members of the frame may be cast separately to be assembled into the complete frame at site. When the frame is cast in separate parts, one of the reinforcing bars of the vertical members of the frame shall be kept projecting so as to tenon into the corresponding hole in the horizontal member. The holes in the horizontal member for taking the projecting reinforcement from the vertical members shall be slightly larger than the bar diameter to facilitate easy insertion of the projecting bar. After assembly at site, the holes shall be grouted with cement slurry of 1 cement: 2 coarse sand.

4.12.6 Mould

The mould for casting shall preferably be of steel to ensure better surface finish of the cast frame. Provision shall be made in the mould to accommodate fixing devices for hinges and the hold fasts. Where specified, suitable rebates may also be provided to act as plaster groove.

4.12.7 Protection and Curing

After casting in moulds, during setting and in first stage of hardening the concrete shall be protected from shocks, running or surface water and the harmful effect of frost, sunshine drying winds and cold. The concrete shall be cured for at least 7 days unless special curing methods are adopted which shall conform to IS:6523

The frames shall be matured before testing or despatch for the following periods:

Type of cement used	Period
Ordinary Portland cement, Portland blast furnace slag cement Portland pozzolana cement	28 days

Rapid hardening cement (to be used
with approval of Engineer-in-charge) 14 days

The frames after maturing shall have sufficient strength to prevent damage when handled.

4.12.8 Arrangements for fixing of hinges to frames

Suitable arrangements for fixing hinges shall be provided in the frame by one of the following methods as directed:

a) Hardwood fixture: Hardwood blocks of well-seasoned teak or other suitable timber 150mm long, 45 to 50mm x 30 to 40mm in cross section, one block for each of the hinge, shall be fixed in position with 6mm mild steel bolts, nuts and washers, after the frame has been cast, cured and matured. After tightening the nuts, the bolt heads and the nuts shall be suitably covered with hard wood fillets, finished flush with concrete surfaces of the frame.

b) Hinge directly attached to frame: L type flap hinge may be attached directly to the frame with the help of 6mm die mild steel bolts and nuts.

c) Hinge welded to frame: The hinge may be welded to 3mm thick mild steel flat embedded in a frame.

4.12.9 Arrangements for door and window fixtures

Suitable arrangements shall be provided in the frame for receiving tower bolts, sliding bolts and other door and window fixtures as indicated.

4.12.10 Fasteners

Arrangements for fixing the frames with holdfasts or metallic fasteners shall be provided in vertical members of frames as specified. Incest of door frame, there will be 3 no's holdfasts and in case of window, there will be 2 no's holdfasts on each vertical member in contact with the opening where the frame is to be fixed. Holes to accommodate 10mm die bolts to be fixed to holdfasts and the nuts shall be left at appropriate locations.

4.12.11 Erection

When a three-piece frame is used, the vertical members shall be held in position with top member placed over them, the whole frame plumbed and firmly supported till the concrete around the holdfasts in the masonry has properly set and hardened. Cement and coarse sand mortar slurry 1:2 shall be used in grouting the joints between the vertical and horizontal members of door frame. Incise where four members are used, the bottom member shall be first placed in position and other erected on this base.,

4.13 HARDWARE FITTINGS

All hardware fittings and fixtures shall be made with structural properties to sustain safety and withstand strains and stresses to which they are normally subjected to such as opening and closing, wind pressure etc. The fittings shall generally conform to relevant specifications.

They shall be made true, clean, straight, with sharply defined profiles and unless otherwise shown or specified, with true smooth surfaces and edges, free from defects, screw holes shall be counter sunk to suit the head of wood screws.

The metal shall be treated with finish as specified in the Bill of Quantities.

4.14 Fixing of glass louvers in wood / steel frame ventilators

In UPVC frames angular grooves will be made as shown in the drawing and glass. Louvers will be fixed at the same angle. The glass shall be rigidly fixed with by fitting the gaps in the grooves by solutions etc.,

4.17 Balustrade and hand rails in staircase

The S.S. railing to detail in staircase and landing shall be fixed along outer edges of the flights and landings with S.S. square/roundhollow tubes of 304 grade 14 gauge and

flats of specified size as per drawing and neatly welded and filed. The top hard rail over the top flat of the baluster may be of wood of approved quality or.S.S. pipes or hollow box section as specified in the drawing which will be screwed or fitted rigidly as per the direction of Engineer-in charge/OWNER/CONSULTANT

SPECIFICATION

FOR

FLOORING

5. FLOORING

5.1 Flooring, Skirting, Dado & Stone Veneering

All Flooring, skirting, dado, stone veneering etc., shall be executed strictly as per relevant Specification and in workmanlike manner.

5.2 VDF flooring:

10cm the R.C.C 1:2:4 bellow VDF flooring using 20 mm. & down size stone aggregates including mixing, transporting, laying, spreading, compaction, the rates quoted shall be inclusive of lateral formwork. [area of each bays shall not exceed more than 2.00 sqm]

5.2.1 Preparation of surface:

Before the operation for laying is started the surface of baseconcrete shall be thoroughly cleaned of all dirt, loose particles, caked mortar droppings and laitance if any by scrubbing with coir orsteel wire brush, where the concrete has hardened so much that roughening of surface by wire brush is not possible, the surface shall be roughened by chipping or hacking at close intervals. The surfaceshall then be cleaned with water and kept wet for 12 hours, surplus water being removed by mopping before the topping is laid.

5.2.2 Laying:

The floor shall be cast in alternate strips and the concrete shall be vibrated and finished smooth by power trowelling and finished as specified and as directed. Required level or slope shall be maintained on the top surface. Care shall be taken to prevent local depressions. Only steel sections such as channels, angles will be allowed to be used as form work. The top level of form work shall be flush with required finished floor level. Under any circumstances form work shall not be allowed to project above FFL. The rates inclusive of wire mesh. Preparation of base & curing properly, cleaning the work area & stacking the debris / waste materials / unwanted materials / things etc., up to a lead of 50 meters outside work premises etc. complete

all as per specification and as directed by the engineer-in-charge at all locations. (Reinforcement steel will be paid separately under respective items) Selection of materials, method of mixing, placing and compactingshall generally conform to the specifications under plain and reinforced cement concrete described earlier. A stiff mix consistent with workability shall be used.

5.2.3 Finishing the surface:

After the concrete has been fully compacted it shall be finished by trowelling or floating with neat cement rendering. Finishing operations shall start shortly after the compaction of concrete andthe surface shall be trowelled three times at intervals so as toproduce a uniform and hard surface. The satisfactory resistance towear of the flooring dependslargely upon the care with whichtrowelling is carried out. The time interval allowed between successive trowelling's is very important.

Immediately after placing cement rendering, only just sufficienttrowelling 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, sometime after the first trowelling, the duration depending upon the temperature, atmospheric conditions and the rate of set of cement used, the surface shall be retro welled to close any pores in the surface and to bring to surface excess water in concrete or laitance which shall be removed. No dry cement shall be used directly on the surface to absorb moisture or tostiffen the mix. The final trowelling shall be done before theconcrete has become too hard but at such a time that considerable pressure is required to make any impression on the surface.

When instead of 1:2:3 or 1:2-1/2:3-1/2 mix, 1:2:4 mix isspecified, the topping shall be rendered with 1:1 cement mortar instead of cement only.

If directed by the Engineer-in-charge, approved mineral pigment shall beadded to the rendering to obtain desired colour and shade to theflooring at no extra cost, unless otherwise provided for in the schedule of quantities.

The floor shall be machine polished as per Engineer-in-charge's instructions, if so specified in the schedule of quantities.

Wherever patent stone flooring is used as a finishing on roof the joints shall be filled with an approved bitumastic filler in workmanlike manner.

5.3 Plain and coloured cement tile, flooring:

The tiles shall conform to IS: 1237 1980, having the colourapproved by the Engineer-in-charge and the rate shall include provision ofborder tiles and tiles of different colours in pattern if directed, the mosaic topping of lighter shade tiles shall be made of white cement with an approved shade pigment and neutral shade tiles shall be of grey cement with an approved shade pigment. The type of tiles shall be as specified in respective items.

The sub-grade shall be thoroughly wetted after cleaning it off of 'all dirt, laitance and loose material. A bed of lime mortar consisting of one part of lime and two parts of sand shall be laid and properly levelled to an average thickness of 20mm and the surfaceshall be kept slightly rough to form a satisfactory key for tiles. Neat cement paste of honey like consistency shall be spread overmortar bed, over such area at a time as would accommodate about 20 tiles. Tiles which had been soaked in water for 15 minutes and allowed to dry for the same duration shall then be fixed with a thincoat of cement paste at the back of each tile, which shall be thengently tapped with a wooden mallet till it is properly bedded and is level with adjoining tiles. Joints shall be fine and as imperceptible as possible.

After the tiles have been laid in a room or a day's fixing workis completed, surplus cement grout that may have come out of the joints will be wiped off gently and the joints cleaned. A thin slurry of coloured cement matching the colour of tiles shall be spread overand rubbed so as to seal even the thinnest joints between the tilesand make the floor surface impervious. The flooring shall be cured for 7 days. The tiles shall then be polished and finished according to IS:1443 - 1972.

5.4 Dado, Skirting and Risers:

Tiles shall conform to IS:1237 - 1980 and shall be of approved design. The tiles shall be fixed with neat cement grout on a backing coat consisting of 1:4 cement sand plaster, 12mm thick. The top and bottom junctions of tiles shall be rounded off neatly as directed. The joints shall be filled with matching coloured cement slurry ofmatching shade. The surfaces shall be kept wet for 7 days and thenpolished withcarbonado stone of different grades to obtain smooth surface and fine polish.

5.5 Shahabad/Tandoor/Cudahy Stone flooring, steps etc:

The floor shall be either with rough or machine cut and machinepolished stones as specified in respective items of specified thickness and of approved quality and size, free from cracks andflakes and uniform in colour, with straight edges. The sides ofmachine cut and machine polished stones shall have perfect right angles and smooth surface. The stone slabs shall be laid and finished as described under plain cement or coloured tiles on bedding of 1:2 lime mortar of 20mm thickness. This finished stone surfacesthus laidshall then be polished to the required degree as approved by the Engineer-in-charge.

5.6 In dado, skirting, risers etc.:

Stone slabs shall be laid on a backing plaster of cement mortar 1:4, 12mm thick and finished as described under plain and coloured cement tile dado.

5.7 White glazed tiles in flooring and dado:

White glazed tiles from an approved manufacturer conforming to IS: 777-1970 shall be used. They shall be of specified size and thickness. All specials viz, covers, internal and external angles, corners, beads, etc., shall be used wherever directed. Underlayer of specified thickness and mortar of stipulated proportion shall be laidas described in marble mosaic flooring. Tiles shall be washed cleanand set in cement grout, each tile being gently tapped with a woodenmallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straightlines or to suit the required pattern. After the tiles have been laid, surplus cement grout shall be cleaned off.

The joints shall be cleared with a wire brush or trowel to adepth of 5mm (3/16") and all dust and loose mortar removed. Joints shall, then be flush pointed with white cement. The floor shall bekept wet for seven days. After curing, the surface shall be washed with mild hydrochloric acid and clean water. The finished floor shall not sound hollow when tapped with a wooden mallet.

5.8 Providing and laying ceramic tiles in flooring, skirting and dado

The ceramic tiles in flooring and dado shall be of first-class quality as specified in the item specification and shall be approved by the Engineer. The tiles shall be of standard size without warp and with straight edges, true and even in shape and size and of uniform colour. The tiles surface shall be of fine-grained texture, dense and homogeneous. The thickness of the tile shall be as per the item specification. The tiles shall be submerged in water till the bubbles cease.

The flooring should be laid on a base as specified in schedule item. They shall be laid truly vertical on walls and truly horizontal on floors or to slopes as directed. The joint shall be very thin, uniform and perfectly straight. The tiles in dado shall be finished in such a way that, only the tile thickness projects over the finished plaster or as specified otherwise. Where full tiles are not possible, the same should be cut or sawn to the required size and their edge rubbed to ensure straight and true joints. After the tiles are laid extra cement grout shall be removed. The joints shall be cleaned with wire brush and then the joint shall be floated with white or grey cement as approved by the engineer. The tiles shall be cleaned after the work is complete.

This shall be measured in sqm. The rate quoted for flooring and dado work shall be inclusive of angles and corner pieces, cutting tiles for water points, such a way that the point is in the junction of four tiles, electrical points etc.

5.9 Granite slab over kitchen counter:

Granite slab shall be of jet-black shade and of approved quality. They shall be of 18mm thick machine cut and mirror polished. They shall be laid over RCC slab. The angles shall be right angles and all edges shall be straight and true. Joints shall be permitted when the length is more than 2 metres. Number of joints in each direction shall not be more than one number of every 2mtrs. Length beyond the initial 2 mars. Length. No joints shall be permitted in the direction of width.

Mortar bed shall be of cement mortar. The mortar will be of ration 1:4 (1 cement and 4 coarse sand). After properly cleaning and wetting the base, the mortar shall be evenly and smoothly spread over the base by the use of screed battens. The average thickness of the mortar bed shall be 20mm. The granite slab shall be wetted before placing in position and levelled. The joints shall be paper thin joint. Joints shall be treated with white cement mixed with matching pigment. The exposed edges of the granite slab shall be rounded/edge polished as shown in drug. The facia shall also be of the same quality, but of 10 mm thick as the slab over the counter and fixed with brass clips and adhesive over a base mortar of 12mm thick in cement mortar 1:3 (1 cement 3 coarse sand) the joints shall be paper thin. The slab and the facia shall be rubbed clean and polished with steel wool to give a smooth and shining surface. The slab over the counter and tiles facia shall be measured individually in smuts

5.10. VitrifiedTilesFlooring–Skirting / Rectified Tiles flooring- Skirting

The specifications in respect of material and execution process for vitrified tiles and rectified tiles flooring and skirting shall be strictly in accordance with the description itemising the BOQ as under

VitrifiedTiles: Providing and fixing in position Premium quality mirror polished /double charged Nano technology vitrified tiles in approved colour and shade conforming to IS15622 of approved make in floors, skirting, dados at all heights depths and levels laid over 20mm thick cement mortared1:4 (1cement:4coarse sand) including grouting the joints with white cement mixed with matching pigment including cost of all material, labour as per directions/ approval of the OWNER/CONSULTANT

SPECIFICATION FOR TERRACING, DAMP PROOF COURSE AND

WATER PROOFING TREATMENT

6.0 WATER PROOFING

1. Providing and applying a coat of hot bitumen 85/25 @ 1.45 kg. per sq. m. on any surfaces and area, at any location and at levels, including cleaning the surfaces with wire brush, etc. complete as per instructions of EIC.

Bitumen
Bitumen shall conform to IS: 702 and IS:73.

Workmanship
In first and third course hot bitumen is applied at the rate of 85/25 or 90/15 at the rate of 1.2 Kg per square meter or as directed byengineer-in-charge.

In second course roofing felt type 3 grade-I (hessian based self finished bitumen felt) laid over the hot bitumen and pressed properly to avoidair gaps.

In fourth and final course stone grit 6mm and down size or pea-sized gravels are spread at 6 cubic diameter per square meter.

Theguaranteebondshallbefurnishedforaperiodof10yearsasperitemno.8.01a.

Mode of Measurement andPayment: Theitemshallbemeasuredandpaidinsqm.

2. Providing and laying 4 mm thick Mineral Finished APP (Atactic Polypropyelne Polymer) modified bitumen membrane of approved make (Pidilite Industries Ltd. /
Sika India Pvt. Ltd. / STP Ltd., brand as per the Additional Specifications) over a priming coat of bitumen primer conforming to IS : 3384 @ 0.10 Litre to 0.30 Litre per sq. m. in any location and at all levels including preparation of surface, making good damages if any, laying APP membrane using butane / LPG torch with a minimum of 10 cm side laps and 15 cm end lap joints, etc. complete all as per manufacturers specifications and as directed by Engineer in charge.

NOTE:

a. 10% of the value of this item shall be retained with BNPAM for leak proof guarantee for a period of ten years from the date of completion. The same shall be refunded only

after successful waterproof performance at the end of three years from the date of completion.

b. No extra shall be paid for overlaps. a minimum of 10 cm side laps and 15 cm end lap joints, etc. complete all as per manufacturers specifications and as directed by engineer in charge

1. Membrane thickness 4mm (+ or – 5%)
2. Tensile strength – Longitudinal 790 N/5cm Transverse 730 N/5cm
3. Elongation of Membrane - Longitudinal 65% Transverse 69%
4. Tear Resistance - Longitudinal 180 N Transverse 190 N
5. Lap joint strength - Longitudinal 750 N/5cm Transverse 550 N/5cm
6. Puncture Resistance – Static 1.4 Dynamic 1.3
7. Water absorption - < 0.15%
8. Water permeability - Nil
9. Chemical resistance – Chloride, sulphate and Nitrate

The area to be water proofed shall be free from loose aggregate, dust free and in dry condition. Primer must be applied to the surface and allowed to dry prior to application of membrane. The membrane shall be applied within 6 hours after application of primer. The membrane comes in a roll form shall be unrolled and placed in the correct position where it has to be torched. Each layer must over lap the next layer by min 10cm at the adjacent and 15cm at the ends. The heat application through propane gas torch shall be applied on membrane thus causing melting and subsequent adhesion in the surface. The membrane should be properly placed and torched on in staggered position.

Mode of Measurements: The item shall be measured and paid in sqm.

3. Providing and laying integral cement based brickbat coba water proofing treatment average 115mm thick and minimum thickness at khurra as 65 mm including preparation of surface as required for treatment on roofs, balconies, terraces etc. at all floors consisting of following operations and furnishing a guarantee bond of 10 years.

i) Cleaning and applying a cement slurry at the rate 2.75 Kg per sqm mixed with water proofing compound as manufacture's specification as directed by engineer-in-charge over the slab including adjoiningwallsupto300mmheightincludingcleaningthesurfacebeforethetreatment

ii) Layingbrickbatswithmortarusingbrokenbricks/brickbats25mmto115mmsizewith50%ofcement mortar1:5(1cement:5coarsesand)admixedwithwaterproofingcompoundconformingtoIS:2645 and approved by Engineer-in-charge over 20 mm thick layer of cement mortar of mix 1:5 (1 cement:5 coarse sand) admixed with

water proofing compound conforming to IS : 2645 and approved by Engineer-in-charge to required slope and treating similarly the adjoining walls upto 300 mm height includingroundingofjunctionsofwallsandslabs.

iii) After three days of proper curing applying a second coat of cement slurry at the rate 2.75 Kg per sqm admixedwithwaterproofingcompoundconformingtoIS:2645andapprovedbyEngineer-in-charge

iv) Finishingthesurfacetomakewiredfinishwithaverage12mmthickjointlesscementmortarofmix1:4 (1 cement :4 coarse sand) admixed with water proofing compound conforming to IS :2645 and approved byEngineer-in-charge.

v) The whole terrace so finished shall be flooded with water for a minimum period of two weeks for curingandforfinaltest.All aboveoperations tobedonein orderandasdirectedandspecifiedbythe Engineer-in-Charge. (Only plan area shall be measured, vata shall not be measured separately and paidfor.)

Material
Water
Water shall conform toM-1.

CementMortar
Cement Mortar shall conform to M-11. The mortar of the specified mix using the type of sand described in the item shall beused.

Cement
Cement shall conform toM-3.

Brickbats
Brick Bat shall conform toM-15.

Water Proofing Compound
Water proofing compound shall conform toM-31.

4.0 Workmanship

Unless otherwise specified proprietary waterproofing treatment shall be executed through approved specialized waterproofing agency. Contractor shall furnish a and the tender rate shall be inclusive of the same which is also to be signed by the specialized agency. However, sole responsibility shall be of main contractor for any leakages.

Copy of work order mentioning the rate issued to the specialized agency shall be

attached with guarantee bond.

A performance guarantee bond on appropriately stamp paper shall be given by the contractor to the client in the manner form prescribed below:

Performance Guarantee for Water-Proofing Treatment for 10 years.

We have treated the roofs/balconies/toilets/OHT etc. of _____ building at **M/s Bank Note Paper Mill Mysore**. We M/s_____ being the main contractor have read and understood the scope and responsibility of the waterproofing work and we have treated the above mentioned roof surfaces/areas as per specifications mentioned in the tender document furnished by us to the BNPM.

After completion of work up to **10 years,** if at any time or times the roofs and other portions if any treated by us starts leaking or in any way get damaged to the influence of sleeping water including forming wet patches, dampness etc. either due to the inadequacy of the work carried out or due to any other reason whatsoever relating to the specification, workmanship etc. including the responsibility for any surface treatment and plumbing works etc. if any, carried out by other agencies, we **M/s** _____ hereby undertake and guarantee to carry out necessary remedial measures up to **10 years** from the date of completion of work to such extent and so often as may be necessary to free the treated areas from such leakages, dampness without any cost to the BNPM. The decision of the BNPM in regard to the question as to whether there is any leakage or the treatment has given way to water or moisture, shall be treated as final and binding on us. We also undertake to reinstate the surface disturbed to attend to the rectification work to its original condition after carrying out the rectification work, if necessary, by bringing new materials at no extra cost to the BNPM.

For Contractor

Name

Designation

Seal & sign

Date:

Note: To be submitted on Rs. 100/- stamp paper.

After awarding the contract, the contractors should clearly stipulate the type of treatment proposed to be provided by them and the name and particulars of firm through whom they propose to carry out the treatment.

The surface shall be cleaned of foreign matter such as fungus, moss, dirt and dust by wire brushing and dusting. Any cracks which may allow leakage of water shall be identified by ponding before starting the treatment

The slab surface shall be washed with water and cement slurry mixed with water proofing compound as manufacture's specification as directed by engineer-in-charge shall be applied over the slab including adjoiningwallsupto300mm height including cleaning the surface before the treatment 20 mm thick cement mortar 1:5 admixed with water proofing compound conforming to IS: 2645 and approved by Engineer-in-charge to required slope and treating similarly the adjoining walls up to 300 mm height including rounding of junctions of walls and slabs.
The surface treated shall have a minimum slope of 1 in 120 or as specified in the BN drawing. Brickbats of varying size (25 mm to 115mm) as per requirement shall be arranged in proper gradient with cement mortar 1:5 according to desired slope.
After three days of proper curing applying a second coat of cement slurry admixed with water proofing compound conforming toIS:2645 and approved by Engineer-in-charge
Finally the surface is finished with to make wired finish with 12 mm thick joint less cement mortar of mix 1:4 (1cement :4 coarse sand) admixed with water proofing compound conforming to IS : 2645 and approved by engineer-in-charge.
The whole terrace so finished shall be flooded with water for a minimum period of two weeks for curing and for final test. All above operations to be done in order and as directed and specified by the Engineer-in-Charge.

At places of construction joints and well defined cracks other than hair cracks in the treated structure shall be cut to `V' section, cleaned and then filled up flush with 1:1 cement sand mortar with polymer based water proofing compound.

The surface under treatment, par to parapet (in case of balcony or terrace) and gutters, drain mouths etc. over which the water proofing treatment is to be applied, shall be cleaned of all foreign matter such as fungus, moss and dust by wire brushing and dusting.

Drain outlet shall be suitably placed with respect to the surface gradient to ensure a pid drainage and preventing on of local accumulation of water on the treated surface.

Masonry drain mouth shall be widened sufficiently and rounded with cement mortar.

For cast iron drain outlets, a groove shall be cut all around to touch the treatment.

When a pipe passes through a roof on which water proofing treatment is to be laid, a cement concrete angle fillet shall be built round it and the water proofing treatment shall be taken over the fillet.
In case of masonry parapet wall over 450mm in height, for tucking in the water proofing treatment, a horizontal groove 75 mm. wide and 65 mm. deep at minimum height of 300 mm. above terrace level shall be left in the vertical face at the time of construction, the horizontal face of the groove shall be shaped with cement mortar 1:4.

In case of low parapet where the height does not exceed 450 mm, no groove shall be provided and the water proofing treatment shall be carried right over the top.

In case of existing R.C.C. and stone wall cutting the chase for tucking in the water proofing treatment is not recommended.

At the junction between the terrace slab and vertical face of the parapet wall, a fillet 75-100 mm. in radius shall be constructed.

At the drain mouths the fillet shall be suitably cut back and rounded of before each application of water proofing treatment for easy flow of water.

Outlet at every low dividing wall about less than 300 mm. in height shall be rounded smooth and corners rounded off or easy application of water proofing treatment.

The top surface shall be kept wired finish to receive the china mosaic. In case china mosaic is not to be provided, the surface shall be kept cement finished at 2.75kg/m2 and marked with 300x300mm false square(with string)

Mode of Measurement and Payment

The rate shall include providing water proof cement concrete terracing of adequate thickness to give desired slope for drainage of rain water from terraces.

The measurements for this item shall be taken as under:

(a) Water proofing of roof shall be measured in $m^{2.}$, plan area of treated surface shall be measured correct to a centimeter.

(b) Measurement shall be taken for the plan are for roofing/terrace.

Flashing/ rounding of treatment including flashing / rounding over the parapet wall up to 300 mm from terrace. Low dividing walls and expansion joints and at the pipe projections etc. Overlapping and tucking into flashing grooves shall not be measured extra and paid for.

(c) In measurements, no deduction shall be made for either openings or recess for chimney stacks, roof lights etc. having areas upto 0.4m2.Deduction shall be made in measurements for full opening but nothing extra shall be paid for extra labor and materials in forming such openings.

The rate includes cost of all materials and labor required to carry the works as per the above specifications. The rate also includes cleaning and hacking the RCC parapet and inverted beam surface and treating the cracks shall not be paid separately. Cutting of horizontal grooves in parapet walls for tucking in water proofing treatment shall not be measured or paid separately.

Measurements shall be based on the drawings or as executed on site, the lesser of the two shall be given. No extra payment shall be made for rounding and vata at the junction of slab & parapet. A deposit at the rate of 50% of the cost of this item from the running and final bills shall be recovered and retained for the first one year after completion of the work and 10% of the same or equivalent bank guarantee shall be retained for the balance of the guarantee period and shall be refunded only after the completion of the guarantee period.

The item shall be measured and paid in sqm.

The work is to be got done through approved specialized agency.

5.0 :- CINDER FILLING

Providing and laying cinder concrete in cement 1:15 (1 cement : 15 cinder of 12.5mm nominal gauge) in sunken slabs.

MATERIALS
Cinder is well burnt furnace residue which has been fused or center end in to lumps of varying sizes.
Cinder aggregates shall be well burnt furnace residue obtained from furnace using coal fuel only. It shall be sound clean and free from clay, dirt ash or other deleterious matter.

Mode of measurements: The item shall be measured and paid in Cum

5. Providing two coats of Acrylic co polymer base water proofing systems in sunken portion as per the FOSRACK specification and as direct at site with 10year manufactures guarantee

Note: The rates excludes bore packing.

Materials

Water

Water shall conform toM-1.

Cement Mortar

Cement Mortar shall conform to 1:3

Water Proofing Compound: Acrylic co polymer base water proofing compound Forsac Make

Workmanship:

The surface under treatment of (toilet/balcony) and gutters, drain mouths etc. over which the waterproofing treatment is to be applied, shall be cleaned of all foreign matter such as fungus, moss and dust by wire brushing and dusting.

Pressure grouting :- Pressure grouting using near cement slurry admixed with expansive grout additive. Treatment includes cutting V-grooves along the joints, cleaning and filling with polymer modified mortar and fixing up of GI nipples wherever necessary and pressure grouting, curing complete.

Hunching: _ Providing 25mm thick polymer modified cement mortar in CM 1:3 at the rate of 1 liter of SBR per bag of cement and coating with polymer modified cement slurry in 2 coats and finishing neat. Treatment includes surface preparation and curing complete.

GUGU Bolt Epoxy Filling :

Providing Nontoxic solvent free high build protective epoxy putty over the gar cut GUGU bolts of 1/2 inch depth and 1 inch wide. It should be hygienic, hard wearing, impervious, epoxy resin based ceramic tile grout with a high degree of resistance to chemical attack, abrasion and impact.The grout should not transfer taints to food stuffs and should not permit the entry of bacteria or dirt and easily maintained in a sterilization. It should be available in all colors to match the color of the tile color. It should attain very good early strength. It should possess good chemical resistance to acid, alkalis etc.

Itshouldpossessgoodtensileandflexuralstrengthandithasaverygooddynamicloadresistance

WATERTANKS,SUMP, SEPTICTANK:

Minimum 20MM thick water proof cement plaster 1:3 with proprietary water proof compound as per specialist firm's specifications including injections/ grouting of the walls /slabs as may be required for any honeycombed surface, hollows in RCC works as per specialist firm's specifications and finishing the surface smooth as directed.

CANOPY CHAJJA ETC.:

It shall be given with1:2:4 IPS finish an average 25-40 MM thick including 3% Proprietary water proofing compound laid in approved bays to be carried out.

Damp proof Course:

Shall consist of 1:3:6 plain cement concrete. Edges of damp proof course shall be straight, even and vertical. Side shuttering shall consist of wooden or steel forms and shall be strong and properly fixed so that the course does not get disturbed during compaction and mortar or cement slurry does not leak through. When forms are struck the surface should be smooth without any honey combing. The surface shall be kept wet for seven days.

Before commencing the superstructure work, the top of the damp proof course shall be cleaned thoroughly and dried. Blown type bitumen shall then be applied uniformly on the surface and side of the concrete coming in contact with flooring on the inside shall also be painted with bitumen.

Instead of concrete, Shahabad, Tandoor or granite stone of specified thickness and full width in one piece may also be used. Stones shall be set in 1:3 cement mortar mixed with approved water proofing material. After curing, the surface shall be treated with hot bitumen as specified. Adjoining walls/ bundsetc.uptoaheightof300MM with all junctions well rounded off.

RAIN WATER FROM TERRACES, BALCONY AND VERANDAH:

Surface water disposal vertical stacks in PVC or CI(as specified in the drawings and Bills of Quantities) pipes of required diameters laid up to 150MM above GL. Surface water disposal from Verandas /Balconies will be through G.I. pipes spouts as provided in the Bills of Quantities. The opening made in the terrace parapet and balcony wall strobe closed with special care and tested for water tightness before

making payments.

FLOWER
BEDS
With average 20 MM thick cement plaster 1:3inclusive of 3% proprietary water proofing compound laid to required slope to be carried over to adjoining walls and sides up to
150MMheight or to full depth of the flowerbed and junctions well rounded off.

BOX TYPE WATERPROOFING
TREATMENT:
This shall also be carried out under appropriator treatment. The Contractor shall submit the complete proposal for approval of the Employer

Basic
steps :

Plain cement concrete raft ,minimum 100MM thick or as specified shall be laid .The mix of PCC shall be cement concrete in the ratio of 1:4:8. The raft shall project about 300 MM than the finished size of RCC structure.

20 MM thick cement sand mortar mixed with water proofing powder 4% by weight of cement shall be laid on PCC and 20MM graded aggregate free from impurities shall be spread on the floor. It shall be cured for 3 days.

Then 25 MM thick rough kota or Shahabad or similar stones 600*600MM in size shall be laid flat and joined with cement-sand-mortar. This shall project 300MM all around RCC raft.

Then the surface shall be screened with cement-sand-mortar and finished smooth. RCC raft, walls, or masonry shall be constructed as designed.

Well–cured walls shall then be treated in the vertical direction by fixing a layer of Kota or Shahabad or similar stones. Treatment shall be carried out 300MM above the finished Ground level.

Treatment to floor and wall shall be scaled such that it is continuous .It shall be the responsibility of the Contractor to achieve correct slopes ,chamfers ,etc. by providing PCC in the ratio of 1:4:8 in required locations as part of items.

MEASUREMENT:

The measurements shall be in Square Meters .Rates shall included all items right from cleaning of surface to completion and the required guarantee.

The following type of failure will be judged as defective work:

Dampness
Leakage
Failure to stay in place Splitting Pulling loose Tearing Undue expansion and contraction Align at oaring etc.

GUARANTEE:

All water-proofing systems described above are to be referred as guide- lines only. The Contractor shall propose the system giving full descriptions .The system shall be guarantee for 10 years against all defects and liabilities thereof from the date of completion of the project. The guarantee shall be on Stamp paper of required value in format be approved by the OWNER/CONSULTANT. The cost of the Stamp Paper shall be to the Contractor's Account .Work shall be carried through approved specialist agency as per method of working approved by OWNER/CONSULTANT.

TECHNICAL SPECIFICATION

FOR

PLASTERING AND POINTING

9. Plastering and Pointing

9.1 Materials

Cement, sand, water and combinations shall conform to material specifications given in 2.0 to 2.2

9.2 Workmanship

9.2.1 Preparation of background surface:

The surface shall be cleaned off all dust, loose mortar droppings, traces of algae, efflorescence and other foreign matter by water or by brushing. Smooth surfaces shall be roughened by wire brushing or hacking for non-hard and hard surfaces respectively. Projections on surface shall be trimmed wherever necessary to get even surfaces. Incise of brick/stone masonry, raking of joints shall be carried out wherever necessary. The masonry shall be allowed to dry out for sufficient period before carrying out the plaster work, the masonry shall not be soaked but only damped evenly thereafter before applying the plaster.

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

9.2.2. Sequence of Operations

For external plaster, the plastering operations shall be started from the top floor and carried downwards. For internal plaster, the plastering may be started wherever the building frame, roofing, and brickwork are ready.

The surface to be plastered, shall first be prepared as described in Preparation of background surface in clause 9.2.1

The first underlay shall then be applied to ceilings. After the ceiling plaster is complete and scaffolding for the same removed, plastering on wall shall be started.

After a suitable time, interval as detailed under various types of plaster in subsequent paras, depending upon the type of mortar, the secondary layers if required shall be applied. After a further suitable time, interval as detailed under various type of plaster in subsequent paras, the finishing coat shall be applied first to the ceiling and then to the walls.

Plastering of cornices, decorative features, etc., shall be completed before the finishing coat is applied. Unless otherwise specified corners and edges shall be rounded off to a radius of 25mm, such rounding off shall be completes along with the finishing coat to prevent any joint marks showing out later.

9.2.3 Scaffolding/staging

Scaffolding/staging for plastering/pointing shall be as per Specification for Brick masonry, clauses 3.1.8

9.2.4 Damage rectification

Any cracks, damages, any part of work which sound hollow when tapped or found damaged or defective otherwise shall be cut out in rectangular shape and redone as directed by Engineer-in-charge.

9.3 Plain Cement Plaster

9.3.1 Preparation of Mortars:

The mortars of specified mix shall be used as per the specifications of 'Cement Mortar' described 3.1.2.2.

9.3.2 Application of Plaster

9.3.2.1 One-layer plaster work

To ensure even specified thickness, plaster of 150mm x 150mm shall be first applied horizontally and vertically at not more than 2-meter interval over the entire surface to serve as gauges. The surface of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall be brought

to true surface by working with a wooden straight edge reaching across the gauges with small upward and sideways movements at a time. Finally, the surface shall be finished off true with a trowel or wooden float to obtain a smooth texture. Excessive trowelling or overworking the float shall be avoided. All corners, arises, angles and junctions shall be truly vertical, horizontal and shall be carefully finished. Rounding or chamfering of corners, arises, junctions etc., shall be carried out with proper templates to the size required.

In suspending the work, the plaster shall be left, cut clean to line, both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scrapped clean and wetted before plastering the adjoining area. Plastering work shall be closed on the border of the wall and nearer than 150mm to any corners or arises and shall not be closed on the body of the features such as plaster bands, cornices nor at the corners or arises.

9.3.2.2 Two-layer plaster work

a. First or under layer

The first or underlay of the specified thickness shall be applied as described in clause no.9.3.2.1. Before the first coat hardens, surface of it shall be beaten up by edges of wooden tapers and close dents shall be made on the surface.

The subsequent coat shall be applied after this coat has been allowed to set for 3 to 5 days depending upon weather conditions. The surface shall not be allowed to dry during this period.

b. Second or finishing layer

The second layer shall be complete to the specified thickness in the same manner as for first layer

9.3.2.3 Curing

Curing shall be started 24 hours after finishing the plaster. The plaster shall be kept wet for a period of 7 days. During this period, the plaster shall be suitably protected from all damages at the contractor's expense by such means as approved by the Engineer-in-charge. The date of execution of plastering shall be marked on the plastering to ensure the proper duration of curing.

9.3.3 Sand face plaster

9.3.3.1 Preparation of mortar

The mortar of specified mix shall be used as per the specifications of cement mortar/described in clause no.3.1.2.2

9.3.3.2 Application of Plaster

Sand face plaster shall consist of 13mm thick (1 cement: 4 coarse sand by volume) under layer and 7mm thick (1 cement: 2 coarse sand by volume) top layer. Application of plaster shall be as described in two coat plaster work in clause no.9.3.2.2. b

The surface of the sand face plaster shall be finished rough with sponge or as directed by the Engineer-in-charge.

9.3.3.3 Curing

Curing shall be as described in clause 9.3.2.3

9.3.4 Exposed aggregate finish plaster

9.3.4.1 Preparation of mortar

The mortar of specified mix shall be used as per the specifications of cement mortar described (in clause no.3.1.2.2) White and coloured marble chips shall be of 6mm to 12mmm size out of Makana/Ambani, grade 1 or Dongyi Chittoor Brown/Rajnagar/ Abu green grade-1 quality. Marble dust shall be obtained from crushing hard marble stone, it shall not be less than 1.0

9.3.4.2 Application of Plaster

Exposed aggregate finish plaster shall consist of 12mm thick plain cement plaster under layer (1 cement: 4 coarse sand by volume) finished rough and 20mm thick top layer (Underlayer shall be applied in accordance with 'One-layer plaster work' described in clause no.9.3.2.1)

Top layer shall be 20mm thick admixture of white cement and grey cement (mix ratio 1:1 by volume) mixed with white/coloured marble chips/pebbles of 6mm to 12mm nominal size as per item description. Mix ratio shall be 1 cement: 1 marble chips/pebbles by volume. Marble dust @ 15% by volume shall be added to the admixture. The pebbles to be used shall be well washed and drained. The admixture shall be thrown wet on the under layer while it is still plastic using strong whipping motion at right angles to the face of the wall. One coat of neat cement slurry @ 2.75 kg cement per square meter of area shall be applied on to the under layer to receive the top layer. The whole plastering laid in panels as per drawing with 12mm x 20mm grooves in between formed by holding removable wooden batons of 12mm x 25mm size over the under layer.

The top layer admixture pressed flat over the under-layer filling uncovered parts by hand, so that the finished surface represents a homogeneous surface. Loose mortar etc., on the top surface shall be cleaned/removed by brushing/washing/spraying with water jet after initial setting of mortar.

9.3.4.3 Curing

Curing shall be as described in clause no.9.3.2.3

9.3.5 Pointing

Pointing shall be of the type specified such as flush, cut or weather struck, raised and cut etc.,

9.3.5.1 Preparation of base surface

The joints shall be raked to such a depth that the minimum depth of the new mortar measured from either the sunk surface of the finished pointing or from the edge of the brick shall be less than 20mm.

9.3.5.2 Mortar

Mortar shall be in accordance with the specifications of cement mortar described in clause no.3.1.2.2

a. Application of mortar and finishing

The mortar shall be pressed into the raked-out joints with a pointing trowel according to the type of pointing specified, the mortar shall be

spread over the corner edges or surfaces of the masonry. The pointing shall then be finished with the pointed tool. The superfluous mortar shall be cut off from the edges.

9.3.6.1 Flush pointing

The mortar shall be pressed into joints and shall be finished off flush and levelled. The edges shall be neatly trimmed with trowel and straight edges.

9.3.6.2 Cut or Weather struck pointing

The mortar shall first be pressed into joints, the top of the horizontal joints shall then be neatly pressed back by about 15mm with the pointing tool so that the joint is sloping from top to bottom. The vertical joint shall also be similarly pointed. The junctions of vertical joints with the horizontal joints shall be at true right angles in case of brick and coursed rubble masonry.

9.3.6.3 Raised and cut pointing

This type of pointing shall project from the wall facing with its edges cut parallel so as to have a uniformly raised band about 6mm and width 10mm more as directed. The pointing shall be finished to a smooth but hard surface.

9.3.6.4 Curing

Curing shall be as described in clause no.9.3.2.3

9.3.7 Measurement and Rate

9.3.7.1 The description of each item, unless otherwise mentioned includes wherever necessary all material, conveyance and delivery, handling, loading/unloading, storing, fabrication, hoisting, all labour for finishing the work, preparation of background surface, staging/scaffolding, application, finishing, removal of staging/scaffolding, curing and other incidental charges. The rate shall be for all heights and at all heights of work.

9.3.7.2 Plastering

Thickness of the plaster shall be the minimum thickness at any point on a surface and shall be exclusive of the key i.e. grooves or open joints in masonry. No extra payment shall be allowed for extra thickness of plaster done by contractor, drip moulds, rounding of edges making grooves, etc.,

All plastering/pointing shall be measured in square meters unless otherwise specified, length, breadth / height shall be measured correct to 0.1 meters. Soffits of stairs shall be measured as plastering on ceiling. Ceiling with projected beams shall be measured over beams and plastered side of beam shall be measured and added on ceiling.

Deductions and additions shall be made in the following manner:

a) No deductions shall be made for ends of joists, beams, posts, openings not exceeding 0.5 sqm area and no addition shall be made for reveals, jambs, soffits etc., of these openings mortar finish to plaster around ends of joists, beams, posts etc.,

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

i When two faces of wall are plastered with different types of plasters or if one face is plastered and the other pointed, deduction shall be made from the plaster or pointing on the side of frame for door, window etc., on which width of reveals in lesser, but no deduction shall be made on the other side. Where widths of reveals on both faces of wall are equal, deduction of 50% of area of opening on each face shall be made.

ii When only one face is plastered, full deduction shall be made from plaster if width of reveal on plastered side is lesser. But if widths of reveal on both sides are equal or more on unflustered side, no deduction shall be made.

c) In case of openings of area above 3 sqm each, deduction shall be made for openings but jambs, soffits and sills shall be measured.

9.3.7.3 Pointing

Pointing shall be measured in square meter and deductions shall be done in accordance with clause no.9.3.7.2

9.4 PROVIDING AND FIXING CHICKEN WIRE MESH

The wire mesh shall be of 24 gauge and it shall be fixed with nails at the junction of brick masonry and RCC elements. The chicken wire mesh shall not sag in between the nails. This shall be done before the application of plaster.

Mode of measurement.

It shall be measured in sq. Measurement shall be taken before the application of the plaster. The rate includes for carrying out the work at all heights.

9.4 Providing and applying rough cast plaster

This shall be carried out in two layers. The base plaster shall be of 22mm thick and of specified proportion of CM. It shall be roughened to receive the top layer. The top layer shall be 7mmthick. It shall be of 3 parts cement, 6 parts course sand & 4 parts of 6mm to 10mm single. Or crushed stone aggregate. The plaster shall be cured at least for 7 days.

Mode of measurement.

It shall be same as that of cement plaster.

9.5 Providing and applying water proof cement plaster

The plaster shall be of specified thickness and of mortar proportions. The contractor shall use approved waterproofing admixture made by reputed manufacturer in the mortar for plaster work. The quantity to be used shall be in accordance with the manufacturer's instructions, however subjected to the approval of the OWNER/CONSULTANT. The use of calcium chloride shall be prohibited unless specifically allowed by engineer and shall conform to IS:2645. The plaster shall be cured at least for 7 days.

Mode of measurement

It shall be measured in sq. The rate shall include the double scaffolding., plastering and curing. The amount of water proofing material added shall be measured and paid for separately

SPECIFICATION

FOR

PAINTING AND POLISHING.

10. WHITE WASHING, COLOUR WASHING, DISTEMPERING, PAINTING AND POLISHING

10.1 General

Reference shall be made to the following Indian Standards:

IS: 6278	**:**	**Code of practice for white washing and colour washing.**
IS: 2395	**:**	**Code of practice for painting concrete, masonry and plaster surfaces.**
IS: 712	**:**	**Specification for building limes.**
IS: 55	**:**	**Specification for Ultramarine blue for paints.**
IS: 63	**:**	**Specification for whiting for paint and putty.**
IS: 427	**:**	**Distemper (dry) colour as required.**
IS: 428	**:**	**Distemper (Oil bound) colour as required.**
IS: 5411	**:**	**Specification for plastic emulsion paint for interior use.**
IS: 2338	**:**	**Code of practice for finishing of wood and wood (Part I, II) Based Materials**
IS: 5410	**:**	**Cement paint, colour as required.**
IS: 2524	**:**	**Code of practice for painting nonferrous metals in buildings**
IS: 384	**:**	**Brushes, paints and varnishes, flat.**
IS: 486	**:**	**Brushes, sash, tool for paints and varnishes**
IS: 110	**:**	**ready mixed paint, brushing, grey filler enamels for use over primers.**
IS: 426	**:**	**Paste filler for colour coats.**
IS: 345	**:**	**Wood filler, transparent liquid**
IS: 3585	**:**	**Ready mixed paint, aluminium brushing priming water resistant for woodwork.**
IS: 426	**:**	**Paste filler for colour coats.**
IS: 106	**:**	**Ready mixed paint, brushing, priming for enamels, for use on metals.**

10.1.1 All materials required for the execution of painting work shall be obtained direct from approved manufacturers and shall be brought to the site in makers drums, keys etc., with seals unbroken.

If in case of ready mixed paints, thinning if necessary the brand of thinner shall be as per recommendations of the manufacturer

Paint shall be applied by brushing or spraying. The brushing operations are to be adjusted to the spreading capacity advised by the manufacturer. During painting, every time after the paint has been worked out of the brush bristles, the bristles shall be opened up by striking the brush suitably.

Spray machine used may be of high-pressure type or low pressure depending on the nature and location of work. After work, the brushes shall be completely cleaned off paint and shall be hung in a thinner if intended to be used afterwards. The spray guns shall be cleaned thoroughly after every break in work. The paint containers, when not used shall be kept close and free from air.

After the finishing of work, the adjacent surfaces not intended to be washed/distempered/painted/polished, shall be thoroughly cleaned of all paint patches and shall be finished in accordance with surface finishing of such surfaces.

10.2 White washing

White washing in general shall conform to IS:6278

10.2.1 Workmanship

10.2.1.1 Scaffolding

Wherever scaffolding is necessary, it shall be erected in such a way that as far as possible no part of scaffolding shall rest against the surface to be white/ colour washed. For white washing of ceiling, proper stage scaffolding shall be erected.

10.2.1.2 Preparation of surfaces

The surface shall be thoroughly cleaned of all dirt, dust, mortar dropping and other foreign matter before white wash is to be applied.

All holes, cracks, patches etc., not exceeding 0.1 sqm in area shall be made good with material similar to that of the surface. Surface affected by efflorescence, moss, fungi, algae, lichen etc., shall be treated in accordance with IS:2395.

10.2.1.3 Preparation of white wash

a) Pre-prepared lime wash like "Janata-Cen" may be used with prior approval of the Engineer-in-Charge.

10.2.1.4 Application

White wash shall be applied with brush to the specified number of coats. The operation for each coat shall consist of stroke of the brush from the top to down wards, another from the down to upwards over the first stroke, similarly one stroke horizontally from right and another stroke from the left. Each coat shall be allowed to dry before the next coat is applied.

The white washing on ceiling should be done prior to that on walls.

10.2.1.5 Protective measures

Surfaces of doors, windows, floors, etc., which are not to be white washed shall be protected from being splashed upon. Such surfaces shall be cleaned of white wash splashed if any.

10.3. Oil bound distempering

10.3.1. Workmanship

10.3.1.1. Scaffolding

Same as in clause no.10.2.1.1

10.3.1.2 Preparation of surface

Pre-surface shall be thoroughly brushed free from dust, grease, mortar dropping, other foreign matter and shall be made smooth by sand papering up to the satisfaction of Engineer-in-charge and unevenness shall be made good by applying putty made of plaster of Paris mixed with water including filling up the undulation and then sand papering the same after it is dry.

10.3.1.3 Primer coat

The primer coat shall be alkali resistant primer or distemper primer and shall be of the same manufacture as oil bound distemper.

If the wall surface plaster has not dried completely, alkali resistant primer otherwise distemper primer shall be applied. The mixture of alkali resistant primer shall be prepared as per approved manufacturer's instructions.

The application of primer coat shall be in accordance with 10.2.1.4

10.3.1.4 Preparation of oil bound distemper

The distemper shall conform to IS:428 and shall be diluted with water or any other prescribed thinner recommended by the manufacturer.

10.3.1.5 Application of distemper

After the priming coat has dried for at least 48 hours, the surface shall be lightly sand papered and dusted off avoiding rubbing off of the priming coat.

Prepared distemper shall then be applied in minimum two coats with proper distemper brushes in horizontal strokes immediately followed by vertical ones which together shall constitute one coat. The subsequent coats shall be applied only after the previous coat has dried. The finishedsurface shall be even and uniform without patches, marks, distemper drops etc., The application of a coat in each room shall be finished in one operation. After each day's work, brushes shall be thoroughly washed in hot water and hung down to dry.

10.3.1.6 Protective measure

Same as in clause in 10.2.1.5

10.4 Waterproof cement paint

10.4.1 Workmanship

10.4.1.1 Scaffolding

Same as in clause no.10.2.1.1.

10.4.1.2 Preparation of surface

Preparation of surface shall in general be in accordance with clause no.10.2.1.2 except that any unevenness shall be made good by applying putty made of plaster of Paris mixed with water including filling up the undulation and then sand papering the same after it is dry.

10.4.1.3 Primer coat

The primer coat of cement primer of same manufacture as the cement paint shall be applied as in clause 10.2.1.4

10.4.1.4 Preparation of paint

Waterproof cement paint of approved make shall be mixed with water and stirred to obtain a thick paste which shall then be diluted tobrush able consistency. The proportion of mixture shall beas manufacturer's recommendation. The paint shall be mixed in such quantity which can be used up within an hour of mixing to avoid setting and thickening of the paint.

10.4.1.5 Application of paint

The surface shall be treated with minimum two coats of waterproof cement paint. No less than 24 hours shall be allowed between two coats and the subsequent coats shall be applied only after the preceding coat has become hard to resist marking by subsequent brushing.

The finished surface shall be even and uniform in shade without patches brush marks, paint drops etc., Cement paints shall be applied with a brush with relatively short stiff hog of fibre bristles.

10.4.1.6 Curing

Curing shall be started after the paint has hardened. Curing shall be done by sprinkling with water two or three times a day. This shall be done between coats and for at least two days following the final coat.

10.4.1.7 Protective measure

Same as in clause in 10.2.1.5

10.5.1 Acrylic emulsion painting

10.5.1.1 Workmanship

10.5.1.1.1 Scaffolding

Same as in clause 10.2.1.1

10.5.1.1.2 Preparation of surface

Same as in clause –10.2.1.2 under specification of oil bound distempering

10.5.1.1.3 Preparation of mix.

Plastic emulsion paint shall conform to IS:5411 (Part-1) and shall be of approved shade. Preparation of mix shall be as per manufacturer's instructions.

10.5.1.1.4 Application of paint

The paint mix shall be continuously stirred while applying for maintaining uniform consistency. Number of coats shall be as per item description. The painting shall be laid evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard at first, then brushing alternately in opposite direction 2/3 times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks, no hair marks no clogging of paint puddles shall be permitted. The full process of crossing and laying off will constitute one coat.

The paint shall be applied by means of brush or roller.

Before starting painting with plastic emulsion paint, the prepared surface shall be treated with two coats of primer consisting of cement primer, whiting and plastic emulsion paint shall start only after the preceding coat has become sufficiently hard to resist brush marking. Subsequent coats of plastic emulsion paint shall also be started after the preceding coat is dried by evaporation of water content.

The surface on finishing shall present a flat, velvety smooth finish, even and uniform shade without patches, marks, paint drops etc.,

10.5.1.1.5 Precautions

I) Brushes shall be quickly washed in water immediately after use and kept immersed in water during break periods to prevent the paint from hardening on the brush. Old brushes, it used shall be completely dried of turpentine/oil paints by washing in warm soap water.

ii) No oil base putties shall be used in filling cracks/holes.

ii) Washing of painted surface shall not be done within 3-4 weeks of application.

10.5.1.1.6 Protective measures

Same as in clause 10.2.1.5

10.6.1 Acrylic Copolymer aggregate finish

10.6.1.1 Material

It shall be an acrylic based textured wall coating consisting of quartz and silica aggregate, inorganic pigments and other additives to form a crack free, flexible, tough, waterproof coating.

10.6.1.2 Preparation of surface

The surface to be coated shall be cleaned and all dirt, dust, grease and loose particles shall be removed. Any old textured surface shall be removed with removing agent as per manufacturer's instructions.

10.6.1.3 Application

Bonding agent and water shall be mixed first. Then the flakes/granules shall be added and mixed thoroughly and kneaded till no lumps are found. The dough shall be left for 20-30 minutes before starting application. The bonding agent, flakes/granules and water shall be mixed in different ratios for different finishes as per manufacturer's specifications.

The first application shall be by steel trowel. It shall be smoothened, if the specified finish requires, by a plastic trowel.

10.7.1 Painting wood and wood-based material

Synthetic enamel paint: It shall be confirmed to IS: 2932 of approved brand and colour shall be used.

10.7.1.2 Preparation of surface

Preparation of surface shall conform to IS:2338 (Part-1) in general. All woodwork shall be dry and free from any foreign matter. Nails shall be punched well below the surface. The surface shall be smoothened off with abrasive paper used across the grain prior to painting with the grain prior to the staining. Any knots, resinous, or bluish sap wood, cutting out of which is not justified shall be covered with red lead conforming to IS:103

Plywood and block board shall be treated in the same manner as for wood work.

Particle boards surface shall be filled with a thin brush able filler and finished as for solid wood.

10.7.1.2 Priming

Priming shall be in accordance with IS:2338 (Part I and II). Dirt or any other extraneous material on the surface shall be removed and the priming shall be applied by brushing.

Priming shall be done on all exposed and unexposed surfaces. Unless specific otherwise all joinery work intended to be painted shall receive at least 2 coats of primer.

Type of primer shall be in accordance with Table-1 and Table-2 of IS:2338 (Part-II)

10.7.1.3 Stopping and filling

Stopping and filling shall be done after priming. Stopping shall be made to the consistency of stiff paste and shall be used to fill holes and cracks. Filler shall be used to level up slight irregularities of the surface. Filler shall be

applied with a putty knife and subsequently rubbed down to a level surface with abrasive paper.

The filler coat shall be allowed to fully flatten and harden before subsequent coat is applied.

10.7.1.4 Application of Under coat

Under coat shall be applied after the surface has been primed, stopped and filled, and rubbed down to a smooth surface. Under coat may be brushed or sprayed. After drying the coat shall be carefully rubbed down and wiped clean before the next coat is applied.

The type of under coat shall be depending upon the finishing and in accordance with Table-1 and Table-2 of IS:2338 (Part- II)

10.7.1.5 Finishing

The finishing paint shall be as specified in the item description and shall be applied either by the brush or by spraying.

Reference shall be made to the Table-1 and Table-2 of IS:2338 (Part-II)

10.7.2 Application of clear finishes

For the application of clear finishes, the following procedures shall generally be adopted in accordance with IS:2338 (Part-I)

I) Filling
ii) Staining
iii) Sealing
iv) Finishing

10.7.2.1 Filling

Fillers shall be applied to prevent the excessive penetration of the finish to the surface for obtaining a smooth finish. Fillers shall be conforming to IS:345

Fillers shall be heavily applied to the wood surface by hand, using hessian or jute rag across the grain. It shall be rubbed when still wet to get better penetration. After 5-10 minutes it shall be wiped off by hand across the

grain followed by a light wipe with the grain. The filled surface shall be dried preferably overnight and smoothened with abrasive paper.

10.7.2.2 Staining

a. Spirit Stains

Spirit stains are solutions of spirit soluble dyes in industrial methylated spirit.

b. Oil stains

Oil stains are solutions of oil soluble dyes in linseed oil, but, usually consist of insoluble, semi-transparent pigments ground in linseed oil and thinned with turpentine or other solvent.

c. Preparation of wood for staining

Surface intended for staining shall be kept scrupulously clean and free from greasy finger marks. It shall be prepared by careful smoothening with fine abrasive paper used in the direction of the grain.

Small cracks/nail holes shall be stopped with plastic wood/fine plaster of Paris. The stopping shall be rubbed down with fine abrasive paper when hard and touched with a thinned knotting before staining. Inciseof oil staining stopping shall be done after staining using tinted putty or wood filler.

d. Application of stains

Stains shall be applied by brushing, and wiping or by spraying. The stain shall be so thinned that it can be applied fairly, liberally without over staining and over lapping.

10.7.3 Sealing

A suitable sealer shall be applied on the filled and sanded surface to prevent absorption by the wood of the succeeding coats of finish and to seal stain and filler and thus preclude their bleeding into the finish coat.

Sealer may be sprayed on taking care not to flood the surface and it shall be allowed to dry hard.

When fully dry the surface shall be sanded taking care not to cut through at corners and edges. Dust shall be blown off and surface wiped with a clean rag.

10.7.3.1 Finishing

The stained surface shall be varnished, wax-polished or French polished as required after it is dried.

10.7.4 Varnishing

Varnishing of wood and wood-based material shall be in accordance with IS:2338 (Part-I)

Surfaces to be varnished shall be prepared to produce a smooth, dry and matt surface and all dust and dirt shall be removed from the surface.

The varnish, shall be applied liberally with a brush and spread evenly over a portion of the surface with short light strokes to avoid frothing. It shall be allowed to flow out while the next section is being laid in. Excess varnish shall be scrapped out of the brush and then the first section be crossed, re-crossed and laid off lightly. The varnish, once it has begun to set, shall not be retouched in case of any mistake, the varnish shall be removed and the work shall be started afresh.

Where two coats of varnish are applied, the first coat shall be a hard drying under coating or flatting varnish which shall be allowed to dry hard and then be flatted down before applying the finishing coat. Sufficient time shall be allowed in between two coats.
When flat varnishing is used for finishing, a preparatory coat of hard drying undercoating of flatting varnish shall first be applied and shall be allowed to harden thoroughly. It shall then be lightly rubbed down before the flat varnish is applied. On larger areas, the flat varnish shall be applied rapidly, and the edges of each patch applied shall not be allowed to set, but shall be followed up whilst in free working conditions.

10.7.5 French Polish

French polish shall conform to IS:348. Suitable pigments shall be added to get the required colour.

The surface to be French polished shall be rubbed down to smoothness with sand paper and shall be well dusted. Pores in the surface shall be filled up with fillers.

A pad of woollen cloth covered by a fine cloth shall be used to apply the finish. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles applying the polish sparingly but uniformly over the entire area to give an even surface. A trace of linseed oil may be used on the face of the pad for the purpose. The surface shall be allowed to dry and the remaining coats applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit and rubbed lightly and quickly with circular motions. The finished surface shall have a uniform texture and high gloss.

10.8.1 Painting of steel and other metal surface

10.8.1.1 General

Reference shall be made to the following Indian Standards IS:2524, IS:1447

10.8.1.2 Preparation of surface

The surface, before painting shall be cleaned of all rust, scale, dirt and other foreign matter with wire brushes, steel wool, scrappers, sand paper etc., The surface shall then be wiped finally with mineral turpentine which shall then be removed of grease etc., The surface then shall be allowed to dry. In case of GI surface, surface so prepared shall be treated with Mordant solution (5 litres for about 100 sqm) by rubbing the solution generously with brush. After about half an hour, the surface if required shall be retouched and washed down thoroughly with clean cold water and allowed to dry.

10.8.1.3 Application of priming and paints

Approved quality primer and paint in specified no. of coats shall be applied as per manufacturer's recommendations either by brushing or spraying. Each subsequent coat shall be applied only after the preceding coat is dried.

Measurement and rate (where painting is not included in the relevant description of item in the bills of quantities)

All work shall be measured in areas. Areas shall be worked out to the nearest 0.01 sqm and all dimensions to the nearest 0.01 metre.

Deductions shall be made in accordance with IS specification For Method of measurements

The equivalent area will be worked out in accordance with IS:1200. The rate shall include the cost of all materials, labour, scaffolding, protective measures etc., and all works involved in specification. The rate shall also include if not mentioned otherwise, conveyance, delivery, handling, unloading, storing etc.,

11.17 Providing and Fixing MS gate.

It shall be as per the drawing. The welding shall be perfect and the junctions shall be ground properly. The gate shall be provided with locking arrangements, hinges and it shall be painted with one coat of primer and two coats of approved synthetic enamel paint.

11.21.1 Mode of Measurement

All the members of the gate shall be measured in unit lengths and the same shall be converted into weight using standard steel tables. The payment shall be made in kg.

11.18 Providing and Fixing GI pipe railing

It shall be done with the specified class of GI pipe as per the item in the Schedule of Quantities. The design shall be as per the drawings/ instructions. All necessary specials, bends, elbows. Tees and holdfasts or clamps shall be provided. If the pipe railing is to be fixed on ground or

brick work, it shall be done by embedding the holdfasts, as directed by the Engineer, in concrete blocks PCC 1:2:4 (1 cement, 2 sand, 4 graded coarse aggregate of size 12 mm and down). If it is to be fixed to an RCC member, the pipe shall be welded to the steel plate by embedding it in the RCC member.

Mode of Measurement

The running length of the railing shall be measured. The verticals shall not be paid separately.

11.19 Textured Paint

General procedure for Texture Finish or Stucco Paint • Sand papering, cleaning the surface properly • Filling the cracks/holes with plaster of Paris • Applying one coat of double boiled linseed oil with mixed cement primer. • Providing a coat of lambi/putty to the full surface • Sand papering the putty works and applying second coat of cement primer • Sand papering the surface and making 'texture finish' using roller or by hand as required. (Using Zinc moist + enamel paint + whiting) • Then painting with two coats of luster paint.

11.20 Oil Paint:-

Oil paint shall be of the specified colour and shade, and approved by the Architect/Engineer-in-charge. The ready mixed paints shall only be used. However, if ready mixed paint of specified shade or tint is not available, while ready mixed paint with approved strainer will be allowed. In such a case the contractor shall ensure that the shade of the paint so allowed shall be uniform. All the paints shall meet with the following general requirements: I. Paint shall not show excessive setting in a freshly opened full tin and shall easily be mixed with a paddle to a smooth homogeneous state. The paint shall show not cording; livening, caking or colour separation and the same shall be free from lumps and skins. II. The paint as received shall brush easily, possess good leveling properties and show no running or sagging tendencies. III. The paint shall not skin wittin.48hours in a three-quartered filled closed container. IV. The paint shall dry to a smooth uniform finish free from roughness, grit, unevenness and other imperfections. Ready mixed paint shall be used exactly as received from the manufactures and generally according to their instruction and without any admixtures, whatsoever.

11.21 MALAMINE POLISH:- Melamine emulsion to be used for polish work shall be of reputed manufacturer or approved type. Sealers and strainers approved by

manufacturer shall be used. Melamine polish shall be canted out on properly primed surface using spray equipment only.

11.22.1 Mode of Measurement

Painting works of plain surfaces measured as usual i.e. Length x Width = Area • If any delicate or intricate areas with designs, grooves, curves, moulding etc., are involved, the mode of measurements for such works shall be indicated by the 'Contractor' on the basis of the actual conditions obtaining at site and approval by the Architects, prior to taking up such works in hand. • Glass doors/windows with mouldings and sash bars to be painted both sides in single shade will be measured on one side only and multiplied by 2.25 times i.e. length x breadth x 2.5 times. No extra measurements for moulding, window jamb thickness etc. Also no deductions for glass openings etc. • Ordinary windows painted on both sides shall be measured on one side only (wall to wall including jambs) and multiplied by 1.5 times i.e. length x breadth x 1.5 times no deduction for glass panes. • M.S. grills shall be measured on one side and multiplied by 2 times i.e. length x breadth x 2 times. • All non painted or polished surfaces shall be thoroughly cleaned without scratches or any kind of damage before handing over and nothing extra shall be payable for cleaning of these items like, windowpanes, flooring, partitions etc

SPECIFICATION

FOR

SANITARY PLUMBING SEWERAGE AND WATER SUPPLY WORKS

TECHNICAL SPECIFICATIONS FOR PLUMBING WORKS

1. MATERIALS

1.0GENERAL:

All materials shall be of the best-approved quality obtainable and unless otherwise specified they shall conform to the respective Bureau of Indian Standard specifications.

Samples of all materials shall be got approved before placing order and the approved samples shall be deposited with the Employer.

In case of non – availability of materials in metric size, the nearest size in FPS units must not be provided with prior approval of the Employer / Consultants for which neither extra will be paid nor shall any rebate be recovered.

If directed / found necessary, materials shall be tested in any testing laboratory selected by the Employer and the Contractor shall produce the test results to the Consultant for his scrutiny and approval. The entire charges for original as well as repeated tests shall be borne by the Contractor. If required, the Contractor shall arrange to test portion of work at his own cost in order to prove the soundness of the same, to the Employer / Consultant or their representatives. The work or portion of work if found to be not satisfactory in the opinion of the Employer / Consultant or their representatives, Contractor shall pull down and re – do the same at his own cost. All defective materials shall be removed from the site immediately as ordered.

It shall be obligatory for the contractor to furnish certificates, if so demanded by the Employer / Consultant from manufacturer or the material supplier, that the

work has been carried out by using their material and installed / fixed as per their recommendations.

1.1 GENERAL:

Equipment offered for supply and installation shall include the following:

All minor items and incidental work, equipment accessories and materials may not be specifically mentioned but are required for the proper completion of the installations in accordance with the true intent and meaning of this specification.

All necessary safety devices for the protection of personnel against injury and the protection of plant and equipment against damage including relief valves, belt guards, fan inlet and / or discharge guards, safety railing effective earthling of electrical components, electrical interlocks, warning lights and alarms.

Readily accessible, dust-proof includes facilities on all moving parts and equipment including provision for cleaning all lubricating lines and bearings and charging same with the correct lubricants after installation but prior to testing and commissioning.

Clearly visible and robust manufacturer's name-plates permanently fitted each and every item of equipment and showing the manufacturer's name, type and/or model number, serial number, and all essential operating data such as speed, capacity, voltage, current draw, etc.

The contractor also shall allow provision for the inspection of all plant and equipment by the manufacturer or his licensed representative, at least twice during the course of the installation.

A.1.0 WATER SUPPLY:

A.1.1 All pipe used for toilet internals, kitchen internal and external piping, ring main pipe (for cold water application only) shall be of chlorinated polyvinyl chloride (CPVC), made as per ASTM–D 2846 from 15 mm die to 50mm dia. They shall be sound with good surface finish, mechanical strength and capacity. They shall be of the diameter (nominal bore) as specified in the item's specification / as directed by the consultants, nominal bore, of the pipes for which they are intended.

DIMENSIONS: CPVC shall confirm to the following thickness and weight for various dimensions.

Nominal Pipe Size (Inch)	Mean Outside Diameter		Minimum Wall Thickness		Nominal Weight
	Inch	mm	Inch	mm	Kg / m
½	0.840	21.34	0.147	3.73	0.337
¾	1.050	26.67	0.154	3.91	0.457
1	1.315	33.40	0.179	4.55	0.671
1- ¼	1.660	42.16	0.191	4.85	0.928
1- ½	1.900	48.26	0.200	5.08	1.13
2	2.375	60.33	0.218	5.54	1.56

A.1.2 PIPE FITTINGS:

The fittings shall be of CPVC and brass with female screwed ends as called for in the specification complying with all the appropriate requirements given in Para A.1.1 or as specified. The fitting shall be designated by the respective nominal bores of the pipes for which they are intended.

The fittings where the taps, stop cock, mixer fitting, are intended to be fixed, shall be of brass body and shall have screw threads at the ends / female threads or fittings shall be parallel and male threads (except on running nipples and collars of unions) shall be tapered. Unions shall be provided at regular intervals in the pipelines for easy Maintenance / Repair / Replacement of pipes.

A.1.3 CUTTING:

CPVC pipes shall be cut with a wheel – Type plastic tubing cutter, a hacksaw or other fine-toothed hand or power saws. Use of ratchet cutters shall be permitted provided blades are sharpened regularly. A mitre box should be used to ensure a square cut when using a saw. CPVC pipes shall be cut as squarely as possible to provide optimal bonding area within the joint. If any indication of damage or cracking is evident at the tubing end, the pipe shall be cut off at least 2 inches (5cm) beyond any visible crack.

A.1.4 The pipes shall be cleaned of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of lock lite wrapped round the screwed in the socket, tee etc., with the pipe wrench. Care should be taken that all pipes and fittings are properly jointed so as to take the joints completely watertight and pipes are kept at all time free from dust and dirt during the fixing. Burr from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporally plugged to prevent access of water, soil or any other foreign matter.

Any threads exposed after jointing shall be painted or in the case of underground piping thickly coated with approved anticorrosive paint to prevent corrosion / wrapped with 4 mm thick pipe running below ground level shall be laid at a minimum depth 600mm.

A1.4 <u>DEBURRING / BEVELING:</u>

Burrs and filings can prevent proper contact between tube and fitting during assembly, and should be removed from the outside and inside of the tubing. A chamfering tool is preferred but a pocketknife or files are suitable for this purpose. A slight bevel on the end of the tubing will ease entry of the tubing into the fitting socket and minimize the chances of pushing solvent cement to the bottom of the joint.

A.1.5 PRIMER / CLEANER APPLICATION:

Primer or cleaner shall be applied for preparing the bonding area for the addition of cement and subsequent assembly. A proper applicator shall only be used. A dauber or natural bristle paint brush approximately ½ the size of the tubing diameter shall be appropriate. Apply primer to both the outside of the tubing end and in the fitting socket. Primer should not be allowed to puddle in the fitting.

A.1.6 SOLVENT CEMENT APPLICATION:

FOR MAKING JOINT ONLY CPVC CEMENT OR AN ALL – PURPOSE CEMENT CONFIRMING TO ASTM F- 493 SHALL ONLY BE USED. When the primed pipe and fitting surfaces are dry, apply a thin coat inside the fitting socket.

A.1.7 LAYING AND JOINTING:

The pipes and fittings shall be inspected at site before use, to ascertain that they confirm to the specification given in parA1.1. The defective pipe shall be rejected. Where the pipes have to be cut or jointed the ends shall be carefully filed, so that no obstruction to bore is offered. The jointing to be dry fit checked. A thick coat of solvent cement shall be applied to the outer surface of the socket by mean of a brush. Solvent cement shall be of approved and of good quality ASTM – F493. The pipe shall be then inserted is to the fitting and turned 90 degree to ensure even distribution of solvent cement with in the joint. Excess solvent cement shall be wiped off. Properly align the fitting. Hold the assembly

for approximately 10 seconds, allowing the joint to set – up. An even bead of cement should evident around the joint. If this bead is not continuous around the socket edge, it may indicate that insufficient cement was applied. In this case, remake the joint to avoid potential leaks. Wipe excess cement from the tubing and surfaces for an attractive professional appearance. Clamps / pipe hooks a required size shall be used for clamping the pipe to the walls.

A.1.8 SET AND CURE TIMES:

Solvent cement set and cure times are a function of pipe size, temperature, and relative humidity. Curing time is shorter for drier environments, smaller size, and higher temperatures. Refer to the following table for minimum cure time after the last joint has been made of before pressure testing can begin.

A.1.9 MINIMUM CURE PRIOR TO PRESSURE TESTING AT 150 PSI (10 BAR)

AMBIENT TEMPERATURE DURING CURE PERIOD	PIPE SIZES ½" – 1"	PIPE SIZES 1 ¼" – 2"
Above 15^0 C	1 Hour	2 Hours
4-15^0 C	2 Hours	4 Hours
Below 4^0 C	4 Hours	8 Hours

Special care should be exercised when assembling CPVC systems in extremely low temperature (below 4^0 C) or extremely high temperature (above 38^0 C). In

extremely hot temperatures, care should be taken to ensure both surfaces to be jointed are still wet with cement when putting them together.

A.1.10 TESTING:

Once an installation is completed and cured per these recommendations, the systems should be hydrostatically pressure tested. 10bar (150 PSI) for one hour is recommended. When pressure testing, the system should be filled with water and all air bled from the highest and farthest points in the run. If a leak is found, the joint must be cut out and discarded. A new section should be installed using couplings. During sub – freezing temperatures, water should be blown out of the lines after testing to eliminate potential damage from freezing.

A.1.11 HANDLING AND STORAGE:

CPVC is a tough, corrosion resistant material, but it does not have the mechanical strength of metal. Reasonable care should be exercised in handling CPVC pipes and fittings. They should not be dropped, stepped on, nor have objects thrown on them. If improper handling or heavy impact results in cracks, splits, or gouge, the damaged section shall be discarded. CPVC tubing should be covered with a non-transparent material when stored outdoors for long periods of time.

A.1.12 HANGERS AND SUPPORTS:

For vertical runs supports shall be provided a at each floor level, plus a mid – story guide. For horizontal runs, supports shall be provided at three-foot (90-cm) intervals for diameters of one inch and below and at four-foot (1.2 m) intervals for larger sizes. Piping should not be anchored tightly to supports, but rather secured with smooth straps or hangers that allow for movement caused by expansion and contraction. Most hangers designed for metal pipe are suitable for CPVC. Hangers shall not have rough or sharp edges which come in contact with the tubing.

A.1.13 HORIZONTIAL AND VERTICAL SUPPORT:

A typical Cold-water distribution system operating at 26^0-30^0 C supports shall be provided for horizontal lines at every 3' (90cm) for sizes ½" – 1", and every 4' (120 cm) on sizes larger than 1". However, the following spacing shall be used at water temperatures indicated.

SPACING							
Nominal Pipe size (In)	**21^0 C (70^0 F)**		**49^0C (120^0 F)**		**71^0C (160^0 F)**		**82^0 C (180^0 F)**	
	FTM		**FTM**		**FTM**		**FTM**	
½	**5.5**	**1.7**	**4.5**	**1.4**	**3.0**	**0.9**	**2.5**	**0.8**
¾	**5.5**	**1.7**	**5.0**	**1.5**	**3.0**	**0.9**	**2.5**	**0.8**
1	**6.0**	**1.8**	**5.5**	**1.7**	**3.5**	**1.1**	**3.0**	**0.9**
1- ¼	**6.5**	**2.0**	**6.0**	**1.8**	**3.5**	**1.1**	**3.0**	**0.9**

1 – ½	7.0	2.1	6.0	2.0	3.5	1.1	3.5 1.1
2	7.0	2.1	6.5	2.0	4.0	1.2	3.5 1.1

A.1.5 Internal Work:

Generally, the galvanized iron pipes and fittings shall run in the wall chase inside the toilets and kitchen but on the surface in the service ducts. For exposed pipes, the clamps fixing shall be done by means of steel / GI angle brackets and clamps, keeping the pipes about 2.5cm to 5.0cm clear of the wall. When it is concealed, the pipe chasing may be adopted with groove cutting machine. For pipes fixed in the ducts or recesses etc., provide sufficient space to work on the pipes with the usual tools. The pipe shall not ordinarily be buried for short distances provided adequate protection is given against damage and shall be fixed at a place a pipe is passing through a wall or floor to allow freedom for expansion and contraction and other movements. In the case, the pipes are embedded in floors it should be painted with anti – corrosive bitumastic of approved quality and pipe shall be wrapped in burlap or Hessian based bitumen pipe coat of 4mm thickness with overlap of minimum 25mm. The wrapping shall be made to fit tightly over the pipe and where wrapping with a new overlap the old pipe and where wrapping one joint it shall be tied with MS wire or nylon thread. Where pipes are encased with in chases made in the wall, they shall be fixed to the wall with MS clamps MS hooks at every 2 m c/c as to prevent movement before filling in grouting and making good the chase.

A.1.6 Insulation for Hot water Pipes:

All hot water piping shall be insulated in the manner specified herein, before applying insulation, all pipe work and fittings shall be brushed and cleaned. Dust, dirt, mortar and oil shall be removed.

For pipes running concealed in wall chases, they shall be provided with elastomeric tube insulation of thickness as mentioned and shall be fixed tightly and evenly over the entire length of pipe including fittings and valves.

A.1.7 External Works:

The galvanized iron pipes and fittings in external work shall be laid in neatly excavated trenches. The widths and depths of the trenches for different diameters of the pipes shall be as given in the table below, and shall be deep enough to have a clear cover of at least 600mm above the top of pipes.

Dia. Of pipe	Width of trench	Depth of trench
15mm to 50mm	30cm	60cm
65mm to 100mm	45cm	75cm

At joints the trench; width shall be widened wherever it is necessary. The work of excavation and refilling shall be done true to line and gradient by watering and consolidating the excavated soil in layers.

The pipes shall be painted with two coats of anticorrosive bitumastic paint of approved quality followed by wrapping with burlap or Hessian based bitumen pipe kite of 4mm thickness with overlap of minimum 25mm. The pipes shall be laid on a layer of 7.5cm sand and filled with excavated earth. The supplies earth shall be disposed of as directed. The filling shall be done after testing & rectifying leakages and after final passing of work by the plumbing management Consultant.

When the excavation is done in rock the bottom shall be cut deep enough to permit the pipes to be laid on a sand cushion of minimum 7.5cm. in case of

bigger diameter pipes where the pressure is very high thrust blocks of cement concrete 1:2:4 (1 cement :2 coarse sand: 4 graded stone aggregate of 20 nominal size) shall be constructed on all bends to transmit the hydraulic thrust without impairing the ground and spreading it over a sufficient area, as directed by the plumbing management Consultant.

A.1.8 Testing the joints:

After laying and jointing, the pipes and fittings shall be inspected under working conditions of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra cost to Owner. The pipes and fittings after they are laid shall be tested to hydraulic pressure of 10kg / sq.cm. (100 meter or double the designed working pressures whichever is more). The pipes shall be slowly and carefully charged with water allowing all air

to escape and avoiding all shock or water hammer. The draw off takes and stopcocks shall be then closed and specified hydraulic pressure shall be applied gradually. Pressure gauge observations shall be made for at least 24 hrs. The pipes and fittings should be tested in section as the work of laying proceeds, keeping the joints exposed for inspection during the testing.

A.1.9 Measurements:

The lengths shall be measured in running meter correct to a cm for the finished work, which shall include GI pipes and sockets, GI fittings such as bends, tees, elbows, reducers, crosses, plugs, sockets, nipples and nuts, but exclude brass or gunmetal taps (cocks), valves, lead connection pipes and shower rose. The length shall be taken along the central line of the pipefitting. All pipes and fittings shall be classified according to their diameter of the internal bore. The pipe shall be described as including all cuttings and wastage. In case of fittings of unequal bore, the largest bore shall be measured.

Digging and refilling of trenches shall be measured separately or clubbed with main item as called for in the item specification/tender bill of quantities.

A.1.10 Internal work:

The rate of internal work shall include the cost of labour and material involved in all the operations described above except in Para A.1.7. The rate shall include the cost of chasing, cutting holes in walls and floors making good the same including clearing of the debris. Insulation of pipes for hot water supply will be paid separately as extra item.

Size of pipe	Width of chasing	Depth of chasing
15mm die	20mm	15 m
20 mm die	25mm	20 m
25mm die	32mm	25 m
32 mm die	38mm	32 m

The grove cutting shall be covered with GI mesh of approved make before grouting

A.1.12 Water supply and waste Fittings: (General)

The brass or gunmetal fitting shall be heavy quality and approved manufacture and pattern with screwed or flanged ends as specified. The fittings shall in all respects comply with the Indian standard specifications No. I.S. 778 – 1984 (Fourth revision) and I.S. 781 – 1984 (Second revision). The standard size of brass or gunmetal fittings shall be designated by the nominal bore of the pipe outlet to which the fittings are attached. A sample of each kind of fittings shall be got approved from the Consultants / Employer and all supplies should be made according to the approved samples.

All cast fittings shall be sound and free from laps, blowholes and filings. Both internal and external surfaces shall be clean, smooth and free from sand etc. Burning, plugging, stopping or patching of the casting shall not be permissible. The bodies, bonnets, spindles and other parts shall be truly machined so that when assembled the parts shall axial, parallel and cylindrical with surfaces smoothly finished. The area of the water – way of the fittings shall be less than the area of the nominal bore.

The fittings shall be fully examined and cleared of all foreign matters before being fixed. The fittings shall be fitted in the line in a workman – like manner. The joints and fittings shall be leak – proof when tested to a pressure of 10kg / sq.cm. as described in Para above and the defective fittings and joints shall be replaced or redone, without any extra cost.

A.1.13 Regulations and Standards:

All equipment supply erection testing and commissioning shall comply with the requirements of Indian standards and code of practices. All equipment and material being supplied by the contractor shall meet the requirements of IS. Tariff advisory committee's regulation (fire insurance) electrical inspectorate and Indian Electricity rule other Codes / publications as given below:

A.1.14 PRESSURE REDUCING VALVE SET:

Each pressure-reducing valve set shall be complete with pressure reducing or pressure regulating valve, isolating valve, pressure relief valve on outlet and filter on inlet.

Each pressure reducing valve shall contain loading neoprene diaphragm and a full floating, self-aligning, ignition resistant seat and shall be of the single stage, pressure reduction type with provision for manually adjusting the delivery pressure. The valve shall fail safe to the low pressure.

Valve shall be capable of operating at the maintaining automatically the respective delivery pressure and flow rates as indicated and shall not be liable

to creep. Valve shall also be capable of maintaining the pre – set down stream pressure under static condition.

The filter on each inlet to a pressure-reducing valve shall be of replaceable porous sintered metal type.

A.1.15 PRESSURE RELIEF VALVES:

Each pressure relief valve shall be of the fully enclosed type and fitted with hand easing gear.

Each pressure relief valve in a pressure reducing station shall have a flow capacity equal to that of the pressure-reducing valve.

Pressure relief valves in locations other than reducing stations shall have flow capacities equal to that of the associated equipment.

A.1.16 PRESSURE GAUGE:

The pressure gauge shall be constructed of die cast aluminium and enamelled. It shall be weather proof with an IP 55 enclosure. It shall be a stainless burden tube type pressure gauge with a scale range from 0 to 16 kg / cm square and shall be constructed as per IS: 3524. Each Pressure gauge shall have a siphon tube connection. The shut off arrangement shall be by ball valve.

A.1.17 DRAWINGS:

a.	Contract drawings duly signed by Architect / Consultant are diagrammatic but shall be followed as closely as actual construction permits. Any deviations made shall be in conformity with the architectural and other services drawings and with the prior approval of OWNER/CONSULTANT
b.	Architectural drawings shall take precedence over services drawings in regard to all Dimensions.

c.	Contractor shall verify all dimensions at site and bring to the notices of Engineer-in-charge / Consultant discrepancies if any Engineer-in-charge 's decision in this respect shall be final.
d.	Large size details and manufactures' dimensions for materials to be incorporated shall take precedence over small-scale drawings.

A.1.18 <u>WORK TO BE CARRIED OUT BY LICENCED PERSONS / FIRMS</u>:

All service installations namely water supply plumbing drainage and sewerage electrical fire detection and fire protection works shall be carried out by technically competent persons holding valid license to carry out their respective trade at the site and having a minimum experience of five years in their relevant trades.

A.1.19 <u>DRILLING, CUTTING, ETC.:</u>

All cutting and drilling of walls or other elements of the building for the proper entry / installation of pipes, and other equipment shall be carried out using electrically operated tools, only. Manual drilling, cutting, chiselling, etc shall be cut or chased with the written permission of the project engineer.

A.1.20 Water **<u>supply Fittings:</u>**

All water supply fittings (including mixer fittings accessories) shall be brass / copper, heavy chromium plated, of the make and design specified. The fittings shall be cast fittings of screw type, machined and threaded properly for fixing to the supply pipes.

The plating shall conform to Indian standard specification IS 4827 –1968 electroplated coating of nickel and chromium on copper alloys.

The fittings shall be supplied complete with chromium plated matching flanges, nuts and extension pieces of required lengths. Metallic washers where required

shall also be of chromium plated brass. All bib cocks and stop cocks shall conform to Indian standard specifications IS: 781 – 1984 (second revision) bib taps and stop valves for water services, sand cast brass screw – down (revised) pillar cocks to IS: 8934 – 1978 – pillar taps, mixing fitting to IS: 1701 – 1960 mixing valves for ablutionary and domestic purpose. Both filler, shower arm, rose spout and other fittings shall match the supply fittings in construction, performance and appearance.

All fixing accessories and screws shall be similar to fittings with all exposed parts chromium plated. All washers shall conform to Indian standard specification IS: 4326 – 1967 washers for water taps for cold water services.

A.1.21 Waste **Fittings:**

All waste fittings (waste, chain, pop-up, over-flow) shall be brass / copper, heavy chromium plated of the make and design specified and match the supply fittings. They shall confirm to Indian Standard specification IS: 2963 – 1964 waste fittings for wash basins and sinks, non-ferrous.

A.1.22 Bottle **Traps:**

Bottle traps (for wash basins, sinks, urinals, etc.,) shall be deep seal (minimum 6cm. seal) cast brass bottle traps, heavy chromium plated. All bottle traps shall be provided with suitable cleaning eye, extension piece, flare nuts – all chromium plated. Bottle traps shall be of approved make and design. Waste coupling for washbasins shall be 32mm, for sinks 40mm, for urinal.

A.1.23 Wall Flange:

Wall flange / caps shall be provided on all walls, floors, columns, etc., wherever supply and disposal of pipes pierce through them. These wall caps shall be chromium-plated brass snugly fitting. The receiving pipes shall be large enough to cover the punctures properly.

A.1.24 Floor Traps:

Floor traps shall be of PVC of the size required, of approved design incorporating a deep seal (6cm. minimum) and venting device unless otherwise indicated. All PVC floor traps in general /unless otherwise specified, shall be of moulded type only. However, floor traps of sizes as mentioned in the BOQ and that are not available in moulded type, shall be of fabricated type. Samples of these fabricated floor traps including other PVC fabricated fittings to be got plumbing management Consultant. The traps shall be supplied with cast iron / PVC cap with collar capable of receiving a grating.

A.2.0 VALVES AND APPURTENANCES:

A.2.1 Ball Float Valves:

The ball valve shall be of high-pressure type and shall be of sizes as specified. The normal size of a ball valve shall be that corresponding to the size of the pipe to which it is fixed. The ball valve shall be of brass or gun metal as specified and the float of copper sheet. The minimum thickness of copper sheet used for making the float shall be 0.45mm for float exceeding 115mm dia. The body of the high-pressure ball valve when assembled in working conditions with the float immersed to not more than half of its volume shall remain closed against a test pressure of 3.5kg / sq.cm.

The ball valve shall generally conform to IS specification No.1703: 1977 (Second revision). The weight of ball cock and the size of the ball cock shall be as per IS specification.

A.2.2 Butterfly/Ball Valves:

Valves up to 40 mm die and below shall be Nickel plated brass body heavy stainless-steel ball, lever operated, tested to 20Kg/sq.cm with female screwed ends. All ball valves shall be of full-bore type.

Valves from 50mm up to 150mm die shall be of cast of iron body butterfly valves lever operated with flange ends. Valves shall carry IS certification mark.

All valves shall be approved by consultants before they are used on work.

All globe and check valves shall have working parts suitable for hot and cold water, as required. Valves shall be tagged with permanent label under hand wheel indicating type or duty.

A.2.3. "Y" STRAINERS:

''Y'' strainers up to 50mm shall be of gunmetal and above 50mm shall be of cast iron body. Strainers shall incorporate a removable bronze screen with mm (1/8'') perforations and a permanent magnet. Strainers shall be provided with flanges at both inlet and outlet. They shall be designed to enable blowing out of accumulated dirt and facilitate dirt and facilitate removal and replacement of the screen without disconnection of the main pipe.

A.2.4 Appurtenances:

The other appurtenances of pipeline are mentioned below:

a) Air Valves:

These are placed at every summit in the pipeline to permit the escape of air when the main is filled and afterwards, if any air carried out in to the mains. These are also placed on long stretches of nearly level main

b) Scour Valves:

These are placed at the bottom of all depressions for emptying the main of letting out the sediment.

c) Reflux /Non-retourValves :

These are fixed so as to open in the direction of flow but automatically close if the water flows back. They are used to diminish the damage done by the escape of water due to a burst or prevent damage to impellers of pumps.

A.2.11 Fixing water meter and stopcock in GI pipeline:

Materials – pipe fittings as described in material section.

Cutting GI pipeline:

The GI line shall be cut to the required length at the position where the meter and stopcock are required to be fixed. The ends of the pipe shall then be threaded unions shall be provided in the pipe assembly for fixing water meter.

Fixing meter and stopcock:

The meter and stopcock shall be fixed in position by means of connecting pipes, GI jam nut and socket etc., The stopcock shall be fixed near the inlet of the water. The paper disc inserted in the ripples of the meter shall be removed and meter installed exactly horizontal or vertical in the flow line in the direction shown on by the arrow cast on the body of the meter.

Care shall be taken that the factory seal of the meter is not disturbed. Wherever the meter shall be fixed to a newly fitted pipeline, the pipeline shall have to be completely washed before fitting the meter. For this purpose, a piece of pipe equal to the length of the meter shall be fitted in the proposed position of the meter in the new pipeline. The water shall be allowed to flow completely to wash the pipeline and then the meter installed as described above by replacing the connecting piece.

A.3.0 Masonry Chambers:

A.3.1 General:

All masonry chambers for stopcocks, sluice valves, etc., shall be built as per supplied drawings.

A.3.2 Excavation:

The excavation for chambers shall be done true to dimension and levels as indicated on plans or as directed by the Consultants / Architects.

A.3.3 Bed Concrete:

This shall be cement concrete 1:4:8 (1cement: 3 fine sand: 6 graded stone aggregate 40mm nominal size).

A.3.4 Brick Work:

This shall be in Class B brick (Table Moulded) with crushing strength not less than 35kg / sq.cm, in cement mortar 1:6 (1 cement: 6 fine sand). Conforming to Relevant IS. codes.

A.3.5 Plastering:

Plastering not less than 12mm thick shall be done in cement mortar 1:3 (1 cement:3 coarse sand) finished with a floating coat of neat cement.

A.3.7 Measurements:

Masonry chambers shall be enumerated under the relevant items.

A.3.8 Rate:

The rate shall include the cost of materials and labour involvement in all the operations described above, except the excavation in soft or decomposed and hard rock. The difference in cost, between ordinary soil and soft or decomposed or hard rock as the case may be, shall be paid for separately if the rock is met with and duly certified by the soil consultant.

A.3.9 BALL FLOAT VALVE:

The ball valve shall be of high-pressure class and shall be sizes as specified and directed.

The nominal size of ball valve shall be that corresponding to the size of the pipe to which it is fixed. The valve shall be of gunmetal as specified with standard polyurethane float. The float should be special in shape. The jointing of float

shall be efficiently finished, lapped and soldered seam or brazing. Polyurethane floats shall be used as specified.

The ball valve shall generally confirm to IS. Specifications No.1703. The weight of ball cock and size of ball shall as per table given below:

Both high pressure and low-pressure ball valves are designed for use on mains having pressure of 17.kg/sq.cm.and above.

Dia. In mm	Total weight high pressure	Total weight Low pressure
15	524 gms	481 gms
20	986 gms	867 gms
25	1549 gms	1411 gms
32	2120 gms	1873 gms
40	2646 gms	2303 gms
50	4454 gms	3959 gms

A.3.10 THRUST BLOCKS AND ANCHORAGE:

At all changes of directions or gradients, thrust blocks made of cement concrete M150 duly designed should be provided around the bends of the pipes made of GI or PVC or CI withstand dynamic and static forces likely to be developed due to water running the pipes. The thrust blocks shall be made after the joints are tested and found OK.

B.3.0 DRAINAGE (INTERNAL AND EXTERNAL WORKS)

B.3.1 Soil, waste, vent pipes and fittings

Materials:

a) All soil, waste and vent pipes and fittings used within the toilets, shafts vertical run, stilt ceiling – suspended run, shall be PVC pipes of SWR quality (4kg / sq. cm pressure rated) as per IS 13592 (latest revision). Pipe of higher Dia i.e. 160mm Dia. and above shall of agricultural series (6kg / sq. cm pressure rated) made as per IS 4985.They shall be made of polyvinyl chloride (PVC) and shall be sound with good surface finish, mechanical strength and capacity. During manufacture only those additives may be added to produce the above characteristics. No additives shall be added separately or together in quantities sufficient to constitute a toxic hazard, or impair its physical or welding properties of the pipe or impair its physical or chemical properties. All pipes shall be spigot and socket type (bell end type) OR rubber ring socket type.

b) Pipe Sizes and Wall Thickness:

Pipe Dia (mm)	Wall Thickness mm
110mm	2.2mm
75mm	1.8mm

c) Tolerances:

Tolerance on diameter and wall thickness shall be as per I.S 13592 and 4985.

d) Fittings:

All fitting shall be injection moulded socket fittings with or without inspection doors as specified and shall be in accordance with requirement of the relevant I.S 7834.

Pressure ratings and tolerances shall be as per I.S 13592 and 4985.

e) Laying and jointing:

Pipes shall be cut to length required including the portion to be inserted in the socket with a hacksaw. The pipe shall be cut square. Pipes and sockets shall be clean and dry and burrs removed both inside and outside with a file. The

surface to surfaces to be in contacted shall be roughened with emery paper, and dry fit checked.

A thick coat of solvent cement shall be applied to the outer surface of the pipe and a thin coat on the inside surface of the pipe and a thin coat on the inside surface of the socket by means of a brush. Solvent cement shall be of approved make and quality. The pipe shall then be inserted in the socket and turned for 90 degree to ensure even distribution of solvent cement. Excess solvent cement shall be wiped off. Leak proof adhesives like FRP paste / M – seal to be applied. GI clamps of required size shall be used for clamping the pipes to the walls etc., pipe shall be clamped atleast two inch / 50mm away from the wall surface using GI clamps screwed to the PVC rawl plugs, not more than 1 meter apart.

f) Clean Outs:

At every bends, branches and where necessary suitable cleanouts shall be provided in to the piping system.

B.3.2 Connecting PVC pipes to CI pipes:

PVC collar ring shall be welded to the spigot end of the PVC pipe by means solvent cement. The spigot end of the pipe to be jointed shall then be inserted in to the socket and aligned. Tarred spun yarn shall be caulked in to the angular space between the spigot and socket up to height of 20mm.

The remaining space shall be filled with C.M. 1:2 and well caulked using wooden caulking tool and finished off neatly. Joint shall be kept for 24 Hours. Alternatively, if so directed by Architect, the following method may be adopted.

The spigot end of the PVC pipe should be jointed to a PVC collar using solvent cement as detailed in 7.3.1.

The other end of the collar is then jointed to the socket of the CI pipe using solvent cement.

a) Connecting CI pipe to PVC pipes:

A connector socket shall be used for such connections, a rubber ring is to be placed over the spigot, which is then inserted in to the socket connector. Gentle, even heat is applied to the connector socket by means of a blowlamp. The connector socket will shrink making a watertight airtight joint.

b) Connecting PVC to GI pipes:

Standard threaded couplers shall be used for this purpose.

B.3.3 Miscellaneous Items:

Supports, pedestals and base for inspection chambers, gully traps and pipes shall be of GI or MS provided with water bar flange.

B.3.4 Pipes sleeves and inserts, etc., through RCC walls either external or internal shall be of GI or MS provided with water tight flange.

B.3.5 During installation open ends of pipes shall be plugged with wood out in to required shape or gunny bags and to be maintained free from dirt.

B.3.6 PVC waste pipes and fittings shall be of agricultural series of supreme / Prince make (4kg / sq. cm pressure rated) or equivalent with PVC unions, tailpiece reducers and connections to be provided between joints to either lead or CI pipes.

B.3.7 The sizes of branch waste pipes for different fittings shall be generally as follows:

Wash Basin	40mm dia PVC (15kg / sq. cm pr. Rated)
Urinal	50mm dia PVC (15kg / sq. cm pr. Rated)
Sink	50mm dia PVC (15kg / sq. cm pr. Rated)
Nahani Trap	75mm dia PVC (4kg / sq. cm pr. Rated)
Special Floor Trap	75mm dia or 110mm dia. As required

B.5.8 W.C pan connectors shall be to suit the requirements as per drawing, with 75mm dia. Vent provision for connection to the anitisiphonage pipe with pan connector.

B.5.9 The pipe Connection to the sewage or storm water collection chambers shall perfectly water tight.

B.5.10 The floor traps for toilet blocks shall be PVC with CP brass grating, bolted down design. The traps shall be provided with minimum water seals of 40mm to 50mm.

B.5.11 Where toilet slabs are sunk, the floor trap shall be of 110 x 75 heavy type PVC `P' trap, with CP brass grating, with rim type design.

B.5.12 Bathroom CP grating shall be of rim type design made out of heavy cast brass with the chromium plating of the best approved standard.

B.6.1 <u>RAIN WATER PIPES AND FITTING:</u>

a) All rain water and vent pipes and fittings used within the plumbing shafts vertical run, basement ceiling suspended run, shall be PVC pipes of SWR quality of pressure rating 4kg / sq. cm. They shall be made of polyvinyl chloride (PVC) and shall be sound with good surface finish, mechanical strength and capacity. During manufacture only those additives may be added to produce the above characteristics. No additives shall be added separately or together in quantities sufficient to constitute a toxic hazard, or impair the fabrication or welding

properties of the pipe or impair its physical or chemical properties. All pipes shall be spigot and socket type (bell and type).

b) Pipe Sizes and wall thickness:

Pipe dia (mm)	Wall Thickness (mm)
110mm	2.2mm
75mm	1.8mm

c) Tolérances :

Tolerances on diameters and wall thickness shall be as per IS 4985.

d) Fittings:

All fitting shall be injection moulded socket fittings with or without inspection doors as specified and shall be in accordance with the requirements of the relevant IS 7834.

Pressure ratings and Tolerances shall be as per IS 4985.

B.6.1 a) Pipe sizes and wall thickness:

Pipe dia (mm)	Wall thickness (mm)
110mm	2.2mm
75mm	1.8mm

b) Tolerances:

Tolerances on diameters and wall thickness shall be as per IS 4985.

c) Fitting:

All fitting shall be injection moulded socket fittings with or without inspection as specified and shall be in accordance with the requirements of the relevant IS 7834.

Pressure ratings and tolerance shall be as per IS 13592 and 4985.

d) Laying and jointing:

Pipes shall be cut to length required including the portion to be inserted in the socket with a hacksaw. The pipe shall be cut square. Pipes and sockets shall be clean and dry and burrs removed both inside and outside with a file. The surface to surfaces to be in contacted shall be roughened with emery paper, and dry fir checked.

A thick coat of solvent cement shall be applied to the outer surface of the pipe and a thin coat on the inside surface of the socket by means of a brush. Solvent cement shall be of approved make and quality. The pipe shall then be inserted in the socket and turned for 90^0 to ensure even distribution of cement. Excess cement shall be wiped off. GI clamps of required size shall be used for clamping the pipes to the walls etc., pipe shall be clamped at least two inches away from the wall surface using GI clamps screwed to the wooden plugs, not more than 1 meter apart.

e) Clean outs:

At every bend, branches and where necessary suitable cleanouts shall be provided in to the piping system.

f) Rain water collection gratings:

I) The rain water collection grating at the terrace level shall be of PVC grating with PVC frame embedded on to the water proof surface. Waterproofing shall be done around the pipe, frame and grating to ensure the water tightness around the collection point. Adequate slope on the terrace level shall be provided for collecting all rainwater at the collection gratings.

ii) The rain water collection detail at the balconies shall be done using PVC pipe bend installed concealed in the concrete slab and connected to the vertical main PVC rain water stack, at the collection point heavy brass CP frame with CP grating shall be provided. The CP frame shall be laid in the slab above the pipe with water seal joint all-round the frame.

k) Rain water / storm water, gullies / Chambers:

Storm water gullies shall be constructed for admitting storm water from the courtyard area. It is constructed of specified size and is provided with precast RCC or CI grating on top for admitting storm water runoff into it. A typical drawing shall be provided giving all details of construction. For other details of construction refer specification for manholes and inspection chambers.

C. SANITARY FIXTURES AND FITTINGS:

C.1.0 Installation of fixtures and fittings:

All Plumbing and Sanitary Fixtures and Fittings should be first 1st (standard) quality and shall be stored in covered stores and handled carefully to prevent damage. The sanitary fittings shall be installed at the correct assigned positions as shown on the drawings and as directed by the Consultants / Architects and shall fully meet with the aesthetic and symmetrical requirements as demanded by the Consultant. Fixtures shall be installed by skilled workman with appropriate tools according to the trade. Manufacturer's instructions shall be followed for the installation of the fixtures.

Fixtures in all toilets shall be standard height mounted rigid, plumb and true to alignment. The outlet of water closet pans and similar appliances shall be examined to ensure that outlet ends are abutting properly on the receiving pipes before making the joints. It shall be ensured that the receiving pipes are clear of obstruction. When fixtures are being mounted, atonement shall be other causes. A check shall be made to ensure that necessary anchoring devices

have been provided for supporting water closets, lavatory has in sinks, flushing cisterns and other appliances. Where the built-in types of brackets are used, they shall be securely fixed to the walls and slabs by approved means. It shall be ensured that while fixing the fixtures and fittings, no tool marks or scratches are developed. All MS / Steel brackets and supports shall be painted.

C.1.1 Cutting, Patching repairing and making good:

Cutting, patching and repairing required for the installation and completion of the work specified in each division, including chasing, plastering masonry work, concrete work, etc. and making good shall be carried out by the contractor wherever required. Holes, which are over size, shall be refilled, so that a tight fit is obtained around the pipe or other passing through.

Any damages to water proofed locations should not be patched up, without rectification by water proofing agency to ensure his guarantee.

C.1.2 Protection of Fixtures / Equipment:

Care shall be taken at all times, particularly after fixing to protect fixtures from damage. All offsets shall be temporarily plugged during progress of work to prevent obstruction. Fixtures shall be finally cleaned to the satisfaction of the consultants. Keep all pipes and conduit openings closed by means of plugs or caps to prevent the entrance of foreign mater.

Protect all piping, conduit, fixtures, equipment or apparatus. Any such items damaged prior to final completion of work shall be restored to its original conditions or replaced at no expense to the Owner.

C.1.3 Accessibility:

The installation of valves, thermometers, cleanout fittings and other indicating equipment or specialties requiring frequent reading, adjustment, inspection, and accessibly located with reference to the finished buildings. Thermometers

and gauges shall be installed so as to be easily read from the floor clean out minimum distance of 600mm shall be available from any wall.

C.1.4 Equipment, material and workmanship:

a) Determine that each piece of equipment meets that detailed requirements of the contract documents and that it is suitable for the installation shown. Notify the Architect of any shortcomings found during the tendering period. Each piece of equipment furnished shall meet all detailed requirements will not be acceptable, even though specified by name along with other manufacturers.

b) Where two or more units of same class of equipment are furnished use products of the same manufacture, component parts of entire system need not product of the same manufacturer, but confirm to I.S.I standard. Furnished all materials and equipment, new and free from defects and of size, make type and quality here in specified or approved by the Employer / Architects. All shall be installed in a neat and workmanlike manner.

C.1.5 Sanitary fixtures and CP fittings (Owner's supply):

Unless otherwise specified the sanitary fixtures shall be of the following specifications:

SANITARY FIXTURES AND FITTINGS:

C.2.1. SCOPE:

a)	Sanitary appliances and fixtures for toilets.
b)	Chromium plated brass fittings.
c)	Stainless steel sinks.
d)	Accessories e.g. towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails, coat hooks etc.
e)	Hand driers, drinking water fountains etc.

Whether specifically mentioned or not the contractor shall provide for all appliances and fixtures all fixing devices, nuts, bolts, screws, hangers as required.

All exposed pipes within toilets and near appliances / fixtures shall be of chromium plated brass or copper unless otherwise specified.

C.2.2 GENERAL REQUIREMENT:

All appliances, fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the schedule of quantities, Specifications, drawings. Accessories shall include proper fixing arrangements, brackets, nuts, bolts, washers, screws and required connection pieces.

The sanitary fixtures and fittings shall be installed at the correct assigned position as shown on the drawings and as directed by the architect / Owner's site representative and shall fully meet with the aesthetic and symmetrical requirements as demanded by the architect / interior designer.

All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per architect requirements. Wherever necessary, the fittings shall be cantered to dimensions and pattern as called for.

Fixing screws shall be half round head chromium plated (CP) brass screws, with CP brass washers unless otherwise specified.

Fixtures shall be installed by skilled workman with appropriate tools according to the best trade practice.

All appliances, fittings and fixtures shall be fixed in a neat workman like manner true to level and to heights shown on the drawings and in accordance with the manufacturer's recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling, plaster, paint, insulations or terrace shall be made good by the contractor at his own cost. Fixtures shall be mounted rigid, plumb and true to alignment.

All materials shall be rust proofed: materials in direct contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.

Wall flanges shall be provided on all walls, floors, columns etc., wherever supply and disposal pipes pierce through them. These wall caps shall be or chromium plated brass fittings and the receiving pipes and shall be large enough to cover the punctures properly.

Sanitary appliances, subject to the type of appliance and specific requirements, shall be fixed in accordance with the relevant standards and the following:

1)	Contractor shall during the entire period of installation and afterwards protect the appliances by providing suitable cover or any other protection so as absolutely prevent any damages to the appliances until handing over (the original protective wrapping shall be left in position for as long as possible).
2)	The appliances shall be placed in correct position or marked out in order that pipe work can be fixed or partially fixed first.
3)	The appliances shall be fixed in a manner such that it will facilitate subsequent removal if necessary.

4)	The appliance shall be securely fixed. Manufacturer's brackets and fixing methods shall be used wherever possible. Compatible rust – proofed fixings shall be used. Fixing shall be done in a manner that minimize noise transmission.
5)	Appliances shall not be bedded (e.g. WC pans, pedestal units) in thick strong mortar that could crack the unit e.g. ceramic unit).
6)	Pipe connections shall be made with demountable unions. Pipe work shall not be fixed in a manner that it supports or partially supports and appliance.
7)	Appliances shall be fixed true to level firmly fixed to anchor or supports provided by the manufacture and additional anchors or supports where necessary.

Size of sanitary fixtures given in the specification or in the schedule of quantities are for identification with reference to the catalogues of make considered. Dimensions of similar models of other makes may vary with in +/- 10% and the same shall be provided and no claim for extra payment shall be entertained no shall payment be deducted on this account.

The contractor shall fix all plumbing fittings such as water faucets, shower fittings, mixing valves etc in accordance with manufacturer's instructions and connect to piping system. The contractor shall supply all fixing materials such as screws raw plugs, unions, collars and shade to match that of the appliances / fixture and the floor / wall to the extent possible.

C.2.3 SUPPORTING AND FIXING DEVICES:

The contractor shall provide all the necessary supporting and fixing devices to install the sanitary fixtures and fittings securely in position. The fixing devices shall be rigidly anchored into the building structure. The devices shall be rust resistant and shall be so fixed that they do not present an unsightly appearance in the final assembly. Where the location demands, the architect may instruct the contractor to provide chromium plated or other similarly finished fixing devices. In such circumstances the contractor shall arrange to supply the fixing

devices and shall be installed complete with appropriate vibration isolating pads, washers and gaskets.

C.2.4 FINAL INSTALLATION:

The contractor shall install all sanitary fixtures and fittings in their final position in accordance with approved trial assemblies and as shown on drawings. The installation shall be complete with all supply and waste connections. The connection between building and piping system and the sanitary fixtures shall be through proper unions and flanges to facilitate removal/replacement of sanitary fixtures without disturbing the built-in piping system. All unions and flanges shall match in appearance with other exposed fittings.

Fixtures shall be mounted rigid. Plumb and to alignment. The outlets of water closet pans and similar appliances shall be examined to ensure that outlet ends are butting on the receiving pipes before making the joints it shall be ensured that the receiving pipes are clear of obstruction. When fixtures are being mounted. Attention shall be paid to the possibility of movement and settlement by other causes. Overflows shall be made to ensure that necessary anchoring devices have been provided for supporting water closets, washbasins, sinks and other appliances.

C.2.5 PROTECTION AGAINST DAMAGE:

The contractor shall take every precaution to protect all sanitary fixtures against damage, misuse, cracking, staining, breakage and pilferage by providing proper wrapping and locking arrangement till the completion of the installation. All the time of handing over, the contractor shall clean, disinfect and polish all the fixtures and fittings. Any fixtures and fittings found damaged, cracked chipped stained or scratched shall be removed and new fixtures and fittings free from defects shall be installed at his own cost to complete the work.

C.2.6 MEASUREMENT:

Rate for fixing only of sanitary fixtures accessories, CP fittings shall etc. include all items, and operations stated in the respective specifications and bill of quantities and nothing extra is payable.

Rates for all items under specifications para above shall be inclusive of cutting holes and chases and making good the same CP screws, nuts, bolts and any fixing arrangements required and recommended by manufacturers, testing and commissioning and making good to the satisfaction of the owner's site representative

C.2.7 TESTING:

All appliances, fixtures and fittings shall be tested before and after installation. Water seals of all appliances shall be tested. The contractor shall block the ends of waste and ventilation pipes and shall conduct an air test.

C.2.8 WATER CLOSET:

Water closet shall be wash or symphonic wash down type floor or wall mounted set, as shown in the drawings, designed for low volume flushing from 3-6 litters of water, flushed by means of a porcelain flushing cistern or an exposed or concealed type (as detailed in the drawings or as directed by the owner's site representative) 32 mm size CP brass flush valve with regulator valve. Flush pipe / bend shall be connected to the WC by means of a suitable rubber adaptor. Wall hung WC shall be supported by CI floor mounted chair, which shall be fixed in a manner as approved by the owner's site representative.

Each WC set shall be provided with approved quality of seat, rubber buffers and chromium plated hinges, seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the WC.

Each WC shall be provided with 110 mm die (OD) PVC pan connector connecting the ceramic outlet of WC to CI pipe.

C.2.9 CISTERNS / FLUSH VALVE:

Low-level fishing cistern (exposed or concealed) shall be provided for WC in specified toilets. Contractor shall install cistern in accordance to the manufacturer's specification to the satisfaction of the owner site representative. Provision of flush valve shall be made for public / staff toilets.

C.2.11 WASH BASIN:

Washbasins shall be white glazed vitreous china of size. Shape and type specified in the schedule of Quantities.

Each basin shall be provided with painted MS angle or CI brackets and clips and the basin securely fixed to wall / counter slab. Placing of basins over the brackets without secure fixing shall not be accepted. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make brand and cooler as approved by the owner's site representative. The cost of fixing the basin shall be inclusive of supply and installation of bracelets as described above.

Each basin shall be provided with 32mm die CP waste with overflow pop-up waste or rubber plug and CP brass chain as specified in the schedule of Quantities.

Each basin shall be provided with hot and water mixing fitting or as specified in the schedule of Quantities.

C.2.12 SINKS:

Sinks shall be stainless shall or any other material as specified in the schedule of Quantities.

Each sink shall be provided with painted MS or CI brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable painted angle iron

brackets or clips as recommended by the manufacturer. Each sink shall be provided with 40mm die CP waste and rubber plug with CP brass chain as given in the schedule of Quantities. The MS angle shall be provided two coats of red oxide primer and two coats of synthetic enamel paint of make. Brand and colour as approved by the owner's site representative.

Sanitary fit tings for sinks shall be deck mounted or wall mounted CP swivel faucets with or without hot and cold-water mixing fittings as specified in the schedule of Quantities. Installation of fittings shall be measured and paid for separately.

C.3.0 Mode of measurement:

C.3.1 All drainpipes shall be measured in linear lengths along the centreline of drainage line laid. Deductions shall be made for chambers and fitting lengths, etc. The rate shall include all works as specified in the respective items.

C.3.2 Stoneware or cast-iron gully, traps, bends and junctions, sewer traps etc. shall be measured in numbers as in above.

C.3.3 All GI pipes for water supply shall be measured in linear lengths along the centre line completed including the fittings like collars, elbows, tees, hex nipples etc. the rate shall include cutting, threading, jointing, pressure testing etc. complete as specified in the respective items.

C.3.4 Same rate shall be applicable for pipes of same size and materials laid in building at any level or floor.

C.3.5 The rock cutting shall be measured in cu. m of the stacks of excavated rock. The deductions for voids being 50%of the stack measurement. Only the rock which is removed by chiselling or blasting etc., shall be measured for this item of

work. Boulders shall not be considered as a rock. The excavated rock will be the owner's property.

C.3.6 All PVC pipes such as soil, waste, vent and rainwater shall be measured in linear lengths along the centreline, to nearest centimetre as completed including length over fittings. The rates shall include all joints and clamps etc. as specified in the respective items.

C.3.7 Plain cement concrete for supports and for encasement or bedding etc. shall be measured as specified in the respective items in the schedule of quantities.

C.3.8 All sanitary fittings and CP fixtures including CP extension pipe with brass screws shall be measured in numbers and the rates shall include all the work specified and described under item in the schedule of quantities.

C.3.9 All gate valves, ball valves, non- return valves, sluice valves, pressure reducing valves etc. shall be measured in numbers, after excluding them from linear measurement.

C.3.10 The diameters of pipes and fittings mentioned in the specifications are the inside nominal diameters in all cases except PVC pipes or unless otherwise specified.

D.0 MISCELLANEOUS WORKS:

D.1.0 HANGERS & SUPPORTS:

D.1.1 General:

Provide proper solid angle iron / channel section, supports for all pipe runs in the vertical ducts and run horizontally suspended from the slab, complete with

clamps. Wherever insulation comes, to provide wooden guide to support pipe on the angle iron hangers / supports. For attachment in concrete, use `Dash' fasteners or Anchor plug type inserts or equivalent. Provide hangers within 900mm of all changes in direction of mains. A minimum of three hangers per expansion bends wherever shown in drawing. Provide all additional structural steel angles, channels or other members not specifically shown but are required for proper support.

Where necessary additional hangers to be provided to arrest water hammers of hydraulic resonance with proper rubber padding.

Space hangers as noted below, except on all soil pipes which shall have a hanger of multiple fittings. Sufficient hangers shall be provided to maintain proper slope without sagging. In case of angle suspended line, the following is suggested.

a)

Pipe Sizes	Hanger Rod Dia.
20 through 50mm	10mm
65 through 125mm	12mm
150 and over	15mm

b)

Pipe Sizes	Spacing of Supports
12 to 20mm	1.5m apart
25 to 40mm	2 m apart
50 above	2 m apart or as per IS.

Provide floor stands, brackets or masonry piers etc. for all lines running under the floor or near walls for those lines can be properly supported or suspended from the walls or floors. Pipelines near concrete or masonry walls shall be supported by hangers carried from wall brackets. Hanging of any pipe from another is prohibited.

D.2.0 Cutting, Patching, Repairing & Making good:

Cutting, patching and repairing required for the proper installation and completion of the work specified in each division, including chasing, plastering, masonry work, concrete work, etc. and making good shall be carried out by the contractor wherever required. Holes which are cut oversize shall be refilled, so that a tight fit is obtained around the pipe or passing through. Any damages to water proofed location should not be patched up, without rectification by the water proofing agency (specialist contractor) to ensure his guarantee. Repair of waterproofing shall be borne by the sanitary contractor if the damage is done by sanitary contractor.

D.2.1 Equipment Protection:

Keep all pipe and conduit openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect all piping, conduit, fixtures, equipment or apparatus. Any such work shall be restored to its original condition or replaced at no expense to the owner.

D.2.2 Accessibility:

The installation of valves, thermometers, cleanout fittings and other indicating equipment or specialties requiring frequent reading, adjustment, shall be conveniently and accessibly located with reference to the finished buildings.

Thermometers and gauges shall be installed so as to be easily read from the floor. For floor cleanouts minimum distance of 600mm shall be available from any wall.

E.0 Cleaning, operation & Tests:

Plumbing equipment fixtures, piping etc. shall be free of stampings, making (except those required by codes) iron cutting and other foreign materials.

E.1.1 Hot, cold and drinking water systems shall be cleaned thoroughly, filled and flushed with water.

E.1.2 The entire mechanical apparatus shall operate at full capacity without objectional noise or vibrations.

E.1.3 Test all plumbing systems in the presence of the site engineer / supervisor and the Architect as herein specified. Provided all equipment, materials and labour necessary for inspection and tests. After repairs are made, repeat test until units / a system is found satisfactory, to the above authorities. Carry out tests prior to concealing, insulating or back filling over any piping. No exceptions will be made.

E.1.4 Test entire system of soil, waste and vent piping by water test after sealing all traps.

E.1.5 Water Test:

Test entire system or sections of system by closing all openings except the highest opening and filling system with water to the point of overflow. If the system is tested in sections, plug each opening except the highest opening of the section filled with water. Keep the water in system or in portion under test for at least 45 minutes before inspection starts with test pressure / head of 10 kg / sq. cm lasting for two hours. The system must be tight at all joints.

E.1.6 Final Test:

After fixtures are set, test the system with smoke test as follows:

E.1.7 Smoke Test:

Fill traps with water, then introduce in to system a pungent thick smoke produced by one or more smoke machines. When smoke appears at stacks on the roof, plug stacks and allow pressure of 1 – inch water column to build up in systems. The system shall be tight at all joints.

E.1.8 Test all down spouts or rain headers and their branches within the building by water as described for the above soil, waste and vent system.

E.1.9 All Water Piping:

Hydro – static test 10 kg / cm 2 or twice the working pressure whichever is higher. Without drop in pressure as for a duration of minimum two hours.

E.1.10 All tests on below ground lines shall be continued to backfill on such a line is completed to disclose any damages caused by back filling.

E.1.11 All system shall be tested in section as required to expedite the work of other trades and meet construction schedules and final test on completion.

E.1.12 On completion of the works, the following tests shall be performed to the satisfaction of the consultants / client's representative before issue of virtual completion certificate, if so required.

a) Smoke Test
b) Hydraulic Test
c) Performance Test for fixtures
d) Tests for anti-siphonage system
e) Pump rating and output
f) Inspection of all units and fixtures.

E.1.13 The contractor shall arrange for similar tests during the progress of works to ensure that there are no defects in materials / workmanship in portions of work to be concealed or embedded under the floor or walls in ceiling and get this approved by the consultants. The under-floor pipe works shall not be closed without the approval of consultant.

F. Disinfection of piping System and Storage Tanks:

Before commissioning the water supply system, the contractor shall arrange to disinfect the entire system as described below. The filtered water storage tanks and pipe shall first be filled with water and thoroughly flushed out. The storage tanks shall be then filled with water again and disinfecting chemical containing chlorine added gradually, while tanks are being filled to ensure thorough mixing. Sufficient chemical shall be used to give the water. One part of chlorine to one million parts of water. If ordinary bleaching powder is mixed to 1000 litter of water, the powder shall be mixed with water to a creamy consistency before being added to the water in the storage tank. If a proprietary brand of chemical is used, the proportion shall be as specified by the manufacturer. When the storage tank is full, the supply shall be stopped and all the taps on the distributing pipes opened successively, working progressively from storage tank. Each tape shall be closed when the water discharge begins to smell of chlorine.

The storage tank shall then be filled up with water from supply pipe and added with more disinfecting chemical in the recommend proportion. The storage tank and pipe shall then remain charged at least for three hours. Finally, the tank and pipes shall be thoroughly flushed out before any water is used for domestic purpose.

G.0. PUMP AND ACCESSORIES

G.1. SCOPE:

This section of the contract involves the design, supply, installation, testing and commission of the complete plumbing system complete with all controls and electrical work for domestic water supply and for cooling tower make-up. All submersible water re-circulation, drainage and ejector pumps for the project are also included in this contract. It also involves testing and commissioning of the pumping system with the domestic water and flushing water supply & distribution.

This specification described the particulars of the contract, designs and systems chosen, and mode of operation.

All installation work shall comply with the latest rules and regulations.

The work embraced by this specification covers the design, submission to authorities, supply, delivery on site, installation, testing, commissioning and maintenance of the pumping system of the building in accordance with this specification and associated drawings.

The scope of work shall include the following (list is indicative and not exhaustive):

01	Suitably sized food grade quality, non-toxic diaphragm type pressure vessels complete with necessary interconnections and controls.
02	Pump control units.

03	Pump monitoring units to monitor operation of pumps.
04	Submersible water re-circulation pump for water fountain, drainage pumps for plant room drainage complete with electrical panels and necessary accessories with automation for pump operation.
05	Electrical equipment and installation work including the PLC in control panel.
06	Painting and labelling of pipe work and equipment.
07	Provision of all hold down bolts, spigots struts and the like required to be built in during construction:
08	Provision of dry contacts to BMS indicating the status of the pumps and pressure vessel in form of hardware interfacing panels inside each pump room and control panels of all pumps.
09	Provision of all level switches flow switches and other sensing devices for status indication.
10	All interfacing work with other trades.
11	Testing and commissioning and balancing of the pumping system:
12	Provision of twenty-four (24) months operational maintenance and breakdown services:
13	Provisions of operating instructions and maintenance manuals:
14	Provision of spare parts:
15	Training of the employer's staff for proper operation of the entire systems:
16	Liaison with local authorities to obtain all necessary certificates and approvals, including the completion of all submission drawings, forms and payment of any fees and charges. All the costs for all the tests required by local authorities shall be included. To attend to any authority's inspection regardless of whether this inspection is carried out after the defect liability period:
17	Provisions of the necessary installation which include pumping works, pope work within the pumping unit up to suction and discharge manifolds, conduit and control wiring, etc. to form a workable system required:
18	All other works and systems as specified in the contract document and or

	shown on the drawings.
9	All cutting, patching, framing up, furring in, chasing and making good associated with the building construction for the passage of pipers, conduits and the like including providing GI pipers sleeves of required size corresponding to pipe die, wherever pipes crossing fire rated walls and floors and sealing with glass wool in between and fire sea lent compound on either end. Details on shop drawings shall also be provided.

G.3.0 SUMP PUMPS:

G.3.1. SUBMERSIBLE:

These shall be fully submersible with a fully submersible motor. The pumps shall be provided with an automatic level controller and all interconnecting power and control cabling which shall cause the pumps to operate when the level in the sump rises to a present level and stop when the present low level is reached.

Pumps for drainage shall be single stage, single entry.

Pump shall be C.I. two vane open with a dynamically balanced impeller connected to a common shaft of the motor. The vane for sewage pump will be open type, while for drainage pump, etc it will be of semi open type. The MOC of the sump shall be in accordance to schedule of quantity.

Stuffing box shall be provided with mechanical seals.

Each pump shall be provided with a suitably rated induction motor suitable for 415 volts, 3 phases, 50 Hz A.C. power supply.

Each pump shall be provided with in built liquid level controller for operating the pump between predetermined levels.

The pumping set shall be for stationary application and shall be provided with pump connector unit. The delivery pipe shall be joined to the pump through a rubber diaphragm, and bend and guide pipe for easy installation.

Pump shall be provided with all accessories and devices necessary and required for the pump to make it a complete working system.

Sump pump shall be complete with level controllers / float switches, power and control switchgear, auto/off/manual switches, pumps priority selections and control and power cabling up to motor and controller/probes etc. (including earthling). Level controller shall be such that one pump starts on required level,

2nd pump cuts in at high level and alarms is given at extra high level. All level controllers / float switch shall be provided with remote level indications.

G.3.2 MOTOR DESIGN:

The pump motor shall be a squirrel cage induction, housed in air filled water-tight enclosure. Oil filled motors are acceptable. The stator windings shall be class ''F'' insulation (155-degree C or 311-degree F) general usage and class 'H' insulation (180-degree C or 317-8 grade 2) for submersible type.

The stator shall be heat shrunk fitted the enclosure and shall not use bolts, pins or other fasteners that penetrate the stator enclosure. The starter shall be equipped with a thermal switch embedded in series in the coils of the stator windings to protect the stator from wheel.

The motors shall design for continuous running duty type at 415 volts, 3 phase, 50 Hz power supply and capable of sustaining a minimum of 20 starts/stops per hour.

Between stator housing and pump, a tandem seal arrangement will be provided with an oil barrier. Both seals run in oil, allowing dry running without seal damage, both seals shall be of the rubber bellows or metallic bellow type with positive drive between shaft and rotating seal face.

I.6.0 COMMISSIONING AND GUARANTEE

I.6.1 SCOPE OF WORK:

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Contractor shall provide all tools, equipment, metering and the sting devices required for the purpose.

On award of work, contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

All tests shall be made in the presence of the architect or his representative or any inspecting authority. At least five working days' notice in writing shall be given to the inspecting parties before performing any test.

Water flow rates of all equipment and in pipe lines through valves shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

Contractor shall ensure proper balancing of the hydraulic system and for the pipes / valves installed in his scope of work by regulating the flow rates in the pipeline by valve operation. The contractor shall also provide permanent tee connection (with plug) in water supply lines for ease of installing pressure gauge, temperature gauge and rotameters. Contractor shall also supply all required pressure gauge, temperature gauge and rotameters for system commissioning and balancing. The balancing shall be to the satisfaction of consultant / project manager.

Three copies of all test result shall be submitted to the engineer in A4 size sheet paper within two weeks after completion of the tests.

I.6.2 PRE COMMISSIONING:

On completion of the installation of all pumps, piping, valves, pipe connections, installation etc., the contractor shall proceed as follows:

a)	Prior to start – up and hydraulic testing, the contractor shall clean the entire installation including all fitments and pipe work and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.
b)	All strainers shall be inspected and cleaned out or replaced.
c)	When the entire systems are reasonably clean, a pre – treatment chemical shall be introduced and circulated for at least 8 hours. Warning signs shall be provided at all outlets during pre – treatment. The pre – treatment chemical shall:
	Remove oil, grease and foreign residue from the pipe work and fittings.
	Pre – condition the metal surfaces to resist reaction with water or air.
	Establish an initial protective film.
	After pre – treatment, the system shall be drained and refilled with fresh water and left until the system is put in to operation.
	Details and procedures of the pre – treatment shall be submitted to the architect for approval.
d)	Check all clamps, supports and hangers provided for the pipes.
e)	Check all the equipment, piping and valves coming under hot water system and operate each and every valve on the system to see if the valves are functioning properly. There after conduct and hydro test of the system as for (b) above.
f)	Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specification. If any leakage is found, rectify the same and retest the pipes.

I.6.3 STATUTORY AUTHORITIES TESTS AND INSPECTIONS:

As and when notified in writing or instructed by the architect, the contractor shall submit shop drawing and attend all tests and inspections carried out by local fire authorities, water authority and other statutory authorities, and shall forth with execute free of charge any rectification work ordered by the architect as a result of such tests and inspections where these indicate non – compliance with statutory regulations. Some of these tests may take place after the issue of practical completion of the main contract and the contractor shall make all allowances in this respect.

The contractor shall be responsible for the submission of all necessary forms and shop drawings to the statutory authorities, which shall conform in layout to the latest architectural plans submitted to and kept by these authorities.

Fixing screws shall be half round head chromium plated (CP) brass screws, with CP brass washers unless otherwise specified.

Fixtures shall be installed by skilled workman with appropriate tools according to the best trade practice.

All appliances, fittings and fixtures shall be fixed in a neat workman like manner true to level and to heights shown on the drawings and in accordance with the manufacture's recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling, plaster, paint, insulation or terrace shall be made good by the contractor at his own cost. Fixtures shall be mounted rigid, plumb and true to alignment.

All materials shall be rustproof materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.

Wall flanges shall be provided on all walls, floors, columns etc. wherever supply and disposal pipes pierce through them. These wall caps shall be or chromium plated brass fittings and the receiving pipes and shall be large enough to cover the punctures properly.

Sanitary appliances, subject to the type of appliance and specific requirements, shall be fixed in accordance with the relevant standards and the following:

a)	Contractor shall, during the entire period of installation and afterwards protect the appliances by providing suitable cover or any other protection so as to absolutely prevent any damage to the appliances until handing over (the original protective wrapping shall be left in position for as long as possible).
b)	The appliances shall be placed in correct position or marked out in order that pipe work can be fixed or partially fixed first.
c)	The appliance shall be fixed in a manner such that it will facilitate subsequent removal if necessary.
d)	The appliance shall be securely fixed. Manufacturer's brackets and fixing methods shall be used wherever possible. Compatible rust – proofed fixings shall be used. Fixing shall be done in a manner that minimize noise transmission.
e)	Appliances shall not be bedded (e.g. WC pans, pedestal units) in thick strong mortar that could crack the unit (e.g. ceramic unit)
f)	Pipe connections shall be made with demountable unions. Pipe work shall not be fixed in a manner that it supports or partially supports and appliance.

The submission shall comply with the requirements set forth in the current codes of practice and circular letters of the statutory authorities. The shop drawings to be submitted shall be forwarded to the architect for checking before submission.

The contractor shall allow for at least two submissions of complete sets of shop drawings to the authorities, one to be made within six months after the award of the contract but not less than six weeks before the inspection. The architect may at his discretion instruct the contractor for additional submissions to the local authorities wherever necessary.

The contractor shall notify the architect at least seven days in advance of his application for local authority tests and inspections. On receipt of a confirmed date for test and inspection the contractor shall inform the architect without delay.

I.6.4 FINAL ACCEPTANCE TESTS:

Following commissioning and inspection of the entire installation, and prior to issue of the completion certificate, the contractor shall carry out final acceptance test in accordance with a programme to be agreed with the OWNER/CONSULTANT

Should the results of the acceptance tests show that plant, systems and / or equipment fails to perform the efficiencies or other performance figures as given in this specification, the contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant authorities having jurisdiction, these tests shall be carried out by the contractor prior to the issue of completion certificate to the acceptance of the authorities.

I.6.5 REJECTION OF INSTALLATION / PLANT:

Any items of plant or system or component which fails to comply with the requirements of this specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site may be rejected by the architect either in whole or in part as he considers necessary / appropriate.

Adjustment and / or modification work as required by the architect so as to comply with the authority's requirements and the intent of the specification shall be carried out by the contractor at his own expense and to the satisfaction of the authority / OWNER/CONSULTANT

After works have been accepted, the contractor may be required to carry out assist in carrying out additional performance tests as reasonably required by the architect / employer.

I.6.6 WARRANTY AND HANDOVER:

The contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the owner.

I.6.7 HANDING OVER OF DOCUMENTS:

All testing and commissioning shall be done by the contractor to the entire satisfaction of the owner's site representative and all testing and commissioning documents shall be handed over to the owner's site representative.

The contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the owner's site representative.

I.6.8 PIPE COLOUR CODE:

Sl. No.	Pipe Lines	Ground / Base colour	First colour brand	Second colour brand
01.	Drinking water (all cold-water lines after filter)	Sea Green	French blue	Single red

02.	Treated water (soft water)	Sea Green	Light Orange	
03.	Domestic hot water	Sea Green	Light grey	
04.	Drainage	Block		
05.	Gas	Canary Yellow		

Colour code to confirm to IS: 2379:1990.

TECHNICAL SPECIFICATION

FOR

FIRE PROTECTION SYSTEM

TECHNICAL SPECIFICATION FOR FIRE PROTECTION SYSTEM

A. SPECIFICATION FOR FIRE HYDRANT SYSTEM.

1.0 Scope of Work.

Following are the different items of work, which have to be designed, supplied, erected, tested and commissioned.

1.1 Automatic fire hydrant system, consisting of Electrical Jockey pump and diesel main hydrant pumps, electrical main pump, G.I. / MS Piping with fittings, valves, yard hydrants and hose cabinets & sprinklers.

2.0 Regulations and Standards.

The installation shall conform in all respects, to the following broad list of standards in general and in particulars, the materials used shall bear the prevalent ISI marking. UL, F.M, approved...

IS: 901-1975	:	Specification for coupling – double male and double female, instantaneous pattern, for firefighting.
IS: 902-1974	:	Specification for suction hose coupling for fighting purpose.
MSS SP 67	:	Butterfly valves.
API 609	:	Butterfly valves, lug type & wafer type.

IS: 1536-1976 : Centrifugally cast (spun) cast iron pressure pipe for water, gas and sewage.

IS: 1239 : Mild steel tube, tubular and other wrought steel fittings.

IS: 1538-78 : Cast iron fittings for pressure pipes for water, gas and sewage.

IS: 8423-1977 : Controlled percolating hose for firefighting.

IS: 5290-1983 : Landing valves.

IS: 5306 : Code of practice for fire extinguishing installation and equipment on premises.

ADI: 610 : Centrifugal pump for general refinery service.

IS: 1648-1966 : Code of practice for building (general) firefighting equipment and their maintenance.

IS: 3844-1966 : Code of practice for installation for internal fire hydrants in multi-storied buildings.

IS: 2871-1983	:	Branch pipe, universal for firefighting purposes.
IS: 384-1969	:	First aid hose reel for firefighting.
IS: 5132-1968	:	Hose reel tubing for fire protection system
BS: 5155	:	Cast iron and carbon steel butterfly valves
NBC	:	National Building Code of India Part IV for Fire Protection System
NFPA	:	Standard on Clean agent fire extinguishing Systems
API 600 / BS 5163: IS778/780/2906		Specifications for Gun Metal gate, globe & check Valves for water supply.
IS-4927	:	Specifications for Canvas Hose Pipes.
IS-903	:	Specifications for Branch pipes Fire hose Couplings and auxiliary equipment's

IS-1200 : Method of measuring of building & civil Engineering Works (water supply, plumbing drain & sanitary fittings)

IS-4853 : Recommended practice for radiographic Inspection of fusion welded butt joints in steel pipes.

IS-636 : Synthetic, jacketed hose pipes.

IS-2198 : Control Panels.

IS-2159 : Hot dip galvanizing of iron and steel

IS-5 : Specification for painting

IS 9137 : Specification for horizontal end suction centrifugal Pump

BS-1965 Part I : Specification for butt-welded Pipe Fittings.

IS 8423 ; Controlled percolating hose for firefighting.

IS 884 : First aid hose reel for fire fighting

IS 2190 : Code of practice for selection, installation

And maintenance of portable first aid fire extinguishers.

IS 937 : Specification for washers for water fittings for fire Fighting system.

IS 9972 : Specification for automatic sprinkler heads.

IS 2171 ; Dry chemical powder type Fire extinguishers

IS 940 : Water type CO2 Fire extinguishers

IS 2878 : Carbon – di – oxide type Fire extinguishers

3.0 DRAWINGS:

The drawings enclosed herewith are for the general guidance to tenderer. The contractor shall, upon award of the work, furnish detailed drawing necessary to carry out the work at site, within 15 days. These shall be submitted for approval, to the architects / owners.

3.1 Drawing information required from successful tenderer within 15 days, after the award of work.

a) Pump GA and cross-sectional drawings.

b) Performance curve for the pump.

c) Necessary civil scope (openings, cut outs, foundations etc.,) drawing for the system.

d) Bar chart showing engineering, manufacturing and dispatch of each equipment and erection services.

e) Drawing, literature and technical particulars of all bought out items.

f) Control logic diagram for the pump to start.

g) Schedule for valves and piping material.

4.0 INSPECTION AND APPROVAL.

The contractor shall arrange for all the tests, andconfirm his workmanship and performance of the works as per the fire authority standards, and record all the test result and submit to the owner / client engineering incharge.

5.0 PAINTING.

All piping, equipment, cabinets furnished under this specification, shall be properly painted with two coats of synthetic enamel paint after installation and shall meet the requirements as outlined in the Fire Protection Manual. The cost of the painting is deemed to be included in the respective items.

6.0 GUARANTEE.

The contractor shall guarantee the material and workmanship of the entire system, are of first-class quality and shall correspond to standard engineering practice. All the equipment / apparatus shall be guaranteed to yield the specified rating and design capacities and speeds. Any defective equipment/material/workmanship found short of the specified quality, shall be rejected and the contractor shall make

good, the rejected items at his own cost. Guarantee certificate of equipment from suppliers/manufacturers shall be handed over to the owner.

7.0 DEFECTS & LIABILITY.

All the equipment/material and the system, shall be guaranteed against defective material and workmanship, for a period of 12 months form the date of commissioning and handing over the installation to the owner, along with all relevant documentation. The contractor shall repair/rectify or replace all the defective materials & components, free of cost. In addition, normal maintenance shall be carried out periodically during the defects and liability period, including replacement of spares, as required.

8.0 INSTRUCTION MANUAL/COMPLETION DRAWINGS/TRAINING.

The contractor shall furnish a detailed instruction and operation manual in quadruplicate. The contractor shall also furnish detailed completion drawings on tracing sheet, drawn to an approved scale. The drawings shall be inclusive of control schematic, if any. The contractor shall train the Employer's personnel in the operation and maintenance of the system for one month.

9.0 TESTING.

The contractor shall arrange to test the entire system as per the procedure enumerated under particular specifications, after the erection is completed. The tests shall be carried out to the satisfaction of the architects /owners. The results of the tests shall be submitted to the owner, in triplicate. If the results of the test are not found to be satisfactory by the architects / engineer in-charge, necessary rectifications shall be done until the test results are found to be satisfactory. The installation shall be deemed to be completed only after the successful completion of the tests.

10.0 TECHNICAL DATA.

The tenderer shall furnish data of their equipment, as per the Performa under 'Technical data'. The tenders without technical data are liable to be rejected.

11.0 ARTICULAR SPECIFICATIONS.

11.1 Data:

11.1.1 Type - Down Comer Systems

a) Number of fire pumps : 2 Nos. of Terrace pump.

b) Over Head Tank Fire : 25,000ltrs 2 Nos.

11.2 Piping:

Underground piping shall be of G.I. tube of heavy grade, conforming to IS: 1239.P-1, The piping shall be laid not less than 1 m below the ground level, suitable masonry supports, concrete anchor blocks of suitable design, shall be provided at every change of direction of pipeline, both horizontal and vertical and near every pipe joint, where soil conditions are unsatisfactory. All fittings shall be G.I. 'C' class, conforming to IS: 1239.P-II.

Flanges shall be faced up and shall have jointing of rubber insertion of asbestos compound. The joints shall be capable of withstanding a pressure of 10.5 Kg / comes. All the ground piping shall be supported by angle iron brackets on walls or suspended by hangers from the ceiling or concrete pedestals at some places. Piping over ground shall be painted with two coats of approved enamel over a coat of primer after the installation and testing.

11.3 Anti-Corrosive Treatment for Underground Piping.

G.I. pipes laid outdoor in trenches/buried in earth, shall be cleaned and painted with two coats of anti – corrosive primer and wrapped with 4mm thick polymer corrosion protection tape confirming to IS – 10221, with proper over lapping, trimming etc., Pipes passing through masonry walls, foundation and beams, shall be taken through embedded pipe sleeve of the same material. The pipe sleeve size should be at least 1 ½ times the diameter of the crossing pipeline. The pipeline running below the floor, shall be given an anti-corrosive treatment same as that for underground piping. The wrapping material shall be fibre glass RP tissue, grade RP 40, with density 800 gm /sq.

11.4 Butterfly valves – Vertical/Horizontal gear type.

Butterfly valves shall conform to the following specifications:

Body: High duty cast iron to IS 210 Gr FG 220 & BS 1452 Gr 220

Seating: Mauled inside resilient lining of black nitrite rubber.

Disk: Nylon coated SG iron to IS 1865/SG 400/12 & BS 2729 Gr 420/12.

Shaft: The shafts are made of stainless steel AISI 431.only flanged end valves to be used with flanges drilled to BS 10 Table F. Valves shall be capable of being locked in open position. Hand wheel shall be with vertical gear unit for smooth opening and closing of the valve-key rods with MS coated extended spindles to be provided whenever the valves are not approachable from the ground surface.

11.5 Non-Return valves.

Non-return valve shall be of cast iron, with gun metal seat, non-return valves shall be of flanged type. Spring loaded valves shall not be used. The valves shall be suitable for a test pressure of 21 kg/sq.cm.

11.6 Hydrant valves (landing valves)

Landing valves shall be gun metal 63mm dia. Oblique female instantaneous pattern with caps and chains. Landing valves shall conform to IS: 5290 in all respects. Double headed landing valves shall have separate control valves. Landing valves shall be of gun metal and fitted with instantaneous coupling, conforming to IS: 901. The coupling shall be fitted with an internal plug secured by a chain. Landing valves shall be installed on hydrant risers, at a height of 1 to 1.2 meter form the floor level. The landing valves shall be connected to the wet riser stand pipes, by means of a suitable tee, the cost of which is deemed to be included in the unit rate for piping.

11.7 Hose pipes.

All hose pipes shall be of 63m diameter and made of RRL, as per IS: 636, Type-I.

11.8 Branch Piping and Nozzle.

Branch pipes shall be of gun metal/iron, to fit into the instantaneous coupling. Nozzle shall be of spray or fog type of diameter of not less than 16mm and not more than 25mm. Branch pipe and nozzle, shall be of instantaneous pattern.

11.9 Hose Cabinet

Hose cabinet shall be glass (4mm thick) fronted with double hinged door and lock. The cabinet shall be made of 16G MS sheet and spray painted to scarlet red colour. The hose cabinet shall be of a suitable size, to accommodate the following:

a) Landing valves (Double headed)
b) 63mm Hose pipe.

c) Branch pipe and nozzles.
d) Two keys of break glass recess for keys.

11.10 Terrace Fire pump:

a) Pumping sets.

Pumping sets shall be single or multistage horizontal centrifugal multi-outlet pumps, with cast iron body and bronze, dynamically balanced impeller, connecting the shaft, shall be of stainless steel.

b) Pumps shall be connected to the drive, by means of a flexible coupling.

c) Pumps shall be provided with approved type of mechanical seals pressure gauge, with isolation cock on the delivery side.

12.0 Testing:

After laying and jointing, the piping shall be pressure tested by hydrostatic method. The piping shall be slowly filled with water, in order to expel all the air. The piping shall then be allowed to stand full of water, for 24 hours. Any leakages at flanges or elsewhere shall be rectified. The pressure shall then be applied by means of a test pump. The test pressure shall not exceed 10.5 kg/sq.cm under any circumstances whatsoever.

Pressure gauges used for the test shall be accurate and shall preferably have been calibrated before the test. The open ends of the piping shall be checked with respect to the contractor's piping and equipment layout. Tests shall be conducted to determine the delivery head, flow end BHP of pumps after installation. All the leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the owner.

The system shall also be tested for its desired performance and function, by opening hydrant valves on each floor separately & four landing valves, simultaneously. The flow of water at the top most hydrant, shall be checked when

three landing valves below, are open. The cutting in and cutting out pressure setting of starting devices shall also be checked for its correct operation.

The test results shall be recorded and countersigned by the owners' representatives and submitted in triplicate for approval by the owner.

13.0 **Fire brigade inlet connection.**

Fire brigade inlet connection to the UG tank shall comprise four instantaneous pattern 63mm dia. Inlets, with caps and chains complete with 4mm thick non-return, housed in a 16G MS cabinet with glass fronted door. The cabinet shall be 1000 x 300 x 400mm size for recess mounting.

14.0 Base plate:

Pumps and motors shall be mounted on a common structural base plate with anti-vibration mounting.

15.0 Yard hydrants.

Yard hydrant shall comprise 80mm dia. MS flanged stand pipe, 63mm dia. Gun metal instantaneous landing valve. The buried protection shall be anti-corrosive treatment as per specification.

TECHNICAL DATA

:

B. TERRACE PUMP.

1. Type :
2. Make :
3. Capacity in LPS :
4. Delivery held, in Mrs. :
5. Material of impeller :
6. Rated speed in rpm :
7. Suction & delivery sizes in mm :
8. Type of drive recommended :
9. Recommended motor rating :
10. Material of casing shaft :
11. Efficiency of the pump at rated capacity & head :

C. PIPES.

1. Make :

2. Standard (IS/BS) :

D. LANDING VALVE:

1. Make :

2. Type :

3. Standard (IS/BS) :

4. Whether approved by F.A / TAC : Yes/No

E. VALVES.

1. Make :

2. Material of seat :

3. Material of body :

4. Whether approved by F.A. / TAC : Yes/No

F. HOSE PIPES.

1. Make :

2. Material of body :

3. Whether as per IS : Yes/No

4. Whether approved by F.A. / TAC : Yes/No

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TECHNICAL SPECIFICATION

FOR

ELECTRICAL WORKS

TECHNICAL SPECIFICATION FOR TRANSFORMERS

1.0 SCOPE:

The following specification cover the supply of transformer required for the proposed project.

GENERALINFORMATION:

Transformer shall design, manufactured and equipped with accessories in accordance with this specification and the applicable standards indicatedbelow.

The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance andservice lift.

Transformers shall be suitable for the following ambient conditions; - Designambienttemperature -- 50oc

Maximumhumidity --100%

CODE ANDSTANDARDS; -

The transformers shall conform to the requirement of the revisions of the following codes andstandards

IS:1886: Installation and maintenance of transformers, code of

practice. IS:2026: Power Transformers.
(Part I to IV)

IS :3639: Power Transformers, fittings and accessories. IS: 2099: Bushings for alternating voltage above 1000V. IS: 5-1961: Colours for ready mixed paints andenamels.

IS: 1866: Code of practice for maintenance of insulating oil. IS: 2166: Guide for insulating co-ordination.

IS: 6600: Guide for loading of oil-immersed transformers.

Wherever Indian Standards are not available, the transformer shall conform to relevant International Standard.

DESIGNCRITERIA:

The transformers shall be oil filled type and designed for natural cooling (ON).
The transformer impedance shall be as specified to limit the fault level on the LV side. The neutral of the low voltage winding will be solidly grounded.

The transformers with all accessories shall be capable of withstanding the thermal and mechanical effects of short circuits at the terminals of any winding without adverseeffect.

Account shall be taken of the different forms of system fault that can be arise in service, such as line to earth faults and line faults associated with the relevant system and transformer earthing conditions. The short circuit levels will be as specified in the DataSheet.

The transformer shall be capable of continuous operation at its rated output without exceeding the temperature limits as below (50 ofabove ambienttemperature).

In top oil by thermometer
--- 50
co. In winding by resistance ---
550C

Overheads shall be allowed within the conditions defined in the loading guide of the applicable standard. Under these conditions no limitations by terminal bushings, on load tap changers or other auxiliary equipment shall apply.

The transformer shall be capable of continuous normal operation at its rated output under the followingconditions:

Voltage varying by +\- 10%
Frequency varying by +\- 3%

The transformer shall be designed and constructed so as not to cause any undesirable interference in radio or communicationcircuits.

Steel bolts and nuts exposed to the atmosphere shall be either galvanized or zincpassivated.

Nuts, bolts and pins used inside the transformer and tap changer compartments shall be provided withlock washers or lock nuts.

Transformer design shall take care of protection againstsurge voltage.

Internal design of transformer shall ensure that air is not trapped in any location.

The neutral terminal of windings shall be designed for the highest over current that can flow through thiswinding.

The design of transformers shall be such as to reduce noise and vibration to the level obtained in good modern practice. The noise level shall not be more than 5db above the NEMATR-1.

All rated quantities such as voltage ratios, impedance, load losses and no-load losses subject to the Supplier's guarantees

shall be within the tolerances given in applicablestandards.

TRANSFORMERTANK

The tank shall be of electrically welded construction and fabricated from sheet steel of adequate thickness. Tanks shall be hydraulically tested to ensure that they are leak proof and subjected to vacuumtest.

The tank shall have adequate strength to withstand without any deformation (I) mechanical shock during transportation and (ii) filling by vacuum.

The tank shall also be provided with two numbers grounding pads for earthing.

The transformer tank shall be provided with sets of bi-directional flat wheels for rolling the transformer parallel to eithercentre lines.

Jacking pads, lifting eyes and pulling lugs shall be provided to facilities lifting and movement of the transformer, filled with oil. All heavy removablepartsshallbeprovidedwitheyeboltforcaseofhandling.

The transformer top shall be provided with a detachable tank cover with a bolted flanged gasket joint. Lifting lugs shall be provided for removing the cover. If necessary the surface of the cover shallbe suitablystopped sothat it does not retain rainwater.

Adequate space shall be provided at the bottom of the tank for collection ofsediments.
The transformer base shall be designed to permit skidding of the complete transformer unit in any direction. Pulling eyes shall be provided for moving the transformer in either directions.

The material used for gaskets shall be Nitride. Rubber or approved equivalent. Gasket joints for the tank and manhole covers bushings and other bolted attachments shall be oil tight and so designed that the gasket will not be exposed to the

weather.

Tank shall be provided with a pressure release device which shall operate at a pressure below the test pressure for the tank and radiators. The device shall be rain-proof after blowing and shall be provided witha device visible from ground to indicate operation. An equalizer pipe connecting the pressure relief device to the conservator shall be supplied.

Materials in contact with oil shall be such as not to contribute to the formation of acid in oil. Surface in contact with oil shall not be galvanized or cadmiumplated.

Inspection covers of manholes of sufficient size shall be provided for access to leads, windings, bottom terminals of bushings andtaps.

Oil sampling taps shall be provided with valve at top and bottom to collect sample of oil from the tank for testing.

To facilitate the oil filtration by streamline filter, suitable inlet and outlet taps with valves at the bottom and to the top of the tank on diagonally opposite corners shall be provided. The valve at the bottom may be used as drain valve.

Thermometer pocket for top oil temperature measurement by liquid thermometer shall beprovided.

Marshalling kiosk boxes, etc. shall be weatherproof having a degree of protection toIP:54.

Cooling tubes or radiators shall permit every part of the cooling surface to be cleaned by hand and shall be suitably braced to protect them from mechanical shock. Each radiator tank shall be detachable type and provided with oil isolating valves at eithersize.

The transformer tank shall be fitted with a double diaphragm type of explosion relief vent at the top with equalizer pipe connection to conservator.
Explosion relief vent should be located on the top cover and

directed in such a way that bursting of diaphragm the oil forced out will not fall in any of the auxiliary equipment of the transformer and the other electrical equipment in thevicinity.

CORE ANDCOIL

The core shall be built up of high quality, low loss, non-aging high permeability grain oriented, cold rolled silicon steel lamination with very low magnetization losses and annealed stresses and develop excellent magneticproperties.

The core clamping frame shall be provided with lifting eyes for the purpose of taking and inspecting the core with drawings mounted thereon and shall have ample strength to take the full weight of the core and winding assembly. The core assembly shall be electrically connected to the transformer tank for effective coreearthing.

All insulating material shall be of proven design. Coils shall be so insulated that voltage stresses areminimum.

The winding shall form electrolytic copper conductor of high conductivity withsuitableclass"B"insulation.Thewindingsshallbedulysectionalized.

Similar coils shall be connected by accessible joints braced or welded and finished smooth.

Coil assembly shall be securely positioned with spacers, pressed board cylinders, barriers and shall be so arranged as to allow free circulation of thesoil.
All leads from the windings shall be suitably supported to prevent damage from vibration or short circuits tresses.

The core and coil assembly shall be rigidly braced and fixed on to the tank so that no shifting or deformation occur during transport and installation or during shortcircuits.

The finally assembled core with all the clamping structure shall be free from deformation and shall not vibrate

duringoperation.

The core clamping structure shall be designed minimize eddy currentloss.

The end turnson the high voltage windings shall have reinforced insulation to withstand any of the voltage surges likely to occur during switching or any other abnormal systemcondition.

INTERNALEARTHING:

All internal metal parts of the transformer, with the exception of individual laminations, core bolts and their individual clamping plates shall be earthed.

The top clamping structure shall be connected to the clamping structure at one point only and this shall be brought out of the top cover of the transformer tank through a suitably rated bushing. A disconnecting link shallbe provided on transformer tank to facilitate dis-connections from the ground for IR measurement purpose.

TAPPINGS:

Offcircuittapsasspecifiedshallbeprovidedtothehighvoltagewinding.

The transformer shall be capable of delivering its rated output at any tap position.
The winding including the tapping arrangement shall be designed to preserve the electromagnetic balance between HV and LV winding at all voltage ratios.

INSULATINGOIL:
The insulating oil shall conform to the latest revision of IS:335, properly inhibited for prevention of sliding.

The necessary first filling of soil shall also be provided (to take care of wastage's) in non-returnable containers suitablefor outdoor storing.

TRANSFORMER BUSHING:

All transformer bushings shall conform to the requirements of the latest revisions of IS:2099 AND3347.

All porcelain used in bushings shall be homogenous, nonporous uniformly glazed to brown colourand free from blisters, burns and other defects.

Stresses due to expansion and contraction in any part of the bushing shall not lead todeterioration.

Fittings made of steel or malleable iron shall be galvanized. Each bushing shall be so co-ordinate with the transformer insulation that all flash over will occur outside thetank.

The bushings shall be located so as to provide adequate electrical clearances between the bushings and also between bushing and ground.

TERMINALARRANGEMENT:

The HV terminals shall be brought to an air insulated disconnecting chamber forming a weatherproofassembly.

The secondary terminations shall be brought to an air insulated disconnecting chamber which in turn connected to but-ductile box connection as required forming a weatherproofassembly.
The cable boxes shall have all standard facilities suitable for XLPE\PILC\PVC cables/copper/Aluminium wire bus duct as mentioned in the datasheet.

The disconnecting chamber shall be air insulated Bushings., drain plugs, relief vent, levels glass, removable links and removable covers shall be provided for the dis-connecting chamber. Plates through which high current carrying conductors pass shall benon-magnetic.

Phase to phase and phase to ground clearances within the chamber shall be such as to enable either the transformer or each cable to be subjected separately to H.V.tests.

NEUTRALTERMINAL:

The size of the neutral bushings shall be as that of phase bushings. On the L.T side two bushings shall be provided for neutral, one through top side wall bushings to the LV bus duct and other connection to earthing. A neutral CT of required ration, burden and knee point voltage fault protection. This will be a matched current transformer which will be mounted in H.T. switchgear. Secondary of the CT to be brought out to a marshalling box of IP-54 suitable for connection to controlcable.

Earth portion of the cable end box shall be provided with 2 nos. grading pads suitable for purchaser's 50x6 mm G.I/Copperflat.

TEMPERATUREINDICATORS:

One set of dial type thermometers with a pointer a register the highest temperature attained for oil temperature indication/winding temperature indication shall be supplied and fitted inside the marshalling box. Two separate sets of contacts shall be provided, one for alarm and the other for circuit breaker trip on highertemperature.

BUILT ONRADIATORS:

The following accessories shall be provided for radiator. Top and bottom shut-off valves and blanking plates on eachradiator.

Lifting lugs.
Top oil fillingplug.
Air release plug attop.
Oil drain plug atbottom.

CONSERVATORTANK:

The conservator tank shall be connected with the main tank by

a pipe through bushels relay (having separate sets of contacts for alarm and tripping) with isolating valves at bothends.

The conservator tank shall be provided with dial type (magnetic) level indicator visible from ground level and fitted with low oil level alarm contact.

A weather proof dehydrating breather shall be provided with silica gel as the dehydratingagent.

MARSHALLINGBOX:

A dust and weather proof marshalling box suitable for outdoor use shall be provided. The box shall contain terminal blocks meant for Buyer's control cable connections and all auxiliary devices. The marshalling box shall be provided with a blank detachable plate for mounting the control glands. The control cable glands are not within the scope of this specification. The marshalling box shall have glass front for reading the temperature indicators from outside. Degree of protectionIP:54.

GAS AND OIL ACTULATED RELAY (BUCHHOLZRELAY):]

A double float type Bushels relay as per specified standards shall be provided if specified in data sheet. All gases involved in the transformer shall collect in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation. A 5mm copper pipe shall be connected from the relay test cock to a valve located about 1.25 M above ground level to facilitate sampling with the transformerin services. The device shall be provided with twoelectrically

independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure. These contacts shall be wired up to the transformer marshalling box. The relay shall be provided with shut-off valves on the conservator side as well as the tank side.

WIRING:

Wiring for winding and oil temperature indicators, magnetic level gauge, Bushels relay contacts and neutral CT etc. provided on the transformer shall be wired up to the terminal blocks inside the marshalling box by means of 2.5 Sq.mm for CT's) f flexible PVC copper cables. Wires shall be identified at the terminations by numbered plasticferrules.

Not more than two wires shall be connected to one terminal. 10% spare terminals shall beprovided.

Auxiliary supply to all indications, alarms and trip contacts provided shall be suitable for operation on a suitable A.C\Dsystem.

All devices and terminal blocks within the marshalling box shall be clearly identified by symbols corresponding to these used on applicable schematic or wiringdiagram.

METAL TREATMENT ANDPAINTING:

All steel surfaces shall be thoroughly cleaned by sand blasting to Sa 21\2 or chemical agents as required to produce a smooth surface, free of scale, rust andgrease.

All paints shall be carefully selected to withstand tropical heat, rain, etc. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling. Preferably painting of Epoxybased.

Tanks are coated inside with oil and heat resistant paint. The external surfaces shall be given a coat of high-quality zinc chromate primer followed by two coats of high-quality paint as

perIS:5-1961.

TOLERANCES ON PERFORMANCE GUARANTEES:

The permissible tolerances on the performance guarantee are as follows:

A. Voltage ratioatno.load.	a) 0.5% of the declaredratio. b) A percentage of the declared ratioequal to 10% of the actual percentage impedance voltage at rated current.
B. No.loadloss	+\-10%.
C. Loadloss	+\-10% on principaltap.
D. Impedancevoltageat Ratedcurrent	In accordance with the toleranceson impedance voltage and losses asApplicable.

REJECTION:

Buyer may reject any transformer if during tests or services any of the following conditions arise.

No load and losses exceedthe guaranteed value by 15% ormore.

Impedance voltage at principal tapping differs the guaranteedvalue by

+\- 10% or more.

Transformer fails during any of thetest

Transformer is proved to have been manufactured not in accordance with the agreedspecification.

Buyer reserves the right to retain the rejected transformer and take it into service until the supplier replaces at no extra cost to buyer, the defective transformer by a new acceptabletransformer.

Seller shall repair or replace the transformer within a reasonable period to the Buyer's satisfaction at no extra costto the Buyer.

DIMENSIONS:

The overall dimensions of the transformer shall be indicated along with theoffer.

TESTS:

RoutineTests:

During manufacture and on completion, transformers shall be subjected to the routine tests as laid down in IS:2026-1977 as amended up to date.

These includes:

a) Resistance measurement of all windings at the rated voltage connection on all taps.
b) Ratio tests at the rated voltage connection on alltaps.
c) Polarity and phase relation tests.
d) Impedance and load loss at rated current on the rated voltage and connection on alltaps.
e) No-load and current at rated voltage on the rated voltage connection and at 95,110 and 115% of the ratedvoltage.
f) Power frequency with stand test.
g) Insulation resistance tests in windings, auxiliary devices, core andtank.

In addition, the following tests shall be performed on each transformer.

a) After fabrication, each tank fitted with all valves, covers, etc., shall be tested for leaks with normal head of liquid plus 0.352 Kg/Sq.cm for a period of 12 hours. If anyleakoccurs,thetestshallbeconductedafterallleakshavebeenrepaired.

b) The tank shall be subjected to vacuum as per CBIPspecifications.

TYPETESTS:

Typical type test certificates shall be furnished for approval before dispatch of equipment's.

TESTCERTIFICATES:

Three (3) copies of test certificates including for bought-out items like relays, valves, etc., shall be furnished to the Buyer, along with complete identification of data including serial number of thetransformer.

TheBuyerwilldeputehisrepresentativetowitnessany (or)allthetests.

If the tolerance exceeds the limits prescribed in standards, Buyer has right to reject thetransformer.

SPARES:

The spares as in data sheet shall be quoted along with the supply of transformers.

PACKING:

Packing should be of high quality to avoid any damage of the equipment's duringtransit.

30.1 DRAWING\DETAIL\DOCUMENT:

A general outline drawing of each transformer shall be furnished with the offer. The drawing shall indicate dimensions net weights, quantity of insulating oil, general constructional features, dimension of the largest part to be transportedetc.

After acceptance of the offer, the Seller shall furnish the following drawings for approval.

a) General arrangement drawing showing the plan, front elevation, side elevation, foundation plan complete with details of bill of materials, detailed dimensions, net, weights, details/drawings of HV\LV terminals, cable boxes, LT trucking arrangement, clearances between HV\LV terminals groundetc.
b) Rating and terminal marking platesdetails.

c) Control and wiring diagram for marshalling boxes, with interconnection details of cable sizes and number of cores required between various equipment such as relays, marshalling box,etc.

Four copies of all final approved drawings shall be furnished by the Seller before dispatch of the equipment.

Any other relevant drawing and data necessary for operation and maintenance purpose shall befurnished.

Three sets of instructed manuals of transformer, its various fittings and gauges (the manual shall clearly indicate the installation methods, check-ups and tests to be carried out before commissioning of the equipment's) shall be furnished to Buyers. One set of the above shall be submitted to Architects.

SPECIFICATION FOR ERECTION, TESTING & COMMISSIONING OF TRANSFORMER

1.0 Inspection, storage, installation, testing and commissioning of transformer shall be in accordance with IS 10028 (Part III), and manufacturer's instructions.

2.0 Whenever stated, transformer will be delivered without oil, filled with inert gas and without bushing and externally mounted accessories as applicable. The contractor shall:

Assemble the transformers with all fittings such as bushings, cooler banks, radiators, conservators, valves, piping's, cable boxes, marshalling boxes, OLTOG, cooling fans/pumps etc.

Arrange for oil filtration beforefilling.

Provide wedges/clamps to rigidly station all transformers on rails Connect up the transformer'sterminals.

Lay and terminate the Owners cables/conduits between all the accessories mounted on the transformer marshalling Kiosk. If necessary, the oil filtration equipment shall be arranged by theContractor.

3.0 Care shall be taken during handling of insulation oil to prevent ingress or moisture of foreign matter. In the testing, circulating. Filtering or otherwise handling of oil, rubber hoses shall not be used. Circulation of filtering of oil, the heating of oil by regulated short-circuit current during drying runs and sampling and testing of oil shall be in accordance with the manufacture's instructions and specified Code ofPractice.

4.0 HANDLING:

Transformer and all its accessories shall be handled carefully in its upright position as indicated in the packing case. Lifting lugs and jacking pads shall be used for lifting of the transformer. While using jacking pads utmost care shall be taken improper application of jacks. Where transformer is dragged or pulled on slier or rollers. The traction eyes provided at the bottom frame shall be used with suitable wire ropes and shackles.

5.0 STORAGE:

Transformer shall be stored under shelter in a place free from fire and explosion hazards. Care should be taken to see that moisture will not contaminate Oil inside the tank by checking all gaskets, bolts and nuts and accessories.

CABLING AND EARTHING:

Cable shall be terminated at cable boxes only after IR values are, measured and found to be in order. Cable termination shall be carried out with utmost care and H.T. cable box shall be filled with compound, after jointing and terminations. Neutral of the transformer shall be connected to two separate and distinct earth station through double run of earth tapes of suitable size. The body of the transformer shall also be provided with effective earthing as per the drawings andspecifications.

MOUNTING ANDERECTION:

The transformer shall be lifted by lugs or shackles or by any other suitable means (such as dragging on rollers) and mounted on the concrete plinth prepared for the purpose. Care shall be taken to see that transformer is not titled during lifting and erection. The roller shall be taken to see that the transformer is not titled during lifting and erection. The roller shall be checked to prevent movement of the transformer after being positioned on the plinth. Adequate and necessary clearance from walls. Other equipment's, etc. shall be provided as indicated on thedrawings.

All the accessories and parts such as conservator tank Bushels relay, breather, explosion vent, thermometer etc. should be mounted on the transformer, tighten all bolts and nuts should be tightened and checked for any leakage. Any leakages shall berectified.

Check the oil level and top it up, if necessary with new oil dielectric strength of oil shall be tested as per IS\BS specifications, with an electric gap of 4mm+or –0.02mm polished Electrodes of 12.5 mm die using three samples of oil drawn from the oil drain valve of the transformer. The test voltage shall be

raised from 15Kv in about 10 seconds. At leasttwo samplesof oil must withstand 40kv voltage for oneminute.

The insulation resistance of the winding shall be measured with 1100 V DC Meguroand results shall correspond to the factory testresults.

If dielectric strength of oil is not as per the requirement, the drying of oil shall be done with the help of suitable streamline oil treatment plant. While drying of oil is being done, the transformer shall be provided with suitable lagging around. The temperature of oil in the spray tank shall not exceed 80Oc during conform to the conditions laid down in IS Specifications.

Phasing oust test with 416 Volts applied to HV winding and voltage across LV winding beingchecked.

Measurement of neutral and body earth resistance with earth testing Margrethe values shall not exceed 1to 2 ohms as required.

Functioning of Buckholt relay (for alarm and trip), thermometer, oil level indicator shall be checked and adjusted, if necessary. The transformer shall be checked and only after the above tests are conducted and approval of neutral and body of the transformer shall be done as per I.E regulations and the requirements and of localauthorities.

However general mode of earthing arrangement indicated on the drawings. The contractor shall supply all the materials and labour for erection and commissioning of transformers.

7.0 TESTS:

The following Preliminary checks and Preconditioning tests shall be carried out before coming the transformers.

8.10 PRELIMINARY CHECKS:

Compare name plates details with thespecifications.

Check for any physical damage, in particular orbushings.

Check tightness of all bolts, nuts, clamps, gasketing and connectingterminals.
Check cleanliness ofbushings.
Check for oil leakage and oil level.
Breather condition, check whether.
Check for clearance, particularly in case of busducts.
Water tightness of terminal boxes and busducts.
Earthing of transformer tank and neutralbushing.
Releasing of air from bushings (very important) bushelsrelay.
Check that the transformer is correctly installed with reference to itsphasing.

Pre-Commissioningtests:

Test the transformer oil for dielectricstrength.

Phase sequencetest.

Line connection as per phasingdiagram.

Insulation resistance of controlwiring.

Bushels relay operation (for alarm andtrip).

Operation test of all protecting devices andinterlocks.

Calibration of temperature indicator (oil and winding) and temperaturerelays.

OLTC gear/control operationaltest.

OLTC control indicating and alarmcircuits.

TECHNICAL SPECIFICATION FOR LT PANELS

❖ GENERAL:

This specification covers design, manufacture, testing and supply at site of the following 415 V, D50HZ,switchboards.

The panels shall be dust, vermin and corrosion proof construction, sheet steel, clad totally enclosed, compartmentalized cubicle design with front access and rear access.

- PANEL DESIGNREQUIREMENTS:
  - The switch gear shall be formed using distinct vertical sections each comprising followingcompartments:
  - A completely metal enclosed horizontal busbar compartment running horizontally at topbottom.
  - Individual feeder modules organized in multitiermode.
  - Completely enclosed vertical busbars serving all feeder modules in the verticalpanel.
  - Cable terminationcompartment.
  - Perforated sheet\insulating material enclosed horizontal auxiliary bus way for control, interlock, indication and metering wiring runninghorizontally.
  - Metal sheets shall be provided between two adjacent verticalpanels running to the full width of the wider panel and up to full useful height of the switch gear.
  - The front of the board shall comprise of individually enclosed Air Break Circuit Breakers, Starters, Fuse switch and Switch Fusemodules.
  - All auxiliary devices for control, indication, measurement and protection such as control and selector switches, indicating lamps, ammeters, voltmeters, energy meter, protective relays shall be mounted on the front side of the respective compartmentonly.
  - The design shall be such that unless required for maintenance/inspection purpose. all power on/off or star/stop and relay reset operations shall be performed without opening the paneldoor.

- CONSTRUCTION:
  - The complete board shall be of co-ordinate design so that shipping groups ofthe board are easily assembled together at site into a continues line-up. Necessary standard connecting materials shall besupplied.
  - Name plates of elegant and durable design and quality shall be fixed to the individual compartments, feeder modules, bus risers, busbars, cable alleys etc.,
  - The framework of the boards shall be constructed of performed steel

channels, angles and side sheets bolted together and suitably reinforced to form a rigid, self-supporting, compact assembly to function properly under both normal and short circuitconditions.

- The bus compartments shall comprise of one main horizontal TPN bus unit with vertical risers for connection to the individualmodules.

- The board shall be of totally metal-enclosed ventilated multiple unit construction. End units shall include provisions for future main bus extension and installation of additional units on either side with the framework suitably drilled to receive the additional modules and the busbars fitted with fishplates and associated hardware enabling future extension without involving major fabrication works on the panel inservice.
- Metallic barrios shall be provided between vertical sections and also between adjacent modules to ensure prevention of accidental contact with live parts during routine inspection/maintenance of functional units or cable terminations of one or more functional units when working on those ofadjacent units. These barriers shall have insulating inserts as necessary for taking the interconnectionsetc.,

- The busbar chamber shall have screwed covers at the front, on the sides and for thetop.
- The covers for the cable chambers and other compartment shall have covers screwed on with captive screws so that these do not fall of when the panel is in use while the operating/maintenance personnel have occasion to open & replace thesecovers.
- The panels shall be suitable for cable entry at top or bottom as specified in drawings/data sheet. Drilled gland plates with glands shall be provided for the switchboards to suit entry of the cables as furnished in the drawings. Cable clamping arrangements shall be provided in the cablealley.
- The switchboards shall have uniform height. The height of the operating handle for the feeder module, indicating lamps, instruments fuses etc., in the topmost tier which may need adjustment shall all be not more than 1800mm from the finished operating level on the floor so that these are easily accessible for the operating maintenance personnel without having to take recourse to ladders/stepsetc.,
- The minimum operating height of the switch handles shall not be less than 400mm from the finished floor level including the safety rubbermat.
- All live parts shall be suitably shrouded with non-deterioratingInsulating barriosso as to prevent any accidental contact with these by the operating/maintenance personnel while the panel is in service and the modules are opened for inspection/servicingetc.,

- BUSBARS:
  - The busbars shall be of Hard drawn high conductivity electrolytic grade (63401 WP) Aluminium confirming to IS:5082. The busbars shall be of uniform cross section is allowed. Current density shall not exceed 0.8A\Sq.mm.
  - Horizontal and vertical busbars shall be provided with PVC sleeves of high quality.
  - The joints in the busbars shall be of the bolted type and it shall be ensured that the following precaution are observed:
  - The busbars shall be phase identified by colour, at regular intervals. Colour code shall be RED, YELLOW and BLUE for phase buses and BLACK forthe.

    neutral. Busbars shall be rated for 40 Deg. C temperature rise over an ambient of 45 Deg. C as measured by thermometer. The cross section of the busbars shall be uniformthroughout.
  - Busbars shall be supported on tough, non-hygroscope, resin bonded self-extinguishingfire-retardant insulators of SMC\DMC with ribbed construction to prevent tracking due to dust accumulation and to have larger creepage paths. All the phases are individually supported. If a common support is provided for all the three phases, anti-tracking barriers shall be incorporated. Busbars and supports shall withstand the maximum stresses that are likely to be induced by the short circuit currentsspecified.
  - The clearance between the individual bare phase power busbars and between the phase and earth busbars in air shall be not less than 25 mm and 16 mm respectively.
  - All busbars joints shall be of the bolted type. Ring washers shall be used for joints to prevent loosening of the nuts and overheating. Lock nuts shall be incorporated for the bolts besides the main nuts. The bolts and nuts used in the current carrying cover of the protective cadmium coating to obviate corrosion while the boards areinservice.

- EARTHINGCONNECTIONS:
  - The panel shall be connected to an earth busbar running throughout the lengthof the switchboard. The minimum earth bus size shall be 50x6mm Aluminium. All doors and movable parts shall be connected to the earth bus with flexible copper connections. Provision shall be made to connect the earthing busbar to the plant earthing grid at two

ends. All non-current carrying metallic parts ofthe mounted equipment shall be earthed. Earthing bolts shall be provided to ground cablearmours.

- PAINTING:
  - All sheet steel surfaces shall be chemically cleaned, degreased and pickled in acid to produce a smooth, clean surface free of scale, grease and rust. After cleaning the surface shall be given a phosphate coating followed by a coat of high-quality primer and Backing in theoven.
  - The assembly shall be finished with two coats of enamel powder coated paint as specified in drawings in light Grey as per IS:5 shade631.

- Connection diagram for all units (like in-comer, outgoing feeders, breaker wiring diagrams,etc).
- Schematic diagram for the completeswitchboard.
- Terminal connection diagram of the main terminalboards.
- Catalogues, Operation & Maintenance/Instruction manuals for major components.

9.0 TESTS:
Switch gear assembly shall be subjected to the routine tests as per latest revision ofIS:8623.

SPECIFICATION FOR WIRING SYSTEM

1.0 SCOPE:

This Specification covers wiring System applicable to 3phase, 4wire 415Volts, 50Hz AC and single phase, 2 wire 230 Volts, 50 Hz ACsystem.

CONDUITS &ACCESSORIES

Ms conduits shall be of welded and screwed sheet steel construction. Conduits shall be black stove enamelled inside and outside. The conduits shall conform to requirements of relevant IS (latest edition) in all respects. Conduits shall bear the name, trademark of the manufacturer and size of conduit on each

length. The conduits shall be delivered to the site in original bundles. Conduits of less than 19 mm die, shall not be used. The minimum wall thickness of conduits shall be asfollows; -

RigidM.S.Conduits a) 19.25&32mm -16gauge.
b) 38mm&above -14
gauge. Rigid PVCConduits-2mm.

Conduit Accessories co: Conduit accessories such as bends, inspection bends, inspection tees, elbows, reducers, draw boxes, junction boxes, etc. shall be of approved makes. Boxes shall have internally tapped spouts, junction boxes/inspection boxes shall be provided wherever required at no extracost.
All the conduits shall be adequately protected while stored on site prior to erection and no damage conduit shall beused.

All conduit accessories shall be made out of 16 Gauge thick MS enclosures.

The inside surface and ends of conduits and threads and fittings used shall be clean, smooth, cut square and free from burrs and other defects. Powdered soap stone, talc or prepared compounds shall be used as lubricants to facilitate the smooth pulling in ofconductors.

INSTRALLATION OF RECESSED CONDUITSYSTEM

The conduit shall be properly and tightly screwed between the various lengths and to the boxes to which it runs and terminates. No part of the conduit shall be under mechanical stress and the whole conduit system shall be electrically and mechanically continuousthroughout.

The conduit shall be installed in such a manner that drawing of wires can be carried out from the outlet box, junction box, pull box and switch boxes only.

Conduits recessed in walls shall be secured in walls shall be secured rigidlyby means of steel hooks/staples at 0.8 mars. Intervals. Before conduit is concealed in the walls, all chases,

grooves shall be neatly made out proper dimensions to accommodate the required number ofconduits.

The outlet boxes, point control boxes inspection and draw boxes shall be securely fixed by means of counter sunk steel screws and awl plugs. They shall be firmly grouted in position prior to plasteringfixed asand when conduit is being laid. The recessing of conduits in walls shall be arranged as to allow at least 12 mm plaster cover on the same. All grooves, chases, etc. shall berefilled with the cement mortar and finished up to the wall surface before plastering of walls is taken up by the general contractor. The top edge of the conduit shall be at least 25 mm below the finished surface of wall. Wherever conduits terminate into point control boxes, boards, etc. with check nuts on either side of the entry to ensure electricalcontinuity.

After conduits, junction boxes, outlet boxes, etc. fixed in position their outlets shall be properly plugged with PVC stoppers or with any other suitable materials so that water, mortar, vermin'sor any other foreign material do not enter into the conduitsystem

INSTALLATION OF SURFACE CONDUITSYSTEM

Conduits shall run in straight lines. Before the conduits are installed, the exact routes shall be marked at site and approval of the consultant shall be obtained. Conduit shall be fixed by heavy gauge GI base plates, saddles, secured to suitable raw plugs, at an interval of not more than 1 Mr. conduits shall be joined by means of screwed couplers and screwed only. In long distance straight runs of conduits, inspection type couplers or running type couplers or pull boxes shall be provided. straight runs of conduits, inspection type couplers or running type couplers or pull boxes shall be provided.

Bends in conduit runs shall be done by bending conduits by bending conduits by pipe bending machine. Bends which cannot be negotiated by pipe bends, shall be accompanied by introducing inspection boxes or inspection bends, not more than three equivalent 90 c bends shall be used in a conduit run from

outlet tooutlet.

INSTALLATION OF CONDUITS ABOVE FALSECEILING

In the false ceiling area, the conduits shall be run above the false ceiling frame work supported by means of MS. straps secured and fixed to both conduits and structural ceiling keeping the outlet box as near as possible to the fittings/fans for connections. The conduits boxes for fittings/fans are independently supported by means of separate fixing arrangements to the box and structural ceiling so that the box is heldrigidly.

DRAW BOXES, PULL BOXES, ENCLOSURESETC

Enclosure for electrical accessories shall have wall thickness of M.S. not less than 1.6 mm. The enclosure boxes shall be provided with a minimum of four fixing lugs located at the corners for fixing the covers. All fixing lugs shall have holes to take machined brassscrews.

Sufficient number of knockouts shall be provided for conduit entries. The enclosures shall be adequately protected againstrust or corrosion both inside and outside. Generally, switch box enclosure will be of standard size to/poressheettobeusedascoverformountingswitchesandsockets.

WIRINGCONDUCTORS

All wiring conductors shall be PVC insulated, copper conductors of 1100V grade, and shall conform toIS:694 Part II (Latest Edition).

Wiring conductors shall be supplied in Red, Yellow, Black and Green coloursfor easy identification of wires. The wires shall be supplied in seated in sealed coils 0 100 Marsiling and shall bear manufacturer's trade mark, name Voltage gradeetc.

INSTALLATION OF WIRINGCONDUCTORS\CABLES

The wiring conductors shall not be drawn into the conduits until all the works of any nature that may cause damage to the wires are completed. The installation and termination of wires shall be carried out

with due regard to thefollowings:

a) While drawing the wiring conductors, care shall be taken to avoid scratches and kinks which cause breakage of conductors. There shall be no sharp bends in the conduitsystem.

b) Strands of the wires shall not be cut for connecting to the terminals or lugs. The terminals shall have adequate cross section to take all thestrands.

Wiring for power and lighting circuits shall be carried out in separate and distinct wiring systems.

The wiring system envisaged is generally shown on the layout drawings and line diagrams.However,abriefaccountofthegeneralwiringsystemisgivenbelow:

a) Submains wiring-wiring from Meter boards/switch boards to the individual distribution boards, and shall consist of wires, conduits, all conduit and fixing accessories as required and specified. The sizes of conduits and number of wires shall be as specified in Schedule of Quantities Wires shall be drawn in conduits as required without being damaged, with necessary draw boxes if required. The wire lengths must be adequate for terminating at either end and identifying ferrules shall be provided at termination. The wiring shall be colour coded. The rate shall include all materials, connections, labour etc. as specifiedabove.

b) Circuit wiring-Wiring from DBs to the first point control boxes for lighting, fans, 5A sockets, call bells, etc. The scope of work shall be same as insub-main wiring.

c) Power wiring: The wiring from DBs to heating supplies. 15 A 3 pin socket outlets,etc. Thescopeofworkshall besameasinthesub-mainwiring.

Each sub-main/ power wiring circuit shall also have its own earth continuity wire asspecified.

All the wiring shall be carried out in loop-in-loop system only and phase or line conductors shall be looped at switch box and neutral conductor can be looped from light, fan orsockets.

Phases- Red, Yellow and
Blue. Neutral- Black.
Earth-Green or Bare wire as specified.

SWITCHES, SOCKETS ANDACCESSORIES

GENERAL REQUIREMENTS: General control switches shall be of a 5 A rating and shall be of approved make/type suitable for flush mounting. Switches shall have either integral mounting plates or white PVC/Perspex of min. 4.5 mmthick.

All sockets, 5A and 15A ratings shall be of flush mounting type with combined control switches of the same rating as that of the sockets. All sockets outlet shall be of 3 pintype.

The switch, plug socket or regulator boxes shall be made of GI/sheet steel of minimum 16SWG on all except in the front. Depth of boxes shall not be less than 75 mm and suitably increased where fan regulators are mounted in flush pattern. The boxes shall be provided with suitable earthing studs. Wherever required switches/fittings shall be fixed on metal strip which in turn are welded to thebox.

10.0 INSTALLATION OF SWITCHES, SOCKETS ANDACCESSORIES

All the switches shall be wired on phases. Connections shall be made only after testing the wires for continuity cross, phase etc. with the help of Meguro.

Regulators shall be fixed on adjustable MS flat straps inside the enclosure. The arrangement of switches and sockets shall be neat and systematic. Covers for enclosures accommodating /Perspex material or laminated hilum sheet and fixed to the enclosure in plumb with counter suck head, chromium plated MS screws and washers. Outlets shall be terminated into a flush type fan box for fan points. For wall plug sockets, the conductors may be terminated directly into the switches and sockets. The outlets point control boxesetc.

POINTWIRING

Point wiring shall commence from the first point control box/local control box for the points connected to the same circuit. Point wiring for lights, ceiling and exhaust fans, 5Asockets, call bells etc. shall be carried out with 1100 V grade PVC insulated wires. The point wiring shall be inclusive of conduits of not less than 19 mm size, switches, wiring along with conduit accessories such as bends, inspections bends, reducers, pull boxes, junction boxes, switch boxes, fans boxes, covers etc. together with wiring up to 1 mar. long at outlet end connectors point control boxes (enclosure for electrical accessories)

switches, etc. point wiring shall be provided with earth continuity wires as specified for earthing 3rd pin of sockets, luminaries and fan fixtures. Light control shall be either single, twin or multiple points controlled by a switch, asspecified.

SPECIFICATION FOR POWER AND LIGHTING DISTRIBUTION GENERAL BOARDS

This specification is applicable to 415 Volts, 3 Phase 4 wire A C supply and shall conform to the following Indian Standards [I S] (Latest Version)

1.0 TYPE AND CONSTRUCTION

Distribution boards shall be made or Robust and rigid construction and of totally enclosed dead front safety type. The enclosures shall be made of MS sheet steel of not less than 16 gauge. The sheet steel shall be treated with a rigorous rust inhabitation process before fabrication followed by two coasts of red oxide primer and two coatsof synthetic enamel paint of approved shade. The distribution boards shall comprise ofswitch fuse unit or miniature circuit breaker as incoming and required number of circuit breaker or HRC asoutgoing.

The main switch and out goings shall have rating as specified in the drawings and schedule. The board shall be designed to have adequate cabling space for either top or bottom of both incoming and outgoing cables Earthing sockets should be fitted to the casing of D.B.

2.0 BUSBAR

Suitable colour coded bus bars made of height conductivity aluminium strips and mounded on non-hygroscope insulating supports shall be provided Neutral bus bars shall be made of half the size of phase bus bar. The earth bus shall be also provided of materials and size as required.

3.0 MINIATURE CIRCUIT BREAKERS

Miniature circuit breakers shall have a minimum breaking capacity of 9 KA. Circuit breakers shall be equipped with individual insulated, braced and protected connectors. The front face of all the breakers shall be flush with each other. The breakers shall have “quick break trip free” mechanism with current limiting an overload and short circuit tripping

characteristics. The mechanism shall be such that thecircuit cannot beheld closed when a fault occurs orpersists.

The contacts shall be silver tungsten or other suitable material to give long contact life. Multiple units shall have an interrupting mechanism thereby ensuring complete isolation in the circuit in the event of an overload anyone of the phases. The connectors shall be suitably shrouded.

SPECIFICATION FOR LOW TENSION CABLES

1.0 SCOPE

This specification covers the technical requirements of supply, laying testing and commissioning of Heavy-duty medium voltage cables up to 1100 Volts for power control and lighting application for efficient and trouble-free operation.

The cable shall be properly packed for transportation, supply and delivery atsite.

2.0 CODE AND STANDARDS

The materials covered by this specification shall unless otherwise stated as designed Constructed, manufactured and tested in accordance with latest revisions of the relevant IndianStandards.

3.0 RATING

The cable shall be rated for a voltage rating of 650\1100 Volts.

4.0 SELECTION OF CABLES

Cables should be selected considering the conditions of maximum connected load, ambient temperature, grouping factor, allowance for voltage drops. However,it is the responsibility of the contractor to recheck the sizes before cables are procured. He should submit the cable departing, voltage drop and length calculation to Architects for approval before procuringcables.

5.0 INSULATION

The conductor is insulated with suitably compounded PVC applied to the conductor by the extrusion.

The PVC compound used for insulation shall have reduced flame propagation properly. This shall also have reuses emission of hydrogen-chloride gas fumes etc., when severely overheated.

6.0 CORE IDENTIFICATION

The cores of the cables shall be provided with the colour scheme of PVC insulation as per IS for any easy identification.

7.0 ARMOURING

The armouring of multicore cable consists of either GI round steel wires or GI flat strips and in case of single core cable armouring shall be of non-magnetic material such as hard drawn aluminium or aluminium alloy wires or strips.

8.0 OUTER SHEATH

The PVC compound used for outer sheath shall be resistant to termites, fungus and rodent attacks and shall also have reduced flame propagation properly as specified above.

9.0 LAYING

Cables shall be laid in outdoor trenches wherever called for. The depth of the trenches shall not be less than 75 CMS. From the Formed Ground level (FGL) which has to be ascertained from the Architects. The width of the trenches shall be allowed between the cables. The trenches shall not be less than 45 CMS.A spacing of not less than 15 CMS shall be allowed between the cables. The trenches shall be cut square with vertical side walls and uniform depth. Suitable shoring and propping may be done to avoid caving in of trench walls. The floor of the trench shall be rammed level. Cable unreeling from drums shall be done only with the help of cable drum rolling supports. The cables shall be laid in trenches over the roller's places inside in trench. The cable drum shall be rolled in the direction of the arrow for rolling. Wherever cablesare bent, the minimum bending radius shall not less than 12 times the diameter of the cable. After the cable is laid and straightened, it shall be covered with 8 CMS. Thick layer

of sand. Cable shall be taken lifted and placed over this and cushion. The cable shall then be covered with an 8 CMS. cushions, where cable is laid in rockysituation.

10.0 JOINTING AND END TERMINATION

Cable jointing shall be done as per the recommendations of the cable manufacturer jointing shall be done by qualified cable jointer under strict supervision. Sample crimping of different size cables shall be subjected to contact resistance and heating tests in the presence of the Architects.

Each termination shall be carried out using Electroplated Brass single compression glands and copper cable sockets and approved jointing materials are to be used Hydraulic crimping tool shall be used for making the end terminations. Cable gland shall be bonded to the earth by using suitable copper/GI wire. The cable armouring is to be earthed properly so that the earth continuity asmaintained.

11.0 TESTING

Cables shall be tested at factory as per the regulations of IS:1554 Part-1. The tests shall incorporate routine tests, type tests and acceptance tests. Copy of such test certificates shall be furnished to theOwner.

Cables shall be tested at site after installation and results shall be submitted toConsultants/Engineers.

Pressure test for 15minutes.

Insulation resistance between conductors and neutral and conductors and earth.

SPECIFICATION FOR EARTHING

1.0 This specification covers the requirements of supply, installation, testing and commissioning of earth electrode system, equipment earthing etc.

2.0 STANDARDS:

Earthing installation shall conform to the Indian Electricity Rules-1956, as amended from time to time and IS 3043 – "Code of Practice for Earthing", with latest amendments.

3.0 TYPES OF EARTH ELECTRODES:

a) Pipe earthelectrodes
b) Plate earthelectrode
c) Strip conductor earthelectrode
d) Coilearthing

Standard GI pipe earth or GI plate earth electrode shall be used except where it is unavoidable to use copper plate earth electrode due to corrosive soil conditions for direct current systems or for large capacity substations.

Strip or conductor electrode shall be used at places where soil is hard and rocky and in locations where there are limitations to the use of pipe or plateearth electrode.

Where the soil is highly corrosive, the earth electrode shall be of copper and when the soil contains sulphur, copper electrode shall be adequately tinned.

EARTH ELECTRODE ARRANGEMENT:

PIPEELECTRODE:

Electrode shall be made of GI pipe having a clean surface and not covered with paint, enamel or poorly conducting material. Galvanized pipeshall

not per

be smaller than 38 mm Ideating with pipe electrode shallbe done as thedetails

indicated in IS3043.

The length of pipe electrodes shall not be less than 3.0 m. If rockis encountered, pipes shall be driven to a depth of not less than 3.0m with suitable inclination. Pipe shall be in one piece and deeply driven.

To reduce the depth of burial of an electrode without increasing the resistance, a number of rods of pipes may have to be connected together in parallel. The distance between two electrodes in such a case shall not be less than twice the length of the electrode. The earthing leads.shall be connected by means of a through bolt, nuts and washers and cable socket.

PLATEELECTRODE:

For plate electrodes, minimum dimensions of the electrode shall be as under.

GI plate electrode: 600X600 6mmthick.

Copper plate electrode: 600x600x3.15 mmthick.

The electrode shall be buried in ground, with its faces vertical and top not less than 2.5 M from the surface of theground.

Earthing using plate electrode shall be done as per details, indicated in IS- 3043.

Plate electrodes shall have a galvanized iron water pipe, buried vertically and adjacent to the electrode. One end of pipe shall be at least 5 cm above the surface of the ground and need not be more than 10 cm. The internal diameter of the pipe shall be at least 19mm. The length of pipe under the earth's surface shall be such that it shall be able to reach the centre of the plate. The earthing lead shall be securely bolted to the plate with two bolts, check nuts andwashers.

STRIP PR CONDUCTORELECTRODES:

Strip electrode shall not be smaller than 25X1.6mm, if of copper and 25x 4mm, ifof galvanized iron and steel. If round conductor's area used as earth electrodes, their cross-sectional area shall not be smaller than

3mm2 if of copper and 6mm2, if of galvanized iron andsteel.

Conductorshallbeburiedintrenchesnotlessthan0.5mdeep.

Coil earthing shall be done using 8 SWG GI wire. The wire shall be wound into spiral form of 50mm die with turns closely made and buried at 1.5 M below ground level. As in the case of pipe electrode, for this earthing also alternate layers of charcoal and salt shall be filledin the earth pit.

5 GENERAL:

5.1 All materials used for connecting the earth and lead with electrode shall be of GI in case of GI pipe and GI plate electrodes, and if tinned brass in case of copper plate electrode. The earthing lead shall be securely connected at the other end to the mainboard.

SPECIFICATION FOR LIGHTNING PROTECTION SYSTEM

1.SCOPE:

This specification covers the requirements of supply, installation, testing and commissioning of lighting protection system in conformity with the requirements of IS:2309, consisting of vertical air termination the horizontal air terminations, down conductors and earth stations.

1 AIRTERMINATION:

The air terminations shall be provided at the points on the drawings. The vertical air terminations shall consist of copper spikes fixed onto 25mm dia. Copper tubes of at least 1.5Mtrs long grouted to the surface of the roof consist of a rigid network of tapes fixed to the surface to be protected shall be bonded to the networkby the conductors of the appropriate crosssection.

2 DOWNCONDUCTORS:

Air terminations shall be connected to the earth terminations by tapes fixed onto wallof the structures with spacers. The taps shall securely fix to walls by means of brass saddles and metallic fasteners. Where the down conductors are laid underground, they shall be laid at a depth of 750mm below the ground level, buried in trench, covered with a 100mm thick layer of sand and protected

by cable protection tiles. All metallic parts of the building above the main roof level including ducts, towers, pipes gutters and other mechanical equipment's shall be bonded to the downconductors.

3 GENERAL:

A. The materials shall be free from rust, scale and other electrical and mechanical defects. The size, materials and quantity shall be asspecified.

B. Steel earthing conductors above ground shall be not dip galvanized. If painted it shall be given two coats of approved bitumastic paint\anti-corrosivepaint.

C. Test links in suitable enclosures shall be installed by the contractor at no extra cost for connection between each lighting conductor down conductor andearth electrode.

D. The scope of installation of lighting conductors on the roof of buildings shall include laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods where necessary, laying, fastening/cleating/welding of the down-comers on the walls/columns of the building and connection to thetest links above ground level, and up to earthstation.

Alighting protection conductors shall not be connected to other general conductors.

Father lightning protection air termination rods and/or horizontal air termination conductors shall be fixed in such a way that they remain in their installed position even during adverse weather conditions.

H The down conductors shall follow a direct path to earth. There shall not be any sharp, turns and kinks in the down conductors.

I All joints in the down conductors shall be welded/brazed type. All metallic structures within 2m vicinity of down conductors shall be bonded to the lightning protectionsystem.

J Every down conductor shall be provided with a test link at about 1000 mm above ground level. The test link shall be directly connected to the earthing System/electrode.

K The lightning protection system shall not be in direct contact with the underground metallic service ducts, cables, cable conduits and metal enclosure of electrical equipment's.
L Lightning conductors shall not pass through or run inside G.I conduits.

M Wherever required, if indicated in drawings, for fuel oil and other Inflammable liquid storage tanks lightning and protection shall be provided with horizontal conductors strung between tall poles covering the entire areas.

4 JOINTBONDING:

The system shall have preferably no joints and they shall be made mechanically and electrically strong and effective. Bolted joints should only be used on test points or on bonds to as existing metal. Generally jointing/connections/installations shall be as in Earthing system.

5 EARTH TERMINATIONS:

Suitable number of earth terminations shall be provided. The earth termination shall consist of pipe/plate earth electrode as specified elsewhere in the Earthing specification, and generally conforming to IS: 3043. The earth terminations shall be complete in all respects with chamber and cover, etc., as per the detailed specifications. Before installing the lightning protection system, the contractor shall obtain approval from the Engineer with respect to the locations of air terminations and the routes for the downconductors.

6 TESTCLAMPS\LINKS:

Test clamps/links shall be manufactured from phosphor bronze or approved equivalent with four fixing holes. Tape conductors shall be fixed to flat roof surfaces by means of suitable fixing arrangement as approved.

All fixing screws shall be brass.

7.0 TESTING:

Suitable testing links be provided at required points as per the code of practice CP 326\IS 2309. The contractor shall carry out tests on completion of the installation and submit the readings for approval.

SPECIFICATION FOR CABLE TRAYS

1.0 SCOPE:

This specification covers the design, supply, fabrication fixing, aligning, and painting of cable trays and other steel frame works at site asrequired.

The cable trays shall be designed and fabricated out of various sections such as M.S angles, flats, and channels etc. and got approved byConsultants.

Before fabrication the MS sections shall be properly straightened, aligned, cleaned properly to remove rust if any.

All materials used for fabrication of cable of cable trays shall conform to IS 226 and fabrication shall be as per IS:800.

After fabrication the cable trays, and accessories shall be free from sharp edges, corners, burrs and unevenness, and a coat of cold phosphating chemical shall be applied followed by a coat of red oxide primer.

The cable trays shall be welded to the mounting supports which in turn are either welded to plate inserts or grouted to structural members.

Plate inserts for cable tray mounting supports shall be provided by Civil Contractor.

Cable trays shall be either run in cable trenches or run overhead and supported from available structure.

Minimum clearance between the top most tray tier and structural member shall be 300mm.

The type and size of tray to be used shall be as required.

Each continuous length of cable tray shall be earthed at minimum two places.

The cable trays, accessories, covers etc. shall be painted with two coats of red oxide primer followed by two finishing synthetic enamel paint of approved shade. Where any cuts or holes are made or welding is done on finished steel

work, the same shall be sealed against oxidation by red oxide primer followed by finished paint.

PREAMBLE TO SCHEDULE OF QUANTITIES

1 All items of work mentioned in the Schedule of Quantities shall be read and executed strictly in accordance with the description in the Schedule of quantities, equipment schedule/Data Sheet, drawings and standard specification read in conjunction with the appropriate IS and Conditions ofContract.

2 The rate for each item of work included in the bill of quantities shall unless expressly stated otherwise include cost of: -

All materials, fixing materials, accessories, hardware, operations, tools, equipment, consumables, civil works wherever involved and incidentals required in preparations for the full and entire execution and completion of the work called for in the item and as per specifications and drawings completely & include the costof:

a) Wastage on materials andlabour.

b) All taxes, duties, octroi, including works contract tax, VAT, Service Tax, transit insurance, packing and forwarding charges, loading, transportation, unloading, handling hoisting, to all levels, setting and fixing in position, disposal of debris and all other labour necessary in accordance with contract documents, good practice and recognizedprinciples.

c) Liabilities, obligations and risks arising out of conditions ofcontract.

d) Liaison servicecharges.

3. All requirements of system whether such of them are mentioned in the item ornot the specifications and drawings are to be read as complimentary to and part of the schedule of quantities and any work called for in one shall be taken as required for all.

4. In the event of conflict between the bill of quantities and other documents the most stringent shall apply and interpretation of the Architect shall be final and binding.

5. The installation price of switchboards, metering panels, DB's or any other items shall include supply and fixing orsupporting steel structures/MS channels grouting of the same civil works etc., asrequired.

6. No change in unit rate shall be allowed for any change in quantity or for any

other reason whatsoever.

7. Supply of materials shall mean supply of materials at site. The rate for supply shall include all taxes, octroi, insurance, packing and forwarding charges, transportation, unloading atsite.

8. The successful contractors shall submit the Schematic diagrams, fabrication drawings with details of all equipment's wiring before commencement of such works. The approval of these drawings will be general and will not absolve to contractor of the responsibility of the correctness of thesedrawings.

9. The tenders must see the site conditions such as type of soil, locations etc., and take all factors into considerations while quoting the rates as no extra cost will be allowed on any ground arising out of or relating to the siteconditions.

Any error in description or in quantity or omission of items from the contract shall not vitiate this contract but shall be corrected and deemed to be a variation required by the Architects/Owners.

TECHNICAL SPECIFICATIONS

FOR

SOLAR WATER HEATERS/PANELS

TERMS AND CONDITIONS

1. The manufacturer shall supply all technical literature and drawing considered necessary for the installation, operation and maintenance of the equipment and its fittings. These shall essentiallyinclude:-

a) Drawing showing over all dimensions and all other details including sectional view of theequipments.
b) List of parts with reference tonos.
c) Manual of instructions for the operation, maintenance and repairs/equipment and special fittings, ifany.
d) Checking methods and schedule for cleaning thesystem.
e) Any other relevant technical data which would be of assistance for efficient operation and maintenance of the system including energy savingsetc.

2. The tender should be selected on the basis of average annual financial turn over which should be at least 50% of estimated cost during last three consecutive financial years and also on the basis of minimum one work done of the 80% or two works of each 60% value put totender

3. The supplier shall train purchaser's personnel for the operation and maintenance of the equipment for a particular period, mutually agreed between the supplier and the customer.

4. The suppliers will have to undertake repair of the system installed by them, in caseof any defect arising out of any point of time. Supplier will attend the minor complaints within 48 hours of receiving the complaint otherwise penalty to be recovered per day as decided by the Engineer-in-incharge.

5. Thesystemandthesolarcollectorsshouldbeguaranteedforsixyearafterthedayof handing over. This include first three year with spare parts and next three year without spare parts. He/She shall submit list for recommended spears to be

required in maintenance with price along with their offer. Manufacturer or their authority/accredited dealer shall be consider for eligibility to participate intenders

6. Thesuppliershallguaranteetheperformanceofthesystemfortheratedoutputof60 degree C in terms of quantity of hot water and the temperature in peak winter for which the system is designed. If it is not achieved, the necessary additions/modifications including installation of extra collectors shall be done by the supplier without charging anyextraprice.However,the purchaserreservestherighttohavethisjobcompleted for achieving the rated output by other manufacturers/after serving 15days notice to the original manufacturers/contracts at his cost &risk.

7. All the elements of the system which fail due to manufacturing defect within the period of guarantee shall be replaced by the tenderer free ofcost.

8. An amount of 10% of the total cost of the system will have to be deposited by contractor, as security which will be reimbursable after 6 years i.e. completion of warrantyperiod.

Note: - These terms & conditions will be in addition to already exiting terms & conditions of the concerned Department.

TECHNICAL SPECIFICATIONS FOR SOLAR WATER HEATER(FPC/ETC)

1. Solar flat plate collector components	Solar flat plate collector cover plate made of toughened glass. Sheet for absorber made of copper. Absorber made of copper sheet and copper tube.
2. Solar flat plate collector specifications	1. Solar flat plate collector shall conform to IS 12933(part 1) with amdt no.1 & 2. 2. and IS : 12933 (part 2)/2003 and various components shall be asunder:- a) Cover plate: cover plate shall be toughened glass and thickness of 4.0 mm (min) conforming to section -1 of IS: 12933(pt-2)/2003 the solar transmittances of the cover plate shall be minimum 82 percent at near normalincidence. b) Collector box: collector box shall be made of

	aluminum sections only type grade, size, workmanship and finish of the material used shall be as per section-2 of IS: 12933 (pt-2)/2003: the minimum thickness of aluminum shall be as under: 1. Channel sectionfor sides 1.6mm 2. Sheetfor bottom 0.7mm 3. Support forglassretaining 1.2mm Sheet forentirebody 1.0mm
a) Absorber	Absorber Shall Consist of riser, Header and Sheet for absorber. The Diameter of header shall be 25.4 + /-0.5mm and thickness 0.71mm. The Diameter of riser shall be 12.7 + /-0.5 mm and thickness 0.56mm and made of copper only. The distance between the risers from center to center shall be 120mm. type grade, size , workmanship and finish of the materialusedshallbeaspersection-3ofIS:12933(pt-2) /2003. 1. Riser and header assembly designed for working pressure up 24.5 k pa (2.5 kg/ cm square) shall be tested for leakage at a minimum hydraulic pressure of 490 k pa (5 kg/ cmsquare). (a) Sheet for absorber: sheet for absorber shall be made of copper only. Type Grade, size, workmanship and finis of the material used shall be per Section -3 of IS: 12933 (pt -2) /2003. A sample piece of the absorber for Having minimum area of 400 square cm. shall be heated in an oven at Temperature of 175degreecfor2hours.Afterheating,thesampleShallbe taken out from the oven and cooled at room temperature. The Cooled sample shall be inspected visually fo rdamages,if any. There Shall not be any appearance of blistering / rupture / peeling off of the Coated /painted surface and of weakening of the bonding between.

b) Absorber sheet and risers/ headers	(a) Collector box insulation shall be provided at back and sides. Thermal resistance (R) of insulation material shall be minimum 0.96 m square degree c/w for back insulation and minimum 0.48 m square degree c/w for side insulation. This shall be derived after determining thermal conductivity (k) value at 100 degree c mean temperature in accordance with IS: 3346. Collector box insulation shall conform to sec. 4 of IS 12933 (pt – 2) /2003. (b) Gaskets and grommets: gaskets and grommets shall conform to Sec. 5 of IS 12933 (pt-2)/ 2003.
3. ASSEMBLY OFCOLLECTORS	Theloadoftheabsorbershouldnotbeontheinsulation. It should be taken by the collector box. The air gap between the glazing and the absorber should be 25mm (+5mm). Insulation should not be allowed to slide. Glazing shall be fixed on the collector box by using EPDM/Neoprene/Synthetic rubber channels. The glass should be firmly held, without strain taking into account the expansions of glass. A typical example is by retaining the glazing with the helpof Selftappingscrewsandaluminumangle retainerof dimensions 25 mmx25mmx1.5mm fixed on the top of the box it shallbeensuredthatthescrewsarenottouchingtheglass edge. Top surface along the edge between the glass and the aluminum angle shall be caulked with suitable sealants such as zincoxidebased/rubberbased/siliconrubberbasedorpolysulphide rubber sealants.
4. Solar Evacuated tubes collector specifications (ETC collectors should be approved from MNRE)	**1.**Inner tankMaterial a) Stainless Steel SS316 b) SS304-2B (22SWG) **2.** Hot water tank insulationdensity a) High Density injected PUF insulation:50mm, b) High des PUF (play urethane foam) Installation of 50mm thickness between inner outer tank ensures maximum heat rotenone ever season (maximum up to 72hours. **3.** Tank Stand andsupports a) Mild Steel with suitable anti corrosivecoating. **4.** Working pressure of thesystem a) Normal, Gravity Feed, Less than 1Kg/cm2.

	b) Recommended Operating Pressure:10Bars. **5.** Tank testPressure a) Factory Pressure Tested for 2Kgs/Cm2. **6.** Solar Evacuated tube dimension a) Double walled glass Outer Tube Dia 47±0.7mm, Tube leangth-1500±5mm. & Inner Diameter:33.4mm. b) Thickness of tube at least 1.60mm. **7.** Tube assemblingframe a) Mild steel section with PPcoating. **8.** Tube assembling framesize a) Length-2.10mtrs. Width-3.20mtrs,Height-1.50mtrs. **9.** Cold watertank a) 2.4 mtrs. From the terracelevel. **10.** BackupProvide a) Electrical heaters: - 1.5 kW with thermostat, 2.0 kW with thermostat. **11.** Tube coating Copper coated tubes with selective absorptive coating Graded AI-N.
5. GASKET FOR FLANGES	3 mm thick gasket of Neoprene/synthetic rubber gasket shall be used for sealing the joints between flanges.
6.COLLECTOR SUPPORT FRAME	The structure should be in a position of withstand a wind velocity of 100 kms/hr. shall be made with angle iron of 35mmx35mmx4mm; will have vertical support at top andbottom edge of the inclined plane of the collector at a distance of 1.5 M or less. The vertical support shall be firmly grouted with the roof.
7. PAINTING OF STANDS	Proper cleaning and degreasing of the surface should be done with the help of three in one Solution before painting. Two coats of zinc chromate red oxide primer shall be applied followed by two coats of enamel paint of suitable Colour as per NIT.
8. STORAGE	a) Material

TANK(HOT WATER	Stainless Steel (SS 316/ IS 1730 grade)
b) Thickness	Minimumthickness Tankcapacity 20gauge (0.91mm)for 100 lpd 20gauge (0.91mm)for 200 lpd 20gauge (0.91mm)for 500 lpd 18gauge (1.2mm) for 1000lpd 18gauge (1.2mm) for 1500lpd 18gauge (1.6mm) for 2000lpd 16gauge (1.6mm) for 3000lpd 16gauge (2.0mm) for 4000lpd 16gauge (2.0mm) for 5000lpd
c).Insulation and installation	All sockets and internal fittings of the tanks should be of stainless steel.100 mm thick insulation of 48 kg/cu.m. density having approx. k value_0.03 W/mk and R value 3.34 sq.mdeg.C/W to withstand a temp. of 250deg.c.Thin polythene sheet shall be used as covering between the glass wool and the cladding sheet besides the retaining material such as chicken mesh etc. Aluminum sheet of thickness 24 SWG shall be used for cladding the tankinsulation. The storage tank shall be properly installed at site using enameled coated appropriate size angle iron stands, girder, cement concrete pedestals of 1:2:3 ratio or any other specific provision suitable to site.To ensure the stability against heavy storm etc. but not less than 1'x1'x6" dimensions. External of the tank should be properly insulated so that hot water temperature does not decrease by more than 5 deg.C in about 16 hrs.Times.
9. PIPING	(cement concrete ratio 1:4) ISI mark strainer of standard make should be fitted in the main cold water supply line before the system.
	a) Material Medium class (B class) GI as per IS 1239 shall be used for piping. **b)** Insulation 25mm thick insulation of 48kg/cu.m. density and K value+0.03 W/MK R value+1.67 sq.m. C/W to withstand and temp. of 250 deg. C be used.

	Thin plastic sheet shall be used as covering between glass wool and aluminum cladding besides other retaining material like chicken mesh etc.26 SWG thick aluminium sheet shall be used for cladding the insulated pipe. The pipe line should be properly supported and fixed with clamp with the help of suitable size stand/civilstructure
10. VALVES/NIPPLE/ TESS/BENDS	Gun metal valve ISI marked shall be used. Nipple/tees and bends of ISI marked of medium class GI (B class) shall be used. Air vents in each row are to be provided.
11.INSTRUMENTATI ON	Temperature gauge: 1 No. (for Hot Water Storage Tank/Outlet) Gun metal strainer: 1 No. (at Cold Water inlet) Water meter -1 at the inlet of cold water tank. Maximum 2 nos. Of chrome plated brass taps for systems up to 200 LPD thereafter 1 tap per 200 LPD superior qualities for distribution line.
12.COLDWATER TANK	HDPE/LDPE material with Gun metal float valve (ISI marked) equal to the capacity of Hotwater storage tank.
13.STANDS&PEDEST A LS FOR THE TANKS	The tanks will be mounted on stands made out of angle iron frame of 35x35x4mm up to 2000 liters and 65x65x6mm for capacity above 2000 liters with each leg duly grouted with PCC 1:2:4 of1'x1'x1'size. The cold water tanks will be placed over angle iron frame having 4 cross members in 4 legs with 5mm thick MS sheet for full bottom support fixed of 4 horizontal members based on the size of the cold watertank.
14. SYSTEM LAYOUT & DESIGN	Maximum number of collectors in series should not be more than ten. Maximum number of collectors in parallel in one row without the use of any piping connections should not be more thansix. Air venting at appropriate places without hindrance of a spring leaded valve to prevent air locking in the system should be provided. For this purpose, the system shall have, at a suitable point, atmospheric pressure conditions preferably in the high temperaturezone. System shall have a suitable expansion/make up tank at a high point in the system to ensure that collectors run full all the times. Capacity of this expansion/make up tank should be 1.5%

	of the system capacity for allsystems.
15.HEAT EXCHANGER	a) Shell-in-Tube Type (i)Material Copper for forced systems only. Shell in tube type heat exchanger may be used if U-type construction is not employed and if V-type construction isemployed, then minimum 4 Nos. of heat exchangers will be used in series. Shell shall be designed for 1.5 times of the designed operating pressure and shall be tested for two times the operating pressure. In case of mild steel shell, corrosion allowance of 1.6 mm shall be provided. Shell shall be designed as per the BIS-2825. All the elements of heat exchanger shall be as per relevant Indian Standard or as per TEMA Class Cconstruction. (ii) Tube Thickness Minimum 22 SWG, but may be higher depending upon the designed pressure requirements. (b) Coil-type Heat Exchanger For thermosyphen systems only. May be used by incorporating Cu/SS coils/retender inside the storage tank. (i) Material Copper/SS tube of ¾" dia. (ii) Thickness Minimum 22 SWG. May be higher depending upon the pressurerequirements. (iii) No. of coils and flowPattern. Shall be so designed to ensure the pressure drop less than 0.3 kg/cm. The surface area of the heat exchanger should not be less an per sq.m of the absorber area of the system (for 100 LPD system the copper tube length of 7 meter is required).
16. ELECTRICAL B	For 100 lpd - 2 KW For 200 lpd- 2 KW For

ACK UP (only upto1000 lpd)	300 lpd- 2x2 KW For 400 lpd- 2x2 KW For 500 lpd- 2x2 KW Electrical wiring of 2:5 mm sq. 2 core unarmored cable, thermostat of Siemens/Danfoss/Honeywell Make with MCB of 16 Amp. For 600 lpd-6 KW For 800 lpd-9 KW For 1000 lpd-9 KW
17. Electrical back up control panel For 6 KW	1. DP switches20Amp. Anchor make orequivalent 2.MCCB 4 pole 16AmpFor 6KW and 32 Amp for9KW Legarand, Schneider, L&T, Siemens, ABBmake. 3. Contactor25-32Amp. L&T/Schneider/Siemensmake 4. Amp.Meter1x30Amps. Rishabh,AE,L&T 5. Voltmeter0-500V -do- 6. Amp.SelectorSwitch AE/Rishabh/ KAAYCEE, L&T .BCH,GE 7. VoltageSelectorSwitch -do- 8. Thermostat for auto cut (6KW) Danfoss/Sieman/Honeywell
18. Electrical back-up control panel for 9 KW	1. DP switches1x32Amp. Anchor make orequivalent 2. Amp.mtr.1x30 Amps. Rishabh,AE,L&T 3. Volt mtr.0-500volts -do- 4.Amp.Selectorswitch AE/KAAYCEE/L&T/BCH,GE 5. VoltageSelectorswitch -do- 6. MCCB 4 pole20 Amp. -do- 7.Thermostat for autocut(9KW) Danfoss/Sieman/Honeywell 8. Contactor25-32 Amp.L&T/Schneider,Seimens Wire should not be less than 4mm 3 cores, Cu, armored/ UnarmoredCabelsPlaza/Havels/National/Paragon/NICCO/Bonton/ Finolex type.

LIST OF APPROVED MATERIALS CIVIL & PHE WORKS

All material to be used in the work shall conform to technical specifications, relevant Indian standard Specification and wherever available ISI marked materials will be used. All material procured shall be subjected to relevant tests specified in B.I.S. at the frequency specified therein from any recognized laboratory.

Sr. No	Details of Materials / Equipment	Manufacturer's Name
1	Ordinary Portland Cement	Ultratech, ACC, L&T
2	Slag Cement	Indorama Commondo
3	White Cement	Birla, J.K or Equivalent
4	Coarse Aggregates (machine cut) 6mm to 40mm sizes	From Approved quarry (Hard black trap stone)
5	Ready Mix Concrete (RMC)	ACC,Ultratech,Lafarge
6	TMT "Fe – 500 " Ribbed bars	Tata,JSW, SAIL
5	Structural Steel	Tata,JSW, SAIL
6	Structural Rolled Steel sections-beams, channels,tee, flats, angles, bars(round, square, hexagonal	Tata,JSW, SAIL
7	Structural Hollow steel sections (Square & , Appolo. Rectangular	Tata, Jindal,or Equivalent
8	Structural tubular sections	Tata, Asian, Jindal,
9	Aluminum Sections	Jindal,Indal, Hindalco
10	Aluminum finish powder Coating	Akzonobel, Jotun, Fuller AG, valspar,
11	Calcium silicate board / Gypsum Board	Saint Gobain (India Gypsum), Hilux ,Lafartz
12	Aluminum Window locks , handle , friction stays.	Alualpha, Securestyle, Giessee, Roto, Geze
13	Gasket of infill panel for Aluminum	Amee rubber, gold seal, Osaka rubber
14	Glazed Ceramic Tiles (Wall & Floor Tiles)	Asian ,Nitco, Kajaria,

15	Vitrified Tiles	Asian ,Nitco, Kajaria,RAK
16	Industrial Tiles (Floor & Wall Tiles)	Johnson Endura or Approved Equivalent
17	Water Proofing Compound, Hardener ,Construction chemicals, Integral water proofing compound, Crystalline water proofing	FOSROC, CICO, Pidilite, Sika, , BASF
18	Non Metalic Floor Hardener	Iornite or equivalent
19	Anti termite chemical & Wood Preservatives	Thiodon, De-nocil ,Bayer, Vam Organic, OCIL. Hindustan Insecticides, Roffe Construction Chemicals
21	Construction chemicals, Plasticisers, Bonding agents, , SBR latex,micro concrete	BASF, FOSRAC
22	Glass Mosaic	Bisazza,PaPalladio
23	Float Glass, Reflective Glass & Mirror	Saint Gobain, Asahi India,Modi Glass
24	Glass Film	3M,Llumar
25	Wall Putty	Birla white, JK White or Equivalent
26	Silicon sealant/ Silicon paint, Polysulphide sealant, P.U sealant/	Wacker, Dowcorning, GE, Soudal, Bostik, Pidilite, Chawksey, sika
27	Pre-coated steel roofing/ walling sheets 550 Mpa	Tata bluescope, Interarch, Nippon Dendro (poly steel),
28	Polypropylene fibers	Nina concrete, Reliance
29	Paints (OBD, Emulsion paints, Synthetic enamel Paints)	ICI, Asian, Berger
30	Water Proof Cement Paints	Snowcem India Ltd.. ICI, Asian
31	Red Oxide & Pink Primers	ICI, Asian, Berger, Nerolac,
32	Melemine /PU Polish	MRF,Asian,ICI,Tarlac
33	PVC Water Stop Bars	Fixopan, Syntex, BASF, FOSROC
34	Precast Cement Concrete Pavers & Tiles	Nitco,Ultra, Johnson, Dura crete, Basant Beton Astana,Swastik
35	Texture Paint (Internal & External)	Oikos,Spectrum,Asian,Berger

36	Laminates	Greenlam.Century ply,Sunmica, Unilam
37	Shuttering plywood/BWP Ply/Commercial Ply	Green, Archid, Kitply, Anchor, Uniply.
38	Plywood & Board (Commercial/ Waterproof)	Duro,Green ply,Century ply,Uniply
39	PVC Water stop	Arti Cables Baroda, Fixopan, Maruti.
40	MDF (Exterior Grade)	Duro, Green ply ,Century ply
41	Natural wood Veneer	Greenlam,Century ply,Uniply
42	Prelam Particle Board	Navopan,Bhutan, or equivalent
43	Flush door	Kitply 'swastik', Duro 'Tower', Archid, Green ply
44	Cement bonded particle board	Shera ,NCL (Bison board), Everest (Eternite).
45	Calcium silicate board / Gypsum Board	Saint Gobain (India Gypsum), Hilux ,Lafartz.
46	Door,Window etc Hardware	Ebco,Shalimar,Navabharat,Ozone
47	Dead Locks/Mortise Locks	Dorma,Ebco ,Ozone
48	Compact sheet	Alfiaca, Sundek, Vir, Bloom, Formica, merino
49	Floor Spring/Door Closer	Dorma,Godrej ,Ozone
50	Aluminum hardware	Ipsa or Approved equivalent
51	Fire Doors	Sukri, Aadhunic,Promat,Shaktimet
52	Fire door Accessories	Briton,Astroflame,Shaktimat,Radient
53	Anchor Fasteners	Hilti, Fischer, Kundan, Buildex
54	Gypsum Board	India Gypsum, Saint Gobain, USG, Lafarge
55	Self taping screws	Hilti, Landmark
56	Welding Rod	ESSAB Ferro Speed plus D&H Norma

57	Tar felt	MAK, Bengal Bitumen, Rishub Petrochemical
58	Adhesive for wood and Tile adhesives & Gouting Material	Fevicol SH, Vamicol, Araldite of Hindustan, Laticrete
59	PU Paint	MRF (Aqua fresh) or approved equivalent
60	Oil and Water Finish	Double boiled CAT brand linseed oil & MTO of reliance
61	GRC Panels	Unistone , Terra Firma
62	Spandrel Insulation	Glass wool
63	Rust Remover/converter	(Pidilite Industries), Feovert (Krishna Conchem),
64	Non-shrink general purpose grout	Fosroc, BASF
65	Anchoring chemical for rebar dowell ba	Hilti, Fischer
66	Mosquito Net	Netmos
67	Aluminium operable Louvers	Technal, Domal
68	Anodising	Bhoruka alum, Alufit alum, Ajit India, Alufin
69	Smoke seal Intumecent	Hilti/3M
70	RCC Pipes NP2 Class, NP3 Class	Indian Hume Pipes, Bharat Pipes, Vaitarana Pipes
71	G.I. Pipe	TATA, Zenith, Jindal, Surya Roshni
72	PVC Pipes	G Finolex, Astrol, Kissan,Surya,Supreme
73	S.W. Pipes	BPerfect, BURN,
74	CI Manhole Covers	NECO, BC Iron Foundry, Ashok Iron
75	Sanitary fittings	Jaguar, Kohler, Parry, Hindware
76	Sanitary Wares	Cera, Hindustan, Parryware, Jaquar
77	GI Fittings	RM, KS ENGG/EQ

	SANITARY WARE:	
79	EUROPEAN WATER CLOSET - WALL MOUNTED 'P' OR 'S' TRAP.	PARRYWARE/HINDWARE / EQ
80	SEAT COVER FOR EWC	PARRYWARE/HINDWARE / EQ
81	WASH BASIN COUNTER BOTTOM	PARRYWARE/HINDWARE / EQ
82	WASH BASIN RECTANGULAR	PARRYWARE/HINDWARE / EQ
83	ORISSA WATER CLOSET - 580 X 440	PARRYWARE/HINDWARE / EQ
84	ORISSA PAN - 'P" TRAP	PARRYWARE/HINDWARE / EQ
85	GI RAG BOLTS FOR WASH BASIN	
86	PVC CONNECTION PIPE	JAQUAR/EQ
87	LARGE FLAT BACK URINAL	JAQUAR,HINDWARE / EQ
	CP FITTINGS:	JAQUAR- CONTINENTAL - RANGE
88	WASTE COUPLING WITH HOLE	JAQUAR / HINDWARE/EQ
89	ANGLE STOP COCK WITH WALL FLANGE	JAQUAR / HINDWARE/EQ
90	BOTTLE TRAP	JAQUAR / HINDWARE/EQ
91	SINK STAINLESS STEEL	NIRALI / FRANKE/EQ
92	PILLAR COCK FOR WASH BASIN	JAQUAR-CONTINENTAL, HINDWARE/EQ
93	SINK COCK	JAQUAR- CONTINENTAL, HINDWARE/EQ
94	MIRRORS	ATUL GLASS WARE / KONICA
95	CP GRATING WITH RIM	CHILLI/EQ
96	HEALTH FAUCET FOR EWC	JAQUAR- CONTINENTAL/ HINDWARE/EQ
97	TWOWAY BIB COCK	JAQUAR- CONTINENTAL/ HINDWARE/EQ
98	DOME TYPE WASTE COUPLING FOR URINAL	JAQUAR / HINDWARE/EQ
99	STAINLESS STEEL PAPER HOLDER	JAQUAR- CONTINENTAL/ HINDWARE/EQ
100	TISSUE PAPER HOLDER	JAQUAR / HINDWARE/EQ
101	SOAP DISH HOLDER	JAQUAR- CONTINENTAL

102	SOAP DISPENSOR	JAQUAR- CONTINENTAL/ HINDWARE/EQ
103	TOWEL RING	JAQUAR- CONTINENTAL/ HINDWARE/EQ
	PIPES AND FITTINGS, VALVES & OTHERS:	
104	CPVC PIPE	SUPREME / ASTRAL/EQ
105	CPVC FITTINGS	SUPREME / ASTRAL/EQ
106	BUTTERFLY VALVE	zolato / sant/EQ
107	BALL VALVE	zolato / sant/EQ
108	AIR RELEASE VALVE	zolato / sant/EQ
109	NON RETURN VALVE	zolato / sant/EQ
110	WATER METER	AQUAMET,DASMESH
111	ANCHOR FASTNER / 'U' CLAMPS	HITECH SUPPORTS/EQ
112	RCC HUME PIPES	INDIAN HUME PIPE/ SUDARASHAN HUME PIPE/EQ
113	PVC PIPES (SWR QUALITY)	ASTRAL/Supreme/SURYA/FINOLEX
114	PVC PIPES (AGRICULTAURAL SERIES)	ASTRAL/Supreme/SURYA/FINOLEX
115	PVC FITTINGS (FABRICATED)	CLARION/EQ
116	PVC FITTINGS (MOULDED)	ASTRAL/Supreme/SURYA/EQ
117	PVC FLOOR TRAPS (MOULDED)	ASTRAL/Supreme/Surya/ Eq
118	MANHOLE COVER - CAST IRON	BIC/NECO/Eq
119	MANHOLE COVER - (RCC PRECAST)	RAJVAIBHAV/SFRC/Eq
120	LEVEL CONTROLLERS	AQUA INTECL TECH/ VINAYAKA/EQ
121	ENAMEL PAINT	ASIAN PAINTS/ APCOLITE/EQ
122	EWC CONNECTORS	MULTICWIK/EQ
	MAKE LIST FOR FIRE PROTECTION SYSTEMS MATERIALS	
Sl. No.	Item	Recommended Make

1.	Fire Pumps	Kirloskar Bros. Ltd, Mather & Platt
2.	Electric Motor	Kirloskar Electric, Crompton Greaves, Siemens, ABB
3.	GI / MS Pipes	Tata, Jindal (Hissar)
4.	Fittings	Tata, Jindal (Hissar)
5.	C.I Gate Valves	H. Sarkar, Kirloskar, Audco
6.	Gate Valves (Screwed End)	Sant, Leader, Audco
7.	Butterfly Valves	Sant, Audco, Advane, Crane
8.	Non-return Valves	H. Sarkar, Audco
9.	Ball Valves (Screwed End)	RB (1510), Leader, Audco
11.	C.I Strainer	Danfoss (Y333), Hammer, Gujrat OTO Filt, Grand Frix
12.	Flow Meter	TANSA, Eureka, RR Flowmeter, Spink Controls – Ori Flowmeter
13.	Pressure Switch	Indfoss, Switzer, Danfos
14.	Pressure Gauge (Glycerine filled)	Waree, H. Guru, Fiebig
15.	Anti-Corrosive Coat & Wrap Material	Integrated Waterproofing Ltd, Rustech
16.	Hydrant Valves	Newage, Shah Bhogilal, Winco, Ghosh Engineering Industries
17.	Branch Pipe with Nozzle	Newage, Shah Bhogilal, Winco, Ghosh Engineering Industries
18.	Fire Hoses	Newage Industries, Chhatariya Rubber & Chemical Industries, BRG Textiles
19.	Hose Couplings	Newage, Shah Bhogilal, Winco, Ghosh Engineering Industries
20.	Hose Reel	Eversafe Extinguisher SDN. BHD. Usha Fire Safety, Newage, Safex
21.	Fire Brigade Inlet Connection	Newage, Shah Bhogilal, Winco, Ghosh Engineering Industries

22.	Fire Extinguisher	Safex, Ajay, Eversafe, Excellent Fire Services
23.	Sprinkler Alarm Valve	HD,TYCO,KIDDE/VIKING/NEWAGE/MINIMAX
24.	Sprinkler Heads	HD,TYCO,KIDDE/VIKING/NEWAGE/MINIMAX
25.	Flow Switch	System Sensor,Potter,Honeywell
26.	Inspector Test & Drain Valve	GJ Innovation,Viking,Tyco
27.	Air Release Valve	Tiemme (1900N),Leader,Hawa
28.	Paint	Asian,Berger/Shalimar,Nerolac
29.	HDPE Tank	Sintex,Hitank
30.	Welding Electrodes	Esab 28,Advani,Sun Arc, Cosmos
31.	Motor Control Center	Pragathi Controls,Load control,Dynamo/Ellins/Lotus
32.	Battery	Exide/Standards/Amar Raja
33.	Cables	Polycab/CCI/Finolex/Universal
34.	MCCB / MCB	GE/L&T/Alstom/Merlin Gerin/ABB
35.	Voltmeter / Ammeter	Meco/AE
36.	Power Contactors / O/L Relays	Siemens/L&T/Schindler/ABB
37.	Selector Switch	Salzer/L&T/Kaycee
38.	Indicating Lamps (LED Type)	Binay/Teknic
39.	Push Buttons	Siemens/Tecnik
40.	Timers	EAPL/AE
41.	Terminal Blocks	Elmex/Wago
42.	Current Transformers	Kalpa/ Voltamps/ Kappa
43.	Single Phase Preventers	Minilec/AE
44.	Battery Charger	Kaybee Powerec/ HBL-NIFE/ AFCO/ Chabbi

45.	Siren / Hooter	Kheraj
46.	End Terminations	Dowells/mULFI
47.	Cable Trays	Pushpak/pan
48.	FRLS Copper Cables / Wires	Polycab/ Finolex/ Anchor/ Power flex
49.	GI Conduits	Bharath/ GB/ Prince
50.	PVC Conduits	VIP/ Precision
	ELECTRICAL WORKS	
1	Luminaires - T5/LED	PHILIPS/WIPRO/HAVELLS/BAJAJ
2	High efficiency fluorescent lamp	PHILIPS/OSRAM
3	Lighting Dimmers/Controls	LEGRAND/ANCHOR ROMA /MK/KOLORS
4	Ceiling fan, pedestal fan, wall mounting fan,exhaust fan	CROMPTON GREAVES/ALMANORD/USHA /HAVELS
5	Modular switches & Sockets	ANCHOR ROMA /MK/ CRAB TREE/KOLORS
6	PVC FRLS Conduits	VIP/AVONE/SUPREEM
7	MS Conduits	GN BHARAT/DUPREME/INDUSTRIES
8	FRLS Wires	FINOLEX/ANCHOR/ KEI
9	LT cables—Aluminium	UNIVERSAL / KEI/POLYCAB /GEM / HAVELLS/
10	Heavy duty cable Lugs and Cable glands	SUNIL/SMI
11	Cable trays	FIXOTECH/Patney / Frobab
12	Flexible & Armoured – Copper Cables	FINOLEX/ANCHOR/ KEI
13	DBs/MCB - C/D Curve/RCD's	SCHINDER/LEGRAND/SIEMENS/ABB
14	Industrial Switch sockets moulded	NEPTUNE/MDS/CLIPASAL
15	Industrial Switch sockets industrial	NEPTUNE/MDS/CLIPASAL
16	LT Switchboard	SV KARANTH/ GV ENG & CONT/RAMPO CONTROLS

17	ACB	SCHINDER/SIEMENS/ABB
18	MCCBs	SCHINDER/SIEMENS/LEGRAND/ABB
19	Contactors & O/L Relay	GEC ASLTHOM/EASUN/SEGC
20	Load Monitors / Multi Data meter with Com. port.	ELMEASURE/CONSERVE/SOCOMAC
21	Capacitor' All PP/ Heavy Duty	Siemens - Epcos / Naptune Ducati
22	CT's & PT's	KAPPA/IMP/AE/KALPA/VOLTAMP
23	Control Switches	ABB/ MG /SIEMENS
24	Earth Fault Relay	MINILEC/PROK DEVICES/DART/NAGOBA
25	Protective relays including multifunction relay	GEC ASLTHOM/EASUN/SEGC
26	Push Buttons	EE/BCH/TECHNIK/SIEMENS
27	Indicating Lamps(LED Type)	EE/BCH/TECHNIK/SIEMENS
28	Terminals	Dowells / HMI / SMI.
29	Ferrules - GRIP BOLTS	Wago / ELMAX - FISHER
30	Bus bar Supports	powermat/electro fiber
31	Energy Meter / MDM / Digital meters	ELMEASURE/CONSERVE/SOCOMAC
32	TRANSFORMER	UNIVERSAL / KIRAN POWER/KIRLOSKAR
33	COMPACT SUBSTASTION	SCHINDER/SIEMENS/ABB
34	HT METERING/LBS	VOYAMA/STAR SWITCHGEAR/MEI
35	COMPACT RMU	SCHINDER/SIEMENS/ABB
36	DG SET	CUMMINS/KIRLOSKAR
37	Ceiling Junction Box	Amar/Home lite
38	Door Bell	Anchor Roma /Lisha
39	Light Fixtures (Decorative commercial, street light fixtures	Havells/PHILIPS
40	Miniature circuit Breaker	Legrand / Indoasian Gold Plus

41	Earth leakage circuit breaker	Legrand / Indoasian Gold Plus
42	Moulded case circuit breaker	A.B.B/Legrand
43	Switch fuse units, fuse switch units with HSR fuse	C&S/A.B.B.
44	Change over switches & Change over fuse switches	H.P.L / A.B.B
45	ELR with CBCT	Prokdevices
46	Indicating Instruments	AE/ MECO/IMP
47	KWH meter	BHEL/ HP/Havells
48	Indicating lamps	L & T /Vaishnav /BCH
49	End termination	Dowells /Usha
50	Telephone cable	Havells / K.E.I
51	TV cable	Finolex / Triscope / comscope
52	Terminals	Elmex /Equivalent.
53	Cable tray & Wire ways	Hi- Tech Fastners / Power pack/Shubam
54	CAT 5 cable	AVAYA / AMP /De-link
55	Information Outlet	AVYA / AMP / De - link
55	Jack Panel	AVAYA / Amp /De-link
56	Panel Board	Hasanamba / Banavathy

Note: * Owner/Consultant reserves the right to choose any one of the makes of materials and in case of equivalent and their decision is final. If any missed out approved makes for some materials, owner/consultant shall decide accordingly