

MAZAGON DOCK SHIPBUILDERS LIMITED
(Formerly known as Mazagon Dock Ltd.)
CIN: U35100MH1934GOI002079
(A Government of India Undertaking)
Shipbuilders to the Nation
Dockyard Road, Mazagon,
Mumbai 400 010.
INDIA

Subject: Modernization of MDRC Tennis Court including flooring and fencing in
Residential Area of MDL

Tender No 1900000084 dated 25 Sept'20

VOLUME -Technical Specification & Preferred Make

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SECTION I-TECHNICAL SPECIFICATIONS FOR CIVIL WORK

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1. EARTHWORK

1.1. Excavation

- 1.1.1. The work to be done under this section comprise performance of all work necessary for excavation with shoring, strutting, dewatering, pumping including disposing of all surplus excavated material from the site as directed by the Engineer.
- 1.1.2. Excavation shall be carried out in any type of soil, gravel, conglomerate, soft rock, boulders, old foundation, hard rock, concrete, asphalt or stone paved surfaces old masonry or concrete (plain or reinforced) encountered within width, length and depths indicated in the drawings. Where any temporary or permanent structure like sheet piling, diaphragm wall or piles have already been taken up, all excavation work shall be from the point carried out earlier and all precaution during further excavation and or any construction operation shall be exercised not to damage such existing temporary or permanent work. Where directed by the Engineer trees encountered within the work site shall be uprooted as per approved manner and serviceable wooden logs shall be stacked at site / disposed of as directed by the Engineer. Branches of trees etc. shall be disposed of or stacked at site as directed by the Engineer. No permanent work shall be commenced in the excavated area until the foundations pits have been inspected and approved by the Engineer. The Contractor may use any

suitable excavated materials for incorporation in the permanent or temporary works as may be convenient subject to compliance with the specifications. Any obstacles encountered during excavation shall be reported immediately to the Engineer and shall be dealt with as directed by the Engineer.

1.2. Site Levels

- 1.2.1. Survey of existing road level by approved survey equipment to establish initial surface level and finalization of related road work activities. Contractor shall submit level book / Graphic chart for each road section.
- 1.2.2. Before the work commences the Contractor shall carry out a survey of the levels of the site and obtain verification by the Engineer of these levels. Levels shall be taken on a grid to be agreed with the Engineer and the Contractor shall submit three prints of the drawing showing the site levels for record purpose.

1.3. Support of Excavation

- 1.3.1. The Contractor shall adequately support the sides of excavation as may be necessary to prevent subsidence or movement of the material in which the excavation is being carried out and to ensure the safety of persons and nearby structures.

1.4. Slips

- 1.4.1. The Contractor shall take all necessary precautions to prevent slips in excavations and shall **at his own** make good any damage or defect and remove to spoil dumps any surplus material caused by slips.

1.5. Excavation beyond Required Limit

- 1.5.1. Any excavation beyond the required limits and against which concrete is to be placed shall be made good with concrete of similar grades. Any excavation beyond the required limits at locations where no concrete is to be placed will not be required to be made good with concrete unless otherwise directed by the Engineer provided always that any consequential additional work caused or necessitated by the excavation beyond limits will not be admitted for payment.

1.6. Dewatering

- 1.6.1. While execution of works, if so encountered, the Contractor shall provide for the purpose of excavation under water all the necessary dewatering equipment like well points, pumps (including stand byes), pipes, conduits, etc. and make necessary arrangement for proper drainage of the pumped water from the well points and its easy disposal without affecting the site and the adjoining areas. The Contractor at his own cost shall take any permission required for such disposal of water to other areas, from the respective authorities.

1.7. Earthwork in Filling and Site Clearing

- 1.7.1. Filling is to be carried out up to the level as shown in the drawing. All old foundations, boulders etc. encountered during filling shall be removed as directed by the Engineer.

1.8. Soft Patches

- 1.8.1. All the soft patches encountered at the desired level of excavation, shall be removed completely as directed by the Engineer and filled back with approved soil and duly rammed and compacted with water to the required density of filling as specified and to the entire satisfaction of the Engineer. In case of rocky founding strata any soft patch and or voids are encountered, such soft patches shall be

replaced and the void filled with plain cement concrete of M-15 grade compacted and finished as per direction and satisfaction of the Engineer.

1.9. Compaction Quality

1.9.1. Compaction of earth and sand filling in areas where foundations and floors are located, the degree of compaction achieved shall be minimum 95% of maximum dry density as obtained by Proctor compaction as per IS: 2720 (Part VII). Unless otherwise specified, in roads & other areas the degree of compaction shall be 90%.

1.10. Testing of Filling Layer

1.10.1. After the compaction of each layer, samples shall be taken from the compacted layer and tested for dry density as per IS Practice. The next layer of filling shall not be permitted to be deposited until the Engineer is satisfied that the previous layer has achieved required compaction. The contractor shall inform the Engineer in writing for inspection after filling and Compaction of each layer. If any particular layer fails to meet the required compaction, it shall be re-compacted as directed by the Engineer and fresh samples shall be taken to ascertain the compaction density. Such re-compaction shall be continued till the desired compaction is achieved. The thickness of each compacted layer shall not exceed 200 mm.

1.11. Dressing & Finishing

1.11.1. The filling after it reaches the required level, shall be dressed and finished as specified to the required alignment, levels, cross sections, dimensions and slopes as shown in the drawing or as directed by the Engineer. No deviation shall generally be allowed from the levels shown in the drawings.

1.12. Surface Excavation

1.12.1. Excavation exceeding 1.5 m in width or / and 10 sq. m. on plan but not exceeding 30 cm in depth shall be described as 'Surface Excavation`.

1.13. Setting Out and Making Profiles

1.13.1. Masonry pillars shall be erected at suitable points in the area, which is visible from the largest area to serve as benchmarks for the execution of the work. These benchmarks shall be constructed as required and connected with standard B.M. as approved by the Engineer. Necessary profiles with pegs, bamboos and strings shall be made to show the correct formation levels before the work is started. These shall be maintained during the excavation.

1.14. Classification of Earth Work

1.14.1. The earthwork shall be classified under the following main categories and measured separately for each category.

- a) **Soil:** It includes various types of soils, mud concrete below the ground level. Shingle and river or nallah bed boulders soling of road, paths and hard core, macadam surface of any description, lime concrete, stone masonry below the ground level, soft conglomerate and laterite when the stone can be detached from the matrix with picks and shovel.
- b) **Ordinary Soils, Sand, Clay & Soft Moorum:** This includes earth, soft murrum, top deposits of agricultural soil, reclaimed soil, clay, sand or any combination thereof which can be excavated with shovels, loose application of pick axes etc.

- c) **Hard soil, murrum, boulders, weathered / soft rock:** All decomposed weathered rock, highly fissured rock, old masonry, boulders bigger than 0.03 cum. in volume but not bigger than 0.5 cum. and other varieties of soft rock which can be removed only with hard application pick axes, crow bars, wedges and hammers with some difficulty. The more fact that the contractor resorts to blasting and / or wedging and chiseling for reasons of his own, shall not mean the rock is classifiable as hard rock.
- d) **Ordinary Rock:** All type of laterite rock will be treated as ordinary rock. If there is any difference of opinion in distinguishing between ordinary and hard rock, then the engineer's decision shall be final and binding.

Note: The scope of work taking site levels, support the sides of excavation, barricades, dewatering, etc. are inclusive of excavation item, no extra payment will be given to the contractor.

2. Earth Work in Filling / Refilling:

- 2.1. Unless otherwise specified, selected excavated earth shall be used for refilling. For general area filling for raising formation level selected earth shall be used as directed by the Engineer. Before filling of such area existing top soil shall be scarified to remove all vegetation and soft or debris already existing. After cleaning of debris etc the top soil shall be compacted before filling with any new soil. In case the filling earth contains deleterious salts it shall not be used. Approval of filling materials is to be obtained well in advance to commencement of work. All clods of earth shall be broken or removed. Where the excavated material is mostly rock with boulders, the boulders shall be broken into pieces not bigger than 7.5 cm size in any direction mixed with fine materials consisting of decomposed rock, murrum or earth so as to fill up the voids as far as possible and then the mixture used for filling, as approved by the Engineer. However, the decision / instructions of the Engineer shall be final.

3. Hard Core Soling (Trap rubble stone Soling)

- 3.1. The hard core shall consist of layers of uniform thickness of trap stone rubble (of size 150 mm to 230 mm) or any other approved stone carefully set as close as possible on ground properly formed for the purpose. The packing shall consist of large stones. The interstices between the rubble stones shall be filled up with stone chips, spalls, and oversized metal removing the projection of the upper part of the packing so as not to loosen the hard core soling. Also spreading approved hard murrum or soil collected/stacked during excavation etc, complete, the hard-core soling should be thoroughly rammed, watered, settled to place and made compact.

4. CONCRETE WORK

4.1. General

- 4.1.1. This section covers the requirements for furnishing of cement concrete including materials proportioning, batching, mixing, testing, placing, compacting, finishing, jointing, curing & all other work as required for cast-in-situ or ready mixed plain and reinforced concrete.

4.2. Submittals

4.2.1. Materials Reports

- a) Prior to start of delivery of materials required for cement concrete the following shall be submitted by the Contractor to the Engineer for approval.
- i) Recommended suppliers and / or sources of all ingredients for making concrete including cement, fine & coarse aggregates, water and additives including samples thereof.
 - ii) Quality Inspection Plan to ensure continuing quality control of ingredients by periodic sampling, testing and reporting to the Engineer on the quality of materials being supplied.

4.2.2. Plant and Equipment

- a) The contractor shall submit the proposed programme, methods and details of plant and equipment to be used for batching, mixing and placing of concrete to the Engineer, well in advance prior to start of work.

4.2.3. **Certificates**

- a) With each mix design, the Contractor shall submit test reports on concrete cubes and as well as on ingredients to be used at the actual construction work for approval of the Engineer.
- b) In case the source, brand or characteristic properties of the ingredients are required to be varied during the term of the contract, a revised mix design report shall be submitted to the Engineer.

4.2.4. **Schedules**

- a) The Contractor shall prepare working schedules for dates and quantity, location of pouring of concrete for each item of work and submit same to the Engineer at least 48 hours before commencement of such work.

4.3. **Materials**

- 4.3.1. Before bringing to the site, all materials for cement concrete shall be got approved by the Engineer. All approved samples shall be retained in the office of the Engineer before placing orders for the materials with suppliers. The materials brought on to the works shall conform in every respect to their approved samples.
- 4.3.2. Fresh samples shall be delivered to the Engineer whenever type or source of any material changes. The contractor shall check each fresh consignment of materials as it is brought on to the works to ensure that they conform to the specifications and / or approved samples.
- 4.3.3. The Engineer shall have the option to have any of the materials tested to find whether they are in accordance with specifications. All bills, vouchers and test certificates which in the opinion of the Engineer are necessary shall be produced for his inspection when required.
- 4.3.4. Any materials which have not been found to conform to the specifications and not approved by the Engineer shall be removed from the site by the contractor within the time stipulated by the Engineer.

4.4. **Cement**

- 4.4.1. The cement used shall be Ordinary Portland Cement conforming to IS: 8112.
- 4.4.2. Whenever possible all cement of each type shall be obtained each from one constant source throughout the contract. Cement of different types shall not be mixed with one another. Different brands of cement, or the same brand of cement from different sources, shall not be used without prior notification and approval of Engineer.
- 4.4.3. The cement shall be supplied either packed in bags or in silos installed for the purpose of supply. Packed cement shall be delivered to the site in original sealed bags which shall be labeled with the weight, date of manufacture, name of manufacturer, brand and type. Cement received in torn bags shall not be used. Moreover, bags of cement which vary in weight by more than 3% shall not be accepted.
- 4.4.4. All cement shall be fresh when delivered and at ambient atmospheric temperature.
- 4.4.5. In fair-faced elements, the cement used in the concrete for any complete element shall be from a single consignment. All cement for exposed concrete shall be from the same approved source and uniform in colour.
- 4.4.6. With each and every delivery of cement the contractor shall provide the manufacturer's certificate that the cement conforms to the relevant Indian Standard.
- 4.4.7. The Contractor shall provide facilities for making 7 days' tests and 28 days from time to time in accordance with IS:3535, IS:4031 and IS:4032 (Latest Edition) and shall allow for carrying out such tests as may be required by the Engineer and for reporting the results.

4.5. Aggregates

4.5.1. Aggregates from natural sources shall be in accordance with IS: 383. The Contractor shall submit to the Engineer certificates of grading and compliance from the suppliers for all consignment of aggregate. In addition, from time to time, the Contractor shall test that aggregate at site in accordance with IS: 2386 Part I, II & III. The contractor shall allow for and provide all necessary apparatus for carrying out such tests and for supplying test records to the Engineer. The aggregates shall be free from salts or other harmful chemical impurities.

4.5.2. For fair-faced concrete, the contractor shall ensure that aggregates are free from iron pyrites and impurities, which may cause discoloration.

4.5.3. Fine Aggregates

a) The fine aggregate shall be pit sand, river sand or other approved sand conforming to IS: 383. It shall be free from clay, loam, and earth or vegetable matter & from salt or other harmful chemical impurities. In case impurities cannot be removed by screening process, sand shall be washed and cleaned to the satisfaction of the Engineer. It shall be clean, sharp, strong, angular and composed of hard silicious material.

i) Silt Content

The maximum quantity of silt in fine aggregates as determined by the Field method shall not exceed 8 percent by volume.

4.5.4. Coarse Aggregate

a) The coarse aggregate shall be crushed stone conforming to IS: 383, having nominal size of 20 mm & 40 mm as per requirements and as approved by Engineer.

b) Coarse aggregate obtained from crushed or broken stone shall be angular, hard, strong, dense, durable, clean and free from soft, friable, thin flat, elongated or flaky pieces.

c) Except where it can be shown to the satisfaction of the Engineer that a supply of properly graded aggregate of uniform quality can be maintained over the period of the works, the grading of aggregate shall be controlled by obtaining the coarse aggregate in different sizes & blending them in correct proportions as and when required.

4.6. Water

4.6.1. Water used in the works shall be potable water & free from deleterious materials. Water used for mixing and curing concrete as well as for cooling and / or washing aggregate shall be fresh and clean, free from injurious amounts of oil, salts, acids, alkali, other chemicals and organic matter.

4.6.2. Water shall be from the source approved by the Engineer and shall be in accordance with IS: 456 (latest edition)

4.6.3. Before starting any concreting work and wherever the source of water changes, the water shall be tested for its chemical and other impurities to ascertain its suitability for use. No water shall be used until tested, found satisfactory and approved by Engineer. Water testing kit shall be made available at site for random checking of water.

4.7. Admixtures and Additives

4.7.1. Chemical admixtures shall conform to IS 9103 & are not to be used unless permitted by the Engineer. In case their use is permitted, the type, amount, chemical property and method of use of any admixture proposed by the contractor shall be submitted to the Engineer for approval prior to the approval of the same.

4.7.2. The contractor shall further provide the following information concerning each admixture to the Engineer.

a) Normal dosage and detrimental effects if any of under dosage and over dosage.

b) The chemical names of the main ingredients in the admixture.

c) The chloride ion content if any expressed as a percentage by weight of admixture.

- d) Whether or not the admixture leads to entrapment of air when used in the manufacturer's recommended dosage.
 - e) Where two or more admixtures are proposed to be used in any one mix, the manufacturer's written confirmation of their compatibility.
- 4.7.3. In reinforced concrete, the chloride ion of any admixture used shall not exceed 2% by weight of the admixture as determined in accordance with IS: 6925 and the total chloride ion in all admixtures used in concrete mix shall not exceed 0.83 percent by weight of cement or as per latest IS code.
- 4.7.4. The admixtures shall conform to IS: 9103. The suitability of all admixtures shall be verified by trial mixes.
- 4.7.5. The addition of calcium chloride to concrete containing embedded metal will not be permitted under any circumstances.
- 4.7.6. Retarding admixtures when used shall be based on lingo sulphonates with due consideration to clause 5.2 and 5.3 of IS: 7861.
- 4.7.7. Waterproofing admixtures shall comply with IS: 2645.

4.8. **Storage**

All goods and products covered by these specifications shall be procured well in advance and stored as specified below:

4.8.1. **Storage of Cement**

- a) Cement shall be stored on a raised floor in dry, waterproof and well ventilated shed.
- b) Cement bags shall be stacked at least 60 cm away from external walls and in stacks of not more than ten bags to avoid lumping under pressure.
- c) Cement stored during monsoons shall be completely enclosed in 700-gauge polythene sheet so arranged that the flap closes on the top stack. The contractor shall ensure that protective polythene sheet is not damaged at any time during use.
- d) Cement of different types shall be stored in separate sheds or separate compartment of a shed. If different types of cement are mixed, the Engineer will have the discretion to condemn all the cement concerned.
- e) Consignment of cement shall be used in order of delivery. A record shall be kept of the batch numbers of cement deliveries in such a form that the part of the works in which the cement is used can be readily identified.
- f) The contractor shall be responsible for the storage of cement at the site and no claim will be entertained in the event of any damage occurring to cement due to faulty storage by the contractors or on account of his negligence.
- g) Cement stored on site for a period longer than eight weeks shall be tested to the satisfaction of the Engineer before it is used in the works.
- h) Cement which has so deteriorated in quality that it no longer conforms in all respects to the requirements of this specification will be condemned by the Engineer & shall not be used in the works. The contractor shall immediately remove from the site all cement, which has been so condemned

4.8.2. **Stacking of Aggregates**

- a) Aggregates shall be stored on a suitable well drained raft of concrete, timber, metal or other approved material. The storage of aggregate on the ground will not be permitted.
- b) Each size of aggregate shall be stored separately in such a manner as to prevent spillage and mixing of one aggregate with an adjacent aggregate. The dividing wells of any bins shall be of sufficient height & the aggregate shall be so deposited that a distance of 300 mm shall be left between the top of the division wall and any part of the aggregate stack.

- c) When stack piling, the aggregate shall not form pyramids resulting in segregation of different size particles. The stacks shall be regular and of a height not exceeding two meters.

4.8.3. **Stacking and Storage of Steel Reinforcement**

- a) Steel reinforcement shall be stored in a way as to prevent distortion and corrosion, bars of different classifications, sizes and lengths shall be stored separately to facilitate issues in such sizes and lengths and to minimize wastage in cutting from standard lengths.

4.9. **Concrete Mix**

- 4.9.1. Cement concrete used in the works shall be either of the two categories given below:

a) **Nominal Mix Concrete**

- i) The proportion of aggregates and cement shall be as specified.

b) **Design Mix or Controlled Concrete**

- i) The design mix or controlled concrete shall conform to the grades specified in item or drawings. The mix shall be designed to achieve the required strength and the ingredients shall be measured by weight in approved weigh batching equipment. Mixing of water shall be measured in graduated liter cans. In case cement is supplied packed in bags one or more complete bags of cement shall be used for each batch of concrete.
- ii) The controlled concrete shall meet with the strength requirement laid down in Table 2. The aggregate cement ratio and water cement ratio to be used for obtaining the specified strengths given in Table 2, shall be determined in accordance with the design of the mix. The water cement ratio shall not be more than the maximum water cement ratio specified hereinafter.

TABLE-1

Grade of Controlled Concrete	Compressive Strength of 15 cm Cubes (Kg/cm ²)			
	Laboratory Design Strength		Field Test	
	7 days	28 days	7 days	28 days
M15	143	210	105	150
M20	190	280	140	200
M25	235	345	175	250
M30	270	410	205	300
M40	360	560	270	400

- iii) The contractor shall be responsible for designing mixes of the specified performance to suit the degree of workability and characteristic strength, required for the various parts of the works.
- iv) Alternative mixes may be designed by the contractor for use in both thin and narrow sections & thick sections. Special mixes using finer aggregates may be designed by him for infilling pockets and narrow spaces and for regions of congested reinforcement.
- v) The minimum cement content for various grades of concrete shall be as follows.

Grade of Concrete	Minimum cement content (Kg/m ³)

	PCC	RCC
M 15 (1:2:4)	240	300
M 20 (1:1.5:3)	260	340
M 30 (Design Mix)	-	340
M 40 (Design Mix)		360

- vi) The maximum water cement ratio shall be 0.45 for M-30 & M-25 grade concrete, and 0.5 for M 20 grade concrete

4.9.2. **Strength of Nominal Mix Concrete**

- a) The compressive strength on field tests for different nominal mixes, if adopted are given in Table - 3 below:

Table – 3

Concrete Mix (Nominal)	Compressive Strength (Kg/cm ²)	
	7 days	28 days
M - 15	105	150
M - 20	140	200

4.10. **Water Cement Ratio**

- 4.10.1. The quantity of water added to the cement and aggregate during mixing shall be such as to produce a concrete having sufficient workability to enable it to be properly compacted to be worked into the corners of the shuttering and around reinforcement.
- 4.10.2. The variation of moisture content within any consignment of aggregate and any variations due to watering, exposure to rain or drying weather shall be taken into account in determining the quantity of water to be added in concrete mix. The contractor shall carry out regular moisture content tests in accordance with IS:2386 Part III on stacked aggregate as directed by the Engineer and results submitted to him.
- 4.10.3. In case of nominal mix concrete the maximum water cement ratio shall be as stated in Table - 9, IS: 456 and in the case of controlled concrete the water cement ratio shall be as determined in the approved mix design subject to maximum limit as stated herein before.
- 4.10.4. The contractor shall exercise tight control on the water content for concrete mix.
- 4.10.5. When a suitable water cement ratio has been determined and approved by the Engineer, it shall be maintained throughout the corresponding part of works. Approved tests shall be undertaken periodically by the contractor to satisfy the Engineer of the maintenance of the consistency. However, the amount of water added to a mix other than for fair faced concrete may be reduced below the agreed design amount with the consent of the Engineer if the contractor is able to demonstrate that such a reduction is consistent with producing concrete of the required workability and characteristic strength.
- 4.10.6. The contractor shall frequently test the concrete for slump cone test. The slump at the actual location of placing as measured in accordance with the methods laid down in IS:1199 shall not be more than 75 mm and not less than 50 mm unless otherwise approved by the Engineer.

4.11. **Approval of Design Mixes**

- 4.11.1. The contractor shall submit to the Engineer for comment sufficient evidence based on trial mixes that for each grade of concrete, the intended workability, the proposed mix proportions & method of manufactures, which will produce concrete of the required quality.

- 4.11.2. The contractors shall obtain from the Engineer his written approval on the mix design for each grade of concrete before any concrete of that grade is placed in the works.
- 4.11.3. For each grade of concrete, three separate batches of concrete shall be made by the contractor using materials typical of the proposed supply and under full scale site conditions.
- 4.11.4. The workability of each of the trial batches shall be determined and 3 specimen preliminary test cubes shall be tested at 7 days & 6 cubes of each set shall be tested at 28 days.
- 4.11.5. Following agreement with the Engineer on the trial mix proportions should the contractor wish to make substantial changes in the materials or in the proportions of the materials to be used in mix, the Engineer will require further trial mixes to be made and their results submitted for comments prior to such materials or proportions being adopted by the contractor.

4.12. Concrete Testing

4.12.1. Cube Test

- a) The strength of concrete either in assessing the suitability of the trial mixes or when placed in the works shall be determined from 150 mm cubes made, cured, stored, transported and tested in accordance with IS:516 and as specified.
- b) Test cubes shall be made as and when required by the Engineer as per the relevant IS Stipulation.
- c) Test cubes shall be made under the direct supervision of the competent person appointed by the contractor to supervise all stages of the preparation and placing of concrete. They shall be made by the contractor in the presence of the Engineer and generally from concrete taken at the point of discharge from the mixer and the contractor shall provide suitable facilities in the form of a shed or other covered protection as agreed with or directed by the Engineer for the storing and curing of the test cubes during the first 24 hours after making them and until they are dispatched to the testing laboratory.
- d) Test cubes shall be marked and dated in such a manner that the trade and the part of the works in which the concrete they represent has been placed can be readily identified.
- e) Testing shall be done in the field laboratory only; in special case with due approval of Engineer or whenever so desired and directed by the Engineer, testing may be carried out in approved laboratory and the results shall be submitted promptly by the contractor to the Engineer without any extra cost.
- f) When concrete of a particular grade is first used in the works, 2 cubes each shall be taken from 3 separate batches during each of the first 7 days of using that grade. Of these 6 cubes made daily, 3 cubes (each cube representing concrete made of a different batch) shall be tested at 7 days and the remaining 3 cubes shall be tested at 28 days.
- g) If the concrete strength determined from such 28 days' cube tests does not reach the characteristic strength for that grade, the materials and / or their proportions for that grade shall be modified by the contractor to the satisfaction of the Engineer.
- h) In addition, the contractor shall at his own expense take such actions as the Engineer may consider necessary on the concrete placed in that part of the works represented by the set of cubes so found to be below the characteristic strength.

4.13. Concrete Production

- 4.13.1. For production of concrete, concrete batching plant of about 12-15 m³/hr. capacity with tested and calibrated water meter, mechanical weigh batcher shall be used for production of all concrete. Necessary approval shall be obtained from Engineer before the installation of mixing arrangement is installed at site. However, the contractor, if desires so can procure ready mix concrete from the market at no extra cost subject to compliance of technical specifications as laid down in the contract agreement for various grade of concrete. Concrete mixer for production of small quantum of concrete and non-structural member can be allowed at the discretion of Engineer.

4.14. Concrete Mixing

- 4.14.1. All concrete in the correct proportion of ingredients approved by the Engineer, whether ordinary or controlled, shall be mixed in a batching plant for the minimum time necessary to ensure adequate quality and uniform distribution of the materials. The cement and aggregates shall normally be first mixed dry until all particles of aggregate are coated with cement after which the water shall be added along with admixture.
- 4.14.2. Allowance shall be made for the moisture content of the aggregates when calculating the amount of water to be added for each mix.
- 4.14.3. The temperature of the aggregate, water and cement when added to the mixer shall be such that the temperature of the concrete at the time of placement is less than 40°C.
- 4.14.4. Materials for concrete shall be deposited into the drum while it is in rotation. Mixers shall not be loaded beyond their rated capacity and each batch shall be completely discharged from the drum before recharging takes place.
- 4.14.5. Facilities shall be provided to spray the mixer drum with cool water between batches and on the completion of concreting the drum shall be washed thoroughly. The surface of the mixer drum shall be maintained in a clean condition at all times.
- 4.14.6. Retempering and / or mixing of concrete, which has partially hardened and set will not be permitted under any circumstances.

4.15. Transporting

- 4.15.1. The period between mixing the concrete and placing it in the final position shall be kept to a minimum and the delivery of concrete shall be coordinated with the rate of placement to avoid delays in delivery and placement.
- 4.15.2. Concrete shall be handled from the place of mixing to the place of final deposit by methods, which prevent segregation, loss of ingredients and contamination and maintain the required workability.
- 4.15.3. Should any segregation have occurred in any batches arriving at the place of deposition, such batches shall be rejected and shall not be allowed to use. Where concrete is conveyed by chutes, the chutes shall be made of metal or fitted with metal linings. The approval of the Engineer shall be obtained for the use of chutes more than 3 metres long.
- 4.15.4. All plant and equipment used in the transportation of concrete shall be thoroughly cleaned before and after each working period and at all changes of concrete mixes.
- 4.15.5. All major concreting is advisable to be done by concrete pump of adequate capacity with necessary approval obtained by the contractor. If concrete pump is used, delivery system with adequate boom length, pipeline and associated items shall be obtained before installation of the concrete pump. There shall also have the provision of approved standby system in case of any eventualities for transportation and placement of the concrete.

4.16. Preparation Before Concreting

- 4.16.1. The inside surface of the forms against which concrete is to be placed shall be clean and free from dried or hardened spattering or coatings of concrete. The forms shall be wetted before placing concrete.
- 4.16.2. When the work has to be resumed on a surface which has hardened, such surface shall be roughened. It shall then be swept clean and covered with a coating of freshly mixed epoxy based concrete adhesive as per manufacturer's instructions immediately before placing of concrete.
- 4.16.3. Before any concrete is placed on the sub grade, the sub grade shall be checked and approved for degree of compaction and alignment. The sub grade shall be kept damp ahead of concreting.
- 4.16.4. Concrete shall not be placed in the works until the Engineer has inspected the formwork, reinforcement, inserts and sleeves if any & given his permission to place concrete.

4.17. Placing

- 4.17.1. Concreting of any portion of the works shall be done only in the presence of the Engineer or his representative.
- 4.17.2. Concreting shall be carried out continuously between construction or expansion joints, shown on the drawings or as agreed with the Engineer. The contractor shall closely follow the sequence of concreting where such is specified in the drawings or instructed at site. If concreting is interrupted before reaching the predetermined joint an approved construction joint shall be provided after obtaining necessary approval from the Engineer.
- 4.17.3. Immediately before placing of concrete for columns & walls, the reinforcement within and the old concrete at the bottom of the formwork shall be given a coating of epoxy based concrete adhesive, to prevent the loss of bonding with existing surface.
- 4.17.4. Concrete shall be deposited as nearly as is practicable to its final position and shall not be dumped in a large quantity at any point to be run or worked along the formwork manually or with vibrators. Concrete shall not be deposited at a faster rate than it can be placed and compacted. Concrete shall not be placed from a height more than 1.5 m.
- 4.17.5. Concrete shall be thoroughly worked into the forms so that they are entirely filled, reinforcing bars adequately and tightly surrounded and entrained air released from the mass of concrete. Placing shall be carried with the use of vibrators in a manner approved by the Engineer.
- 4.17.6. For members having thickness more than 300 mm, the concrete shall be placed in layers not greater than 300 mm thickness and thoroughly compacted before succeeding layers are placed. Concrete shall be placed in single operation to the full thickness of slabs, beams and similar members. No concrete shall be placed on concrete which has set sufficiently to cause the formation of planes of weakness & where these are likely to occur due to unforeseen circumstances and the procedure to be followed shall be as given earlier of this specification. As far as possible, cold joints in concrete shall be avoided.

4.18. Compaction

- 4.18.1. Each layer of concrete whilst being deposited shall be compacted by approved methods to form a dense material with all surface free from honeycombing, air holes or other blemishes. The contractor shall use mechanical vibration for all concrete and shall take care that internal vibrators shall not be brought into contact with the reinforcement or the formwork.
- 4.18.2. An adequate number of vibrators shall be used to ensure that compaction of concrete is achieved within 10 minutes of placing. Particular attention shall be given to the compaction of the concrete around the water bars to ensure that no voids or porous areas are left.
- 4.18.3. Compacting shall cease as soon as excess water appears on the face of concrete. Any water accumulating on the surface of newly placed concrete shall be removed by approved methods and no further concrete shall be placed thereon until such water has been removed.
- 4.18.4. Notwithstanding the requirements regarding mix design, should it be found that the proportion of water in the mix is such that the laitance forms before compaction (i.e. completion of expulsion of air) is complete and unacceptable, the quantity of water in the mix shall be reduced. Approved admixture / plasticizer shall be used to achieve the necessary workability, as approved by the Engineer and strictly in accordance with manufacturer's instructions. Whenever either of the aforesaid procedures are to be adopted, an additional set of 6 cubes for testing at 7 or 28 days shall be made from the adjusted mix.
- 4.18.5. The time elapsed between the discharge of the concrete from the mixer and the completion of compaction shall not exceed 30 minutes where concrete admixture is not used.
- 4.18.6. A sufficient number of spare vibrators of various capacities & types shall be kept readily accessible to the place of deposition of concrete to assure adequate vibration in case of breakdown of those in use.

4.19. Finish

- 4.19.1. All concrete surfaces shall have a good, dense form finish. The top surfaces specified as smooth shall be leveled and troweled before the concrete begins to set to a smooth finish at levels and falls shown on the drawings. The troweling shall be done at such a time and in such a manner that excess of mortar is not brought to the surface of concrete nor the aggregate displaced. The top surfaces of concrete slabs specified to receive an integral finish shall be uniformly roughened by deep hacking before the finish is laid.
- 4.19.2. Immediately after striking the formwork and removing any superficial water, honeycombed areas in normal unfinished concrete shall be inspected by the Engineer and where directed the contractor shall immediately make it good to the satisfaction of the Engineer. All air holes shall be similarly filled up.
- 4.19.3. The contractor shall be responsible for providing an adequate key in concrete where plastering or rendering is specified to be applied. Hacking of the concrete surface after striking the formwork will be permitted only after 3 days after the concreting is done.
- 4.19.4. The faces of all fair faced concrete shall be of even colour throughout, free from air bubbles, cracks, honeycombing or other blemishes and will be inspected by the Engineer on report by the Contractor, immediately after the formwork has been struck. Such faces shall not be rubbed down or otherwise repaired to remove any defects or imperfections without the prior permission of the Engineer.
- 4.19.5. Concrete surface finishes shall accord to the requirements and all instructions by the Engineer with regard to the method of achieving such finishes as implemented. Wherever directed or specified, concrete surface shall be made broom finished.

4.20. Curing and Protection

- 4.20.1. Walling or further loading on concrete shall not be permitted for at least 48 hours after it has been placed in position, or for such additional length of time as the Engineer may direct.
- 4.20.2. Immediately after compaction and completion of any surface finishes, the concrete shall be protected from the evaporation of moisture by means of polythene sheeting, wet hessian or other suitable material kept soaked by spraying. As soon as the concrete has attained a degree of hardening sufficient to withstand surface damage, continuous moist curing shall be implemented and maintained for a period of at least 15 days after casting to full satisfaction of the Engineer.
- 4.20.3. Method of curing and their duration shall be such that the concrete will have satisfactory durability and strength and members will suffer a minimum distortion, be free from excessive efflorescence and will not cause, by its shrinkage, undue cracking in the works.
- 4.20.4. The top surfaces of slabs and other horizontal surfaces shall be cured by ponding of water in cement mortar bunds. Steeply sloping and vertical formed surfaces shall be kept completely and continuously wet prior to and during the striking of formwork and thereafter by applying adequate water to the top surfaces and allowing it to pass down between the formwork and the concrete, if required by discharging water through hose pipes and pumps.
- 4.20.5. The Contractor shall give careful consideration to the curing methods and conditions for fair-faced concrete. Components which are specified to have exposed concrete finish shall receive the same curing treatment. Moreover, water used for curing shall be clean and free from deleterious materials so as not to discolour the concrete.
- 4.20.6. All fair faced concrete shall be protected from damage at the time of striking the formwork. All edges and surfaces of such concrete shall be protected from chipping using notched timber or aluminium corner pieces or other suitable covers, which shall be maintained, in place until the completion of the works.
- 4.20.7. The Contractor shall be responsible for ensuring all fair faced concrete free of blemishes defect & stains and shall remove all such staining as may occur as soon as possible to the satisfaction of the Engineer.

4.21. Internal Vibrators

- 4.21.1. These should invariably be used. However, vibrators shall not be used for displacing concrete. Overloading the vibrators by placing too much concrete per vibrator, over vibrating by using too many vibrators relative to quantity of concrete shall be avoided. Segregation by excessive vibration or excessive water content should be strictly avoided. Vibrator shall be withdrawn gradually and smoothly, and in a manner which shall not cause suction, voids or air entrapment.

4.22. Construction Joints

- 4.22.1. Prior to concreting, the Contractor shall submit his proposals giving the position, form and treatment of such joints to the Engineer for his approval.
- 4.22.2. Vertical construction joints shall be formed against a stop board of approved quality and horizontal construction joints shall be level.
- 4.22.3. Except where shown otherwise on the drawings, reinforcement shall continue through construction joints and stop boards are to be formed to suit such requirements at site.
- 4.22.4. As soon as possible after the formwork has been struck for vertical joints or after the concrete has set in horizontal joints, the surface laitance of the hardened concrete on the face of the joint shall be removed to expose the coarse aggregate in such a manner that the loosened particles of aggregate and damaged concrete are not left on the surface. The exposed face shall be swept clean of foreign matter and laitance. Immediately before placing the new concrete, a coat of epoxy based concrete adhesive shall be put over the old concrete followed for joints of thickness as per manufacturer's instructions.
- 4.22.5. Before next operation is started, all timber spoils, laitance, scum or loose concrete shall be removed by hacking the surface and then scrubbing off with a wire brush to remove all loose mortar or aggregates. Thereafter, before resuming concreting operation, the surface should be thoroughly cleaned and a coat of epoxy based conc. adhesive shall be applied. As an additional precaution, approved water bars (as in IS: 3370 (Part-I)-1965) shall be used, if required at such joints as per manufacturer's instruction. But sufficient care shall be taken when such water barriers are used during pouring concrete from height, so that these strips shall not get bent; and thereby restrict the passage of concrete; causing large size pores and honeycomb concrete. The rate of epoxy based conc. Adhesive is deemed to be included in the concrete item.

4.23. Expansion Joints

- 4.23.1. Expansion joints shall be provided where shown on the drawings. They shall be constructed with an initial gap between the adjoining parts of the works of the width specified in the drawings.
- 4.23.2. The contractor shall ensure that no debris is allowed to enter and be lodged in expansion joints.
- 4.23.3. Expansion joints shall be provided with approved joints filler, a joint sealing compound and in waterproof concrete a water bar as specified in drawing.
- 4.23.4. **Joint fillers:**
- a) The joints filler compound shall be easily and uniformly compressible to its original thickness, tamp able, easily cut or sawn, robust, durable, resistant to decay due to termite or weathering, unaffected by water & free of any constituent which will bleed into or stain the concrete.
 - b) The joint filler shall be of same thickness of the joint width, it shall extend through the full thickness of the concrete unless otherwise specified and shall be sufficiently rigid during handling & placing to permit the formation of straight joints.
- 4.23.5. **Joint Sealing Compounds**
- a) Joint sealing compounds shall be in accordance with the IS 3037-1986 and approved by the Engineer and shall seal joints in concrete against the passage of water, prevent the ingress of grit or other foreign material and protect the joint filler. The compound shall have good extensibility and adhesion to concrete surfaces and shall be resistant to flow and weathering.

- b) Where so specified joints shall be sealed with approved polysulphide / polyurethane, stored, mixed, handled, applied and cured strictly in accordance with the manufacturer's printed instructions. Such joints shall be formed to the correct dimensions, thoroughly cleaned and treated with recommended primer. The Contractor shall use only competent personnel experienced in the application of sealant for such work.
- c) Where specified in the drawings, rubber / bituminous based sealants shall be of an approved manufacturer. The treatment of the joint and the use of sealing compound shall be strictly in accordance with the manufacturer's printed instructions.

4.24. Cracks

- 4.24.1. If any cracks develop in the reinforced cement concrete construction which in the opinion of the Engineer may be detrimental to the strength of the construction, the contractor shall test the structural element in question. If under these test loads the cracks shall develop further the contractor shall dismantle the construction, cart away the debris replace the construction and carryout all consequential work thereto.
- 4.24.2. If the cracks are not detrimental to the stability of the construction in the opinion of the Engineer, the contractor shall grout the cracks with pneumatically applied mortar or epoxy grout or by other specified treatment as directed by the Engineer at his own expense and risk.
- 4.24.3. The repair work shall be carried out to the satisfaction of the Engineer. The decision of the Engineer as to the extent of the liability of the contractor in the above matter shall be final and binding on the contractor.

4.25. Load Testing on Completed Structures

- 4.25.1. During the period of construction or within the defect liability period as the case may be, the Engineer may at his discretion order the load testing of any completed structure or any part thereof if he has reasonable doubts about the adequacy of the strength of such structure for any of the following reasons:
 - a) Unsatisfactory values of the Cube strength of the grade of concrete specified.
 - b) Premature removal of formwork.
 - c) Inadequate curing of concrete.
 - d) Over loading during the construction of the structure or part thereof.
 - e) Carrying out concreting of any portion without prior approval of the Engineer.
 - f) Honey combed or damaged concrete, which in the opinion of the Engineer is particularly weak and will affect the stability of the structure to carry the design load, more so in important or critical areas of the structure.
 - g) Any other circumstances attributable to alleged negligence of the contractor which in the opinion of the Engineer may result in the structure or any part thereof being of less than the expected strength.
- 4.25.2. All the loading tests shall be carried out by the contractor strictly in accordance with the instructions of the Engineer. Such tests should be carried out only after expiry of minimum 28 days or such longer period as directed by the Engineer.
- 4.25.3. The structure should be subjected to a load equal to full dead load plus 1.25 times the imposed load. This load shall be maintained for a period of 24 hours before removal. During the test, struts strong enough to take the whole load shall be placed in position leaving a gap under the members as directed.
- 4.25.4. The deflection due to the superimposed load shall be recorded by sufficient number of approved deflectometers capable of reading upto 1/500 of a cm and located suitably under the structure as directed by the Engineer. If within 24 hours of the removal of the superimposed load, the structure does not recover at least 75% of the deflection under the superimposed load, the test loading shall be repeated after a lapse of 72 hours. If the recovery after the second test is less than 80% of the

maximum deflection shown during the second test, the structure shall be considered to have failed to pass the test and shall be deemed to be unacceptable.

- 4.25.5. If the maximum deflection in mm, shown during 24 hrs. under load is less than $40l^2 / D$, where l is the effective span in m; and D , the overall depth of the section in mm, it is not necessary for the recovery to be measured and the recovery provisions as stated above.
- 4.25.6. The part of the work failed in test shall be taken down or cut out and reconstructed to comply with the specifications. Other remedial measures may be taken to make the structure secure at the discretion of the Engineer. Moreover, such remedial measures shall be carried out to the complete satisfaction of the Engineer.
- 4.25.7. In addition to the above load tests, non destructive test methods such as core test and ultrasonic pulse velocity test shall be carried out by the Contractor at his own expense if so desired by the Engineer. Such tests shall be carried out by an agency approved by the Engineer and shall be done under expert guidance using only recommended testing equipment. The acceptance criteria for these tests shall be in accordance to IS: 1959 and IS:456.

4.26. **Non-Destructive Test**

- 4.26.1. If necessitated, the Engineer may ask for Non-Destructive Test for the structural members under doubt about their strength. None-Destructive Test include Ultrasonic Pulse velocity (IS: 13311, Part-1) & rebound hammer IS: 13311 (Part-2).
- 4.26.2. All costs involved in carrying out the Load Tests and Non-destructive Test and other incidental expense thereto shall be borne by the contractor regardless of the result of the tests. The Contractor shall take down or cut out and reconstruct the defective work or shall make the remedial measures instructed at his own cost.

4.27. **Supervision**

- 4.27.1. All concreting work shall be done under strict supervision of qualified and experienced representatives of the Contractor as well as those of the Engineer. The contractor's supervisor who is in charge of concreting work shall be experienced & skilled in this class of work and shall personally supervise all the concreting operations at all stages.

4.28. **Special attention shall be paid to the following**

- 4.28.1. Proportioning, mixing and quality testing of the materials with particular control on the water cement ratio.
- 4.28.2. Laying of material in place and thorough compaction of the concrete to ensure solidity and freedom from voids and honeycombing.
- 4.28.3. Proper curing for the requisite period.
- 4.28.4. Reinforcement positions are not disturbed during concreting & consolidation by vibration.

4.29. **Quality Control**

- 4.29.1. The Engineer reserves the right to make changes in the mix proportions including the increased cement content or / and a change in the Contractor's control procedure, should the quality control during progress of the works prove to be inadequate in his opinion and the contractor shall carry out the same. Any extra cost due to change in mix proportions shall be deemed to have been included in relevant item rates.
- 4.29.2. All the concrete work shall be true to level, plumb & square within the acceptable tolerance. The corners, edges and rises in all cases shall be unbroken and finished properly and carefully.

5. **SPECIFICATION FOR TESTING CONCRETE**

5.1. **Cement**

5.1.1. The Contractor shall make his own arrangement for procurement of cement. Cement should be of Ultratech, ACC, Gujarat Ambuja or equivalent brand Ordinary Portland cement conforming to IS 8112 – 1989 (Grade 43 or higher).

5.2. **Concrete:**

5.2.1. Controlled concrete shall be based on a mix design carried out in a laboratory, approved by MDL, and shall conform to IS 456-2000. The requirements of sampling and testing shall be as given in these specifications.

5.2.2. **Design Mix Concrete:**

- a) As the guarantor of quality of concrete used in the construction, the Contractor shall carryout the mix design and the mix so designed (not the method of design) shall be approved by the Employer within the limitation of parameters and other stimulations laid down by IS: 456-2000.
- b) The mix shall be designed to produce the grade of concrete having the required workability and a characteristic strength not less than appropriate value given in Table I below. The target mean strength of concrete mix should be equal to the characteristic strength plus 1.65 times the standard deviation.
- c) Mix design done earlier not prior to one year may be considered adequate for later work provided there is no change in source and quality of the materials.

Table I: Grades of Concrete

Table I Grades of Concrete		
Group	Grade Designation	Specified Characteristic Compressive Strength of 150 mm Cube at 28 days in N/mm ²
(1)	(2)	(3)
Ordinary Concrete	M 10	10
	M 15	15
	M 20	20
	M 25	25
Standard Concrete	M 30	30
	M 35	35
	M 55	55

Notes:

- i. In the designation of the concrete mix M refers to the mix and the number to the specified compressive strength of 150 mm size cube at 28 days, expressed in N/mm².
- ii. For concrete of compressive strength greater than M 55, design parameters given in the standard may not be applicable and the values may be obtained from specialised literatures and experimental results.

5.3. **Standard Deviation**

5.3.1. The standard deviation for each grade of concrete shall be calculated separately.

5.3.2. **Standard deviation based on test strength of sample.**

- a) Number of test results of samples – The total number of test strength of samples required to constitute an acceptable record for calculation of standard deviation shall not be less than 30. Attempt should be made to obtain the 30 samples, as early as possible, when a mix is used for the first time.
- b) In case of significant changes in concrete – When significant changes are made in the production of concrete batches (for example changes in materials used, mix design, equipment or technical control), the standard deviation value shall be separately calculated for such batches of concrete.

- c) Standard deviation to be brought up to date – The calculation of the standard deviation shall be brought up to date after every change of mix design.

5.3.3. **Assumed Standard Deviation**

- a) Where sufficient test results for a particular grade of concrete are not available, the value of standard deviation given in Table II may be assumed for design of mix in the first instance. As soon as the results of the samples are available, actual calculated standard deviation shall be used and the mix design properly. However, when adequate past records for a similar grade exist and justify to the designer a value of standard deviation different from that shown in Table II, it shall be permissible to use that value.

Table II Assumed Standard Deviation	
Grade of Concrete	Assumed Standard Deviation (N/mm ²)
M 10	} 3.5
M 15	
M 20	} 4.0
M 25	
M 30	} 5.0
M 35	
M 40	
M 45	
M 50	

Note:

The above values correspond to the site control having proper storage of cement; weigh batching of all materials; controlled addition of water; regular checking of all materials; aggregate grading and

moisture content; and periodical checking of workability and strength. Where there is deviation from the above, the values given in the above Table shall be increased by 1 N/mm².

5.4. Specimen

5.4.1. Test specimens shall be cubes whose sizes shall be as given below.

Minimum size of Coarse Aggregate	Size of specimen cubes in cm.
Not exceeding 20 mm	10 x 10 x 10
Greater than 20 mm but not exceeding 40 mm	15 x 15 x 15

5.4.2. Sampling of Concrete

a) Samples for concrete for test specimens shall be taken at the mixer or in the case of ready mixed concrete from the transportation vehicle during discharge. The sample of concrete from which test specimens are made shall be representative of the entire batch. Such samples shall be obtained by repeatedly passing a scoop or pail through the discharging stream of concrete, stacking the sampling operation until the entire batch is discharged. The sample thus obtained shall be transported to the place of moulding of specimen, and to counteract segregation, the concrete shall be mixed with a shovel until it is uniform in appearance. The location in the work of the batch of concrete thus sampled shall be noted for further reference. In the case of paving concrete, samples may be taken from the batch immediately after deposition on the sub-grade. At least five samples shall be taken from different positions of the pile and these samples shall be thoroughly mixed before being used to form the test specimens.

5.4.3. Preparation of Test Specimens

a) The interior surfaces of the mould and base plate shall be lightly oiled before the concrete is placed in the mould. From the samples of concrete, the test specimen shall be immediately moulded by one of the following methods.

- i) When the job concrete is compacted by ordinary methods, the 1st specimen shall be moulded by placing the test concrete in the mould in layers, each approximately one-third of the volume of the mould. In placing each scoopful of concrete, the scoop shall be moved around the top edge of the mould as the concrete there slides from it, in order to ensure a uniform distribution of concrete within the mould. Each layer shall be rodded 25 times with a 16 mm rod, 60 cm in length, bullet pointed at the lower end. The strokes shall be distributed in a uniform manner over the cross section of the mould and shall penetrate into the underlying layer. The bottom layer shall be rodded throughout its depth. After the top layer has been rodded, the surface of the concrete shall be struck off with a trowel and covered with a glass plate at least 6.5 mm thick or a machined metal plate. The whole process of moulding shall be carried out in such a manner as to preclude the alteration of the water cement ratio of the concrete, by loss of water either by leakage from the bottom or overflow from the top of the mould.
- ii) When the job concrete is placed by vibration and the consistency of the concrete is such that the 1st specimen cannot be properly moulded by hand rodding as directed under (i) above, the specimens shall be vibrated to give a compaction corresponding to that of the job concrete. The fresh concrete shall be placed in the mould in two layers, each approximately half the volume of the mould. In placing each scoopful of concrete, the scoop shall be moved around the top edge of the mould as the concrete there slides from it, in order to ensure a symmetrical distribution of concrete within the mould. Either internal or external vibrators may be used. The vibration of each layer shall not be continued longer than is necessary to secure the required density. Internal vibrators shall be of appropriate size and shall penetrate only the layer to be compacted. In compacting the first layer, the vibrators shall not be allowed to rest on the bottom of the mould. In

placing the concrete for the top layer, the mould shall be filled to the extent that there will be no mortar loss during vibration. After vibrating the second layer, enough concrete shall be added to bring the level above the top of the mould. The surface of the concrete shall then be struck off with a trowel and covered with a glass or steel plate as specified under (a) above. The whole process of moulding shall be carried out in such a manner as to preclude the alteration of the water cement ratio of the concrete, by loss of water either by leakage from the bottom or overflow from the top of the mould.

5.5. Method of Testing

- 5.5.1. The tests shall be made at the age of the concrete corresponding to that for which the strengths are specified.
- 5.5.2. Compression tests shall be made immediately upon removal of the concrete test specimens from the curing tank i.e. the test specimens shall be loaded in damp condition. The dimensions of the test specimens shall be measured in millimeters accurate to 0.5 mm.
- 5.5.3. The metal bearing plates of the testing machine shall be placed in contact with the ends of the test specimens. Cushioning materials shall not be used. In the case of cubes, the test specimen shall be placed in the machine in such a manner that the load is applied to the sides of the specimen as cast. An adjustable bearing block shall be used to transmit the load to the test specimen. The size of the bearing block shall be the same or slightly larger than that of the test specimen. The upper or lower section of the bearing block shall be kept in motion as the head of the testing machine is brought to a bearing on the test specimen.
- 5.5.4. The load shall be applied axially without shock at the rate of approximately 140 kg/cm^2 per minute. The total load indicated by the testing machine at failure of the test specimen shall be recorded and the unit compressive strength calculated in kg/sq.cm . Using the area computed from the measured dimensions of the test specimen. The type of failure and appearance of the concrete shall be noted.

5.6. Standard of Acceptance

- 5.6.1. The standard of acceptance shall be as described below:
 - a) Three test specimens shall be made for each age at which tests are required. The average of strength of the three specimens may be accepted as the compressive strength of concrete, provided the difference between the maximum and minimum strengths of the three specimens does not exceed 15% of the average strength. If the difference exceeds 15% of the average strength, repeat tests shall be made unless the minimum strength is greater, than the strength specified.
 - b) In order to get a relatively quicker idea of the quality of concrete, compressive strength tests at 7 days may be carried out in addition to 28 days' compressive strength tests. For this purpose, the values given in Table above may be taken for general guidance in the case of concrete made with ordinary Portland cement. In all cases, the 28 days' compressive strength specified in Table above shall alone be the criterion for acceptance or rejection of the concrete. If, however, from tests carried out in a particular job over a reasonably long period, it has been established to the satisfaction of the Engineer –in-charge that a suitable ratio between 28 days compressive strength and the 7 days compressive strength exists, the compressive strength at 7 days may be accepted, and the Engineer-in-charge may suitably relax the frequency of 28 days compressive strength specified provided the expected strength values at the specified early age are consistently met.
 - c) If the average strength of the sample concrete is less than the specified strength, the work for that day shall be accepted at reduced rate, provided the average strength of sample concrete is not less than 75% of the specified strength. The Engineer-in-charge shall determine the reduced rate

and the quantity of the day's work for which the rate is to be reduced. If the strength of sample concrete is less than 75% of the minimum specified strength after 28 days, the Engineer-in-charge shall reject the defective portion of the work done during the day along with the other concrete work structurally affected by the defective portions and get it dismantled.

Note: Six cubes shall be made for a test and 3 out of these shall be tested after 7 days, the remaining 3 cubes shall be tested after 28 days. The result of the 28 days' test shall be taken into account while reducing the rate of rejecting the concrete represented by the sample. The result of the test conducted by the approved testing laboratory shall be taken as final and binding on the Contractor.

6. READY-MIXED CONCRETE

6.1. Concrete mixed in a stationary mixer in a central batching and mixing plant or in a truck-mixer and supplied in the fresh condition to the purchaser either at the site or into the purchaser's vehicles.

6.2. **Approved Plant: Ready mixed concrete conforming to IS 4926: 2003 shall be supplied from Ultratech, ACC, Godrej, Lafarge RMC plants or other any plants as approved by MDL Engineer in Charge.**

6.3. MATERIALS

6.3.1. Selection and Approval of Materials

a) Materials used should satisfy the requirements for the safety, structural performance, durability and appearance of the finished structure, taking full account of the environment to which it will be subjected. The selection and use of materials shall be in accordance with IS 456. Materials used shall conform to the relevant Indian Standards applicable. Where materials are used which are not covered by the provisions of the relevant Indian Standard, there should be satisfactory data on their suitability and assurance of quality control. Records and details of performance of such materials should be maintained. Account should be taken of possible interactions and compatibility between materials used. Also, prior permission of the purchaser shall be obtained before use of such materials.

6.3.2. Cement

a) Cement used for concrete shall be in accordance with the requirements of IS 456.

b) Mineral Admixtures — Use of mineral admixtures shall be permitted in accordance with the provisions of IS 456.

6.3.3. Aggregates

a) Aggregates used for concrete shall be in accordance with the requirements of IS 456. Unless otherwise agreed testing frequencies for aggregates shall be as given in Annex B.

6.3.4. Chemical Admixtures

a) Use of chemical admixtures shall be permitted in accordance with the provisions of IS 456.

b) It shall be the responsibility of the producer to establish compatibility and suitability of any admixture with the other ingredients of the mix and to determine the dosage required to give the desired effect.

c) Admixtures should be stored in a manner that prevents degradation of the product and consumed within the time period indicated by the admixture supplier. Any vessel containing an admixture in the plant or taken to site by the producer shall be clearly marked as to its content.

d) When offering or delivering a mix to a purchaser it should be indicated if such a mix contains an admixture or combination of admixtures or not. The admixtures may be identified generically and should be declared on the delivery ticket.

e) The amount of admixture added to a mix shall be recorded in the production record. In special circumstances, if necessary, additional dose of admixture may be added at project site to regain the workability of concrete with the mutual agreement between the producer and the purchaser.

6.3.5. Water

- a) Water used shall be in accordance with the requirements of IS 456-2000 cl.5.4
- b) The use of re-cycled water is encouraged as long as concrete of satisfactory performance can be produced and steps are taken to monitor the buildup of chlorides in any recirculated water and that any subsequent adjustments to the mix design are made to ensure that any overall limit on chloride contents is satisfied. The addition of any recycled water shall be monitored and controlled to meet these requirements.
- c) The total amount of water added to the mix shall be recorded in the production record. The water content of concrete shall be regulated by controlling its workability or by measuring and adjusting the moisture contents of its constituent materials. The producer's production staff and truck-mixer drivers shall be made aware of the appropriate responses to variations in concrete consistence of a particular mix caused by normal variations in aggregate moisture content or grading.

6.4. GENERAL REQUIREMENTS

6.4.1. Basis of Supply

- a) Ready-mixed concrete shall be supplied having the quality and in the quantity in accordance with the requirements agreed with the purchaser or his agent. Notwithstanding this, the concrete supplied shall generally comply with the requirements of IS 456.
- b) All concrete will be supplied and invoiced in terms of cubic metres (full or part) of compacted fresh concrete. All proportioning is to be carried out by mass except water and admixture, which may be measured by volume.

6.4.2. Transport of Concrete

a) General

- i) Ready-mixed concrete shall be transported from the mixer to the point of placing as rapidly as practicable by methods that will maintain the required workability and will prevent segregation, loss of any constituents or ingress of foreign matter or water. The concrete shall be placed as soon as possible after delivery, as close as is practicable to its final position to avoid re-handling or moving the concrete horizontally by vibration. If required by the purchaser the producer can utilize admixtures to slow down the rate of workability loss, however this does not remove the need for the purchaser to place the concrete as rapidly as possible. The purchaser should plan his arrangements so as to enable a full load of concrete to be discharged within 30 min of arrival on site.
- ii) Concrete shall be transported in a truck-mixer unless the purchaser agrees to the use of non-agitating vehicles. When non-agitating vehicles are used, the mixed concrete shall be protected from gain or loss of water.

b) Time in Transport

- i) The general requirement is that concrete shall be discharged from the truck-mixer within 2 hrs of the time of loading. However, a longer period may be permitted if retarding admixtures are used or in cool humid weather or when chilled concrete is produced.
- ii) The time of loading shall start from adding the mixing water to the dry mix of cement and aggregate or of adding the cement to the wet aggregate whichever is applicable.
- iii) Ready-mixed concrete plant shall have test facilities at its premises to carry out routine tests as per the requirement of the standard.

6.5. SAMPLING AND TESTING OF READY-MIXED CONCRETE

6.5.1. Point and Time of Sampling

a) For the assessment of compliance of ready-mixed concrete, the point and time of sampling shall be at discharge from the producer's delivery vehicle or from the mixer to the site or when delivered into the purchaser's vehicle. It is critical that the sampling procedure and equipment used enables as representative a sample as possible to be taken of the quantity of concrete delivered (see Annex C). The sampling may be carried out jointly by the purchaser and the supplier with its frequency mutually agreed upon. However, it will not absolve the supplier of his responsibility from supplying concrete as per the requirements given in this standard or otherwise agreed to where so permitted in the standard.

6.5.2. Workability

a) The test for acceptance is to be performed upon the producer's delivery vehicle discharge on site or upon discharge into the purchaser's vehicle. If discharge from the producer's vehicle is delayed on site due to lack of preparedness on behalf of the purchaser, then the responsibility passes to the purchaser after a delay of more than 30 min. The workability shall be within the following limits on the specified value as appropriate:

Slump: ± 25 mm or $\pm 1/3$ of the specified value, whichever is less.

Compacting factor : ± 0.03 , where the specified value is 0.90 or greater,
 ± 0.04 , where the specified value is less than 0.90 but more than 0.80, and
 ± 0.05 , where the specified value is 0.80 or less.

b) Flow table test may be specified for concrete, for very high workability (see IS 9103). Acceptance criteria for spread (flow) are to be established between the supplier and the purchaser.

6.5.3. Specified Strength

a) Compliance shall be assessed against the requirements of IS 456 or other agreed Indian Standard. The purchaser may perform his own sampling and testing or may enter in to an arrangement with the producer to provide his testing requirements.

6.5.4. Unless otherwise agreed between the parties involved, the minimum testing frequency to be applied by the producer in the absence of a recognized ready mixed concrete industry method of production control, should be one sample for every 50 m³ of production or every 50 batches, whichever is the greater frequency. Three test specimens shall be made up for each sample for testing at 28 days (see also IS 456).

6.5.5. In order to get a relatively quicker idea of the quality of concrete, optional test on beams for modulus of rupture at 7 + 2 h or at 7 days or compressive strength test at 7 days maybe carried out in addition to 28 days' compressive strength test. For this purpose, the value should be arrived at based on actual testing. In all cases 28 days' compressive strength shall alone be the criteria for acceptance or rejection of the concrete.

6.5.6. The purchaser shall inform the producer if his requirements for sampling and testing are higher than one sample every 50 m³ or 50 batches, whichever is the greater frequency.

6.5.7. Additional Compliance Criteria

a) Any additional compliance criteria shall be declared to the producer by the purchaser prior to supply and shall be mutually agreed upon in terms of definition, tolerance, frequency of assessment, method of test and significance of result.

7. PLASTERING

7.1. General**7.1.1. Scope**

a) This section shall cover plastering to masonry wall for over brick work. Before commencing the work sample of works shall be made in accordance with the specifications indicated below and got approved by the Engineer.

7.1.2. Mortar

a) The mortar of specified mix shall be used. Cement and sand shall be tested as specified in the section on concrete.

7.1.3. Preparation of Surface

a) Joints of stonework/brick work shall be raked-out if not done properly at the time of stonework. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scraping. The surface shall be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

b) Plastering work shall be started where all conduits, pipes, fittings and fixtures clamps, hooks, doors and window frames etc. are embedded, grouted and cured and all defects are removed to the satisfaction of the Engineer. Special approval shall be taken from the Engineer before commencing each plastering work. No cutting of finished plaster shall be allowed under any circumstance. No portion shall be left out initially to be patched up later on.

7.2. Mixing

7.2.1. The ingredients shall be mixed in specific proportions by volume. The mixing shall be done in a mechanical mixer or by hand mixing on watertight platform. The cement and sand shall first be mixed thoroughly dry in the mixer. Water shall then be added gradually and wet mixing continued for at least a minute until mortar attains the consistency of a stiff paste and uniform colour. Mortar shall be used within 30 minutes of addition of water. Mortar which has partially set shall not be used and removed from the site immediately.

7.2.2. Wherever specified, waterproofing compound of approved make shall be added to the mortar & mixed strictly in accordance with manufacturer's printed instructions.

8. STRUCTURAL STEEL FABRICATION AND ERECTION WORK

8.1. The structural steel fabrication and erection work will be required wherever the structural steel members of the workshop shed are rusted beyond repairs and mainly will consist of crane girders, walkways, bracing and purlins and runners, hand railing and other miscellaneous structures.

8.2. The fabrication and erection of structural steel work shall be in compliance with:

8.2.1. General specifications for structural steel work as per IS: 800.

8.2.2. Necessary drawings to be prepared by the contractor to be got approved through MDL before execution of work.

8.3. The fabrication and erection of steel work shall consist of accomplishing of all jobs including providing all labour, tools and plant, all materials and consumables such as welding electrodes, bolts and nuts (GKW Quality) Oxygen and Acetylene gases, oils for cleaning, etc., all of approved quality as per the relevant IS Specifications. The work shall be executed according to the drawings, specifications and relevant IS codes in an expeditious and workmanlike manner and of best standard to the complete satisfaction of the Engineer of MDL.

8.4. All materials shall be new and shall conform to the respective specifications as specified. The use of equivalent or higher grade or alternative materials will be considered only in very special cases subject to the approval of the Engineer of MDL.

8.5. Structural steel shall conform to IS: 226 or IS: 2062. Steel plates for crane girders shall conform strictly to IS: 2062. Bolts and nuts shall be of GKW Quality and in accordance with IS: 1363.

8.6. The fabrication work shall be done in accordance with IS: 800, in addition to the following:

- 8.6.1. The fabrication work shall be done as per the approved fabrication drawings or as directed. The connections shall be welded or bolted as per the approved drawings or as directed. The work shall include also fabrication of built up section, if required. Any fault fabrication pointed out at any stage of the work by MDL shall be made good by the contractor at his own cost.
- 8.6.2. The structural steel member shall be cut mechanically or by oxy-acetylene flame. All edges cut by oxy-acetylene process shall be cleaned of all slag materials prior to assembly. Edge preparation for welding of members more than 10mm thick shall be done by edge cleaning machine only.
- 8.6.3. All bolt holes shall be drilled. The drilling shall be made to the diameter specified in the drawings. No enlarging of holes by filling, by man drilling or oxy-acetylene flame shall be allowed.
- 8.6.4. The assembly of structural members shall be done with proper jigs and fixtures to ensure the correct positioning of the members. The first component / assembly fabrication in such jigs and fixtures shall be inspected thoroughly by the contractor and then offered to the Engineer of MDL for approval before proceeding with the fabrication.
- 8.6.5. All welding shall be done either manually by the shielded metallic arc process. Welding shall be carried out only by fully trained and experience approved welders. All welds shall be usually made continuous and watertight. The welding electrodes shall conform to IS:816, low hydrogen type covering or equivalent.
- 8.7. The erection work in general shall be carried out as required only after approval by the Engineer of MDL.
- 8.7.1. All scaffolding work required for the erection work will have to be made by the contractor and included in the structural steel rate.
- 8.7.2. Positioning, levelling of the structural members and their alignment shall be done in accordance with the relevant drawing and to the complete satisfaction of the Engineer of MDL.
- 8.7.3. The various parts of the steel structure shall be done so erected so as to ensure stability against inherent weight, wind and erection trusses.
- 8.7.4. All field assembly and welding shall be executed in accordance with the requirement of the relevant fabrication drawings. The bolted joints shall be tightened so that the entire surface of the bolt heads and nuts shall rest on the members. For parts with sloping surfaces tapered washers shall be used.
- 8.7.5. Any faulty erection done by the contractor shall be made good at his own cost. The contractor shall satisfy himself about the levels, alignment, etc., before starting the erection work.

9. PAINTING OF CONCRETE MASONRY & PLASTERED SURFACES

9.1. MATERIALS

- 9.1.1. Oil bound distemper shall conform to IS:428. The primer shall be alkali resistant primer of the same manufacture as that of the distemper.
- 9.1.2. Cement paint shall conform to IS: 5410. The primer shall be a thinned coat of cement paint.
- 9.1.3. Acrylic emulsion paint shall be of an approved manufacture.
- 9.1.4. Plastic emulsion paint shall conform to IS: 5411.
- 9.1.5. Lead free acid, alkali and chlorine resisting paint shall conform to IS: 9862.
- 9.1.6. White wash shall be made from good quality fat lime conforming to IS: 712. It shall be slaked at site and mixed with water in the proportion of 5 litres of water to 1 kg of unslaked lime stirred well to make a thin cream. This shall be allowed to stand for a minimum period of one day and strained through a clean coarse cloth. Four kg of gum dissolved in hot water shall be added to each cu.m of cream. 1.30 kg of sodium chloride dissolved in hot water shall then be added per 10 kg of lime used for the white wash to be ready for application.
- 9.1.7. Colour wash shall be made by addition of a suitable quantity of mineral pigment, not affected by lime, to the prepared white wash to obtain the shade/tint as approved by the ENGINEER.

9.1.8. All the materials shall be of the best quality from an approved manufacturer. CONTRACTOR shall obtain prior approval of the ENGINEER for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.

9.2. WORKMANSHIP

9.2.1. CONTRACTOR shall obtain the approval of the ENGINEER regarding the readiness of the surfaces to receive the specified finish, before commencing the work on painting.

9.2.2. Painting of new surfaces shall be deferred as much as possible to allow for thorough drying of the sub-strata.

9.2.3. The surfaces to be treated shall be prepared by thoroughly brushing them free from dirt, mortar droppings and any loose foreign materials. Surfaces shall be free from oil, grease and efflorescence. Efflorescence shall be removed only by dry brushing of the growth. Cracks shall be filled with Gypsum. Workmanship of painting shall generally conform to IS: 2395.

9.2.4. Surfaces of doors, windows etc. shall be protected suitably to prevent paint finishes from splashing on them.

MEASUREMENT

9.2.5. Measurement shall be in Sq. M. correct to two places of decimal. Measurement shall be for the areas as executed duly deducting for any openings etc. Rate quoted shall take into account the provision of necessary enabling works such as scaffolding, painter's cradle etc.

10. PAINTING OF STEEL WORK

10.1. MATERIALS

10.1.1. Red oxide - zinc chrome primer shall conform to IS: 2074.

10.1.2. Synthetic enamel paint shall conform to IS: 2932.

10.1.3. Aluminium paint shall conform to IS: 2339.

10.1.4. All the materials shall be of the best quality from an approved manufacturer. CONTRACTOR shall obtain prior approval of the ENGINEER for the brand of manufacture and the colour/shade. All the materials shall be brought to the site in sealed containers.

10.2. WORKMANSHIP

10.2.1. Painting work shall be carried out only on thoroughly dry surfaces.

10.2.2. Painting shall be applied either by brushing or by spraying. CONTRACTOR shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirement of IS:1477 (Part 2).

10.2.3. The type of paint, number of coats etc. shall be as specified in the respective items of work.

10.2.4. Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.

10.2.5. All the surfaces shall be thoroughly cleaned of oil, grease, dirt, rust and scale. The methods to be adopted using solvents, wire brushing, power tool cleaning etc., shall be as per IS: 1477 (Part-1) and as indicated in the item of work.

10.2.6. It is essential to ensure that immediately after preparation of the surfaces, the first coat of red oxide-zinc chrome primer shall be applied by brushing and working it well to ensure a continuous film without holidays. After the first coat becomes hard dry, a second coat of primer shall be applied by brushing to obtain a film free from 'holidays'.

10.2.7. After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of synthetic enamel paint of optimum thickness shall be applied by brushing with minimum of brush marks. The coat shall be allowed to hard dry. The under coat shall then be wet rubbed cutting down to a smooth finish,

taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

10.2.8. The first finishing coat of paint shall be applied by brushing and allowed to hard dry. The gloss from the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing.

10.2.9. At least 24 hours shall elapse between the application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the ENGINEER.

10.2.10. All parts i.e. rail sections (except top surface of rail), sole plates, clamps, stoppers, washers, welded joints, etc., are to be thoroughly cleaned with wire brush and painted with anti-corrosive bitumastic paint of approved make such as Shalimar, Asian Paint, British Paint, etc.

10.3. MEASUREMENT

10.3.1. Measurement shall be in S q.M. correct to two place of decimal. Measurement shall be for the projected area between out to out of frames and no multiplying factor is allowed on any account. Rate shall be inclusive of enabling works such as scaffolding, etc. Measurement and payment is applicable only if a separate item is specified and not if it is already made as part of a combined item.

11. APPLICABLE CODES AND SPECIFICATIONS

11.1. The following specifications, standards and codes, including all official amendments/revisions and other specifications & codes referred to therein, should be considered a part of this specification. In all cases the latest issue/edition/revision shall apply. In case of discrepancy between this specification and those referred to herein below or other specifications forming a part of this bid document, this specification shall govern.

11.2. MATERIALS

11.2.1. IS: 269 - Specification for 33 grade ordinary Portland cement (If specially intended to be used as per drawings/ specifications)

11.2.2. IS: 455 - Specification for Portland slag cement.

11.2.3. IS: 1489 - Specification for portland-pozzolana cement.

11.2.4. IS: 8112 - Specification for 43 grade ordinary Portland cement.

11.2.5. IS:12330- Specification for sulphate resisting Portland Cement

11.2.6. IS:383 - Specification for coarse and fine aggregates from natural sources for concrete.

11.2.7. IS: 432(Parts I & II) - Specification for mild steel and medium tensile steel bars and hard-drawn steel wires for concrete reinforcement.

11.2.8. IS: 1786 - Specification for high strength deformed steel bars and wires for concrete reinforcement.

11.2.9. IS: 1566 - Specification for hard-drawn steel wire fabric for concrete reinforcement.

11.2.10. IS: 2062 – Steel for general structural purposes.

11.2.11. IS: 9103 - Specification for admixtures for concrete.

11.2.12. IS: 2645 - Specification for integral cement water proofing compounds.

11.2.13. IS: 4990 - Specification for plywood for concrete shuttering work.

11.3. MATERIAL TESTING

11.3.1. IS: 4031(Part 1 to 13) - Methods of physical tests for hydraulic cement.

11.3.2. IS: 4032 - Method of chemical analysis of hydraulic cement.

11.3.3. IS: 650 - Specification for standard sand for testing of cement.

11.3.4. IS: 2430 - Methods for sampling of aggregates for concrete.

11.3.5. IS: 2386(Part 1 to 8) - Methods of test for aggregates for concrete.

- 11.3.6. IS: 3025 - Methods of sampling and test (physical and chemical) water used in industry.
- 11.3.7. IS:6925 - Methods of test for determination of water soluble

11.4. MATERIAL STORAGE

- 11.4.1. IS: 4082 - Recommendations On Stacking and Storing of Construction Materials at Site.

11.5. CONCRETE MIX DESIGN

- 11.5.1. IS: 10262 - Recommended guidelines for concrete mix design.
- 11.5.2. SP: 23(S&T) - Handbook on Concrete Mixes.

11.6. CONCRETE TESTING

- 11.6.1. IS: 1199 - Method of sampling and analysis of concrete.
- 11.6.2. IS:516 - Method of test for strength of concrete
- 11.6.3. IS:9013 - Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.
- 11.6.4. IS: 8142 - Method of test for determining setting time of concrete by Penetration resistance.
- 11.6.5. IS:9284 - Method of test for abrasion resistance of concrete
- 11.6.6. IS: 2770 - Methods of testing bond in reinforced concrete.

11.7. EQUIPMENT

- 11.7.1. IS: 1791 - Specification for batch type concrete mixers.
- 11.7.2. IS: 2438 - Specification for roller pan mixer.
- 11.7.3. IS: 4925 - Specification for concrete batching and mixing plant.
- 11.7.4. IS: 5892 - Specification for concrete transit mixer and agitator.
- 11.7.5. IS: 7242 - Specification for concrete spreaders.
- 11.7.6. IS: 2505 - General Requirements for concrete vibrators: Immersion type.
- 11.7.7. IS: 2506 - General Requirements for screed board concrete vibrators.
- 11.7.8. IS: 2514 - Specification for concrete vibrating tables.
- 11.7.9. IS: 3366 - Specification or pan vibrators.
- 11.7.10. IS: 4656 - Specification for form vibrators for concrete.
- 11.7.11. IS: 11993- Code of practice for use of screed board concrete vibrators.
- 11.7.12. IS: 7251 - Specification for concrete finishers.
- 11.7.13. IS: 2750 - Specification for steel scaffolding.

11.8. CODES OF PRACTICE

- 11.8.1. IS: 456 - Code of practice for plain and reinforced concrete.
- 11.8.2. IS: 3370(Parts I TO IV) - Code of practice for concrete structures for storage of Liquids.
- 11.8.3. IS: 3935 - Code of practice for composite construction.
- 11.8.4. IS: 2502 - Code of practice for bending and fixing of bars for concrete reinforcement.
- 11.8.5. IS: 5525 - Recommendation for detailing of reinforcement in reinforced concrete works.
- 11.8.6. IS: 2751 - Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.
- 11.8.7. Specification for welding cold worked bars for reinforced concrete construction.
- 11.8.8. IS:3558 - Code of practice for use of immersion vibrators for consolidating concrete.
- 11.8.9. IS:3414 - Code of practice for design and installation of joints in Buildings.
- 11.8.10. IS:4326 - Code of practice for earthquake resistant construction of building.
- 11.8.11. IS: 13920 – Code of Practice for ductile detailing of reinforced concrete structures subjected to seismic forces.
- 11.8.12. IS: 4014(Parts I & II) - Code of practice for steel tubular scaffolding.
- 11.8.13. IS: 2571 - Code of practice for laying in-situ cement concrete flooring.

11.8.14. IS: 7861 - Code of practice for extreme weather concreting. Part-I Recommended practice for hot weather concreting. Part-II Recommended practice for cold weather concreting.

11.9. CONSTRUCTION SAFETY

11.9.1. IS: 3696(Parts I & II) - Safety code for scaffolds and ladders.

11.9.2. IS: 7969 - Safety code for handling and storage of building materials.

11.9.3. IS: 8989 - Safety code for erection of concrete framed structures.

11.10. MEASUREMENTS

IS:1200 (Part 1 to 23) - Method of measurement of building and engineering works

13. Following are the list of preferred makes to be used in execution of works, if the same are not specified.

LIST OF PREFERRED MAKE:

S.N.	DESCRIPTION OF MATERIAL	MAKE OF MATERIALS
1.	Cement	Ultratech/ ACC / Ambuja / Birla
2.	Steel (Thermo Mechanically Treated Steel) High strength deformed bars or mild steel reinforcement (TOR-Steel)	SAIL, VIZAG, TATA, JSW, RINL, Jindal, Ispat
3.	Clay Bricks	Good quality locally available material approved by Engineer / Architect
4.	Water proofing material / compound.	Sika / Roff / Sunanda / Krishna Conchem
5.	Paint	Burger/ Nerolac/ Asian/ Dulux/ Tractor.
6.	White cement	Birla cement, JK cement
7.	Putty	Birla White Putty
8.	Red Oxide	Asian
9.	Acrylic Exterior paint	Asian Ultra/Nitcotex / Sandtex / Berger Weathershield

Note (i) Wherever specification of BOQ item is not mentioned; then CPWD specification shall be applicable.
(ii) Wherever make is specified in BOQ then manufacture's specifications & procedure shall be applicable.
(iii) Wherever no specifications or make is specified than work is to be carried out as per the written direction of Engineer-In-Charge

14. POLYPROPELYNE INTERLOCKING TILES:

Thickness: 15.7 mm

Tile Size: 304 mm x 304 mm

Force Reduction: 36%

Vertical Deformation: 2 mm

Ball rebound: 100%

Slip Resistance: 100

Resistance to wear: 115 mg

Rolling load: 0.4mm

Note: Warranty period of outdoor Professional interlocking tiles (polypropylene tiles Size) will be 10 years.

15. BASKETBALL POST:

International standard board size: 180cm x 105cm

Transparent acrylic board thickness- 30mm

Double dia frame

Pole extension 1.20m

Height from ground to ring 3.05m

Board height adjustable system by jack

Adjustable height from 6 ft. to 10 ft.

Made of 6 inches' square pipe heavy gauge with heavy duty dunking ring three spring & nylon net, pole padding on front 3 inches thick non tearing

SECTION II-TECHNICAL SPECIFICATIONS FOR ELECTRICAL WORK

1.0 PREFACE

All the Electrical Work shall be carried out as per

- i. The relevant Indian standards formulated by Bureau of Indian Standards
- ii. Indian Electricity Rules 1956 amended time to time.
- iii. National Electrical Code
- iv. Chapter 16 of PWD Hand Book Government of Maharashtra
- v. Bombay Lift Act and Rules amended time to time.
- vi. Maharashtra Fire prevention and life safety measure Act 2007.
- vii. National Building Code 2016.

1.1 Preamble

The technical specification for electrical services to be provided in New Family Court Building on LTS 629/1285 at BKC Bandra, Mumbai is detailed out in this particular document. These are to be read in conjunction with the Drawing Volumes & Bill of Quantities.

SCOPE OF WORK

Scope of work covers under this tender are as below

1. Internal Electrical Installation along with UPS system etc.
2. External Electrical Installation consisting of Service connection to all buildings, Street lights, Land scaping Lighting etc.
3. Supplying, erecting and commissioning of lifts.
4. Supplying, erecting and commissioning of Transformers along with all accessories mentioned in Schedule-B.
5. Supplying, erecting and commissioning of DG Sets along with all accessories mentioned in Schedule-B
6. Supplying, erecting, testing and commissioning of Firefighting system.
7. Supplying, erecting, testing and commissioning of Low voltage system consisting of Fire alarm system, C.C.T.V. system, Lan/Wan, P.A. system etc.
8. Supplying, erecting, testing and commissioning H.V.A.C. System.
9. Supplying, erecting, testing and commissioning of Solar P.V. System

NOTE: -

All codes and standards mean the latest where not specified otherwise installation shall generally follow the Indian Standard codes of practice in the absence of corresponding Indian Standards.

1.2 ELECTRIFICATION WORK**General:**

All material shall be conforming to relevant standard as per BIS and shall carry ISI mark. If any particular category of material for which ISI mark is not available in market, it shall either carry valid 'Quality Control' certificate issued by the Chief Engineer (Elect), P.W. Dept. Maharashtra State Govt. as included in approved list.

Work shall be carried out as per the Method of Construction specified by BIS. If there is no reference for particular Method of Construction in IS, such work shall be carried out as per the approved Method of Construction specified in chapter 16 of P.W. Dept. Handbook.

Material and Work not qualifying to any provision mentioned above shall be to the satisfaction of the Engineer in Charge.

Material shall be tested in approved Testing Laboratory and shall qualify the relevant tests as and when directed by Engineer In-Charge.

Seven copies of all submittals shall be submitted (PWD- 3set, Client- 1set, Design consultant- 1set, Architect- 1 set and Contractor- 1 set) for review.

Recommended Standards:

The following list is showing Indian Standards, which are acceptable as good practice, and accepted standards.

IS 732: 1989	Code of Practice for Electrical Wiring Installations.
IS 4648: 1968	Guide for Electrical Layout in residential buildings
IS 9537 (Part 1): 1980	Conduits for Electrical Installations: General requirements
IS 9537 (Part 2): 1981	Rigid Steel Conduits
IS 9537 (Part 3): 1983	Rigid Plain Conduits of insulating material
IS 3419: 1989	Specifications for fittings for rigid nonmetallic conduits
IS 694:	PVC insulated cables for working voltages up to and including 1100V

IS 1554 (Part 1): 1988	PVC insulated (heavy-duty) electric cables for working voltages up to and including 1100V
IS 3961 (Part 5): 1968	Recommended current ratings for cables: PVC insulated light duty cables.
IS 4288: 1988	PVC insulated (heavy duty) electric cables with solid aluminium conductors for voltages up to and including 1100V
IS 14772: 2000	Specifications for Accessories for household and similar fixed Electrical Installations
IS 3043: 1987	Code of practice for Earthing
SP 30: 1984	National Electrical Code
SP 7 (Group 4): 2005	National Building Code
IS 14927(Part 1): 2001	Cable Trunking and Ducting systems for electrical installations.
IEC 61439	Low voltage switchgear and control gear assemblies

1. Conduits / Trunking (Casing Capping) (Surface type)

PVC Conduits

- **Specification No (WG-MA/CON)**
- **Scope:**

• PVC Conduits: Surface

Providing specified PVC Conduits and erecting as per approved Method of Construction; on surface of wall / ceiling, etc. including entries through walls / slabs / flooring as per requirement, and with all necessary hardware, accessories such as Spacers, Saddles, Bends, Tees, Junction boxes, Check-nuts, etc.; making conduits erection work rigid and duly finishing, removing debris from site.

Material:

PVC Conduit:

PVC pipe minimum 20mm dia and above depending on No. of wires to be drawn (refer Table No. 1/2) ISI mark, HMS grade (2mm thick), accessories for PVC pipes of the same make that of pipe; such as Spacers & Saddles, Couplers, Bends, inspection or non inspection type Elbows, Tees, Junction boxes of required ways and resin / adhesive to make all joints rigid. Black pipe shall not be used for surface type wiring.

Hardware:

Sheet Metal (SM) screws of sizes specified in Method of Construction, washers, rawl / PVC / fill type plugs, wooden gutties, etc.

Method of Construction:

Erection PVC Conduits for Surface type wiring:

General:

Erection shall be done as per the final approved layout, in perfect level and plumb. Conduits shall be firmly fixed on spacers with saddles. Fixing of spacers shall be equidistant and at ends, bends, elbows, junction boxes, couplings, boards. CSK screws of minimum 35x8 mm and suitable plugs shall be used for fixing spacers and 12x5 mm, round headed screws for fixing saddles on spacers. In case of stonewalls wooden gutties shall be grouted in wall for fixing of spacers. Distance between 2 spacers shall not be more than 600mm. Size of conduit shall be correct depending on number of wires to be drawn (as per Table No. 1/2 for PVC conduits). Separate pipe shall be used for each phase in 1-ph distribution and for power and light distribution. Also for wiring for other utilities like data, telephone, TV cabling distance between pipes shall not be less than 300 mm. or ant electrostatic partition/separate pipe should be used. Adequate use of conduit accessories shall be made at required locations. Entries in wall shall be at level of surface and with colour coding conduit (For visual identification) as per Table No. 1/4. Flexible conduits shall be used at expansion joints.

Especially for PVC Conduits of surface type wiring:

In addition to general instructions above, all joints shall be made rigid with resin / adhesive. Wherever offsets are necessary, it shall be done with bending spring. Size of conduit shall be as per Table No. 1/2 for number of wires to be drawn through the conduit.

PVC Trunking (Casing capping)

Specification No (WG-MA/CON)

Scope:

PVC Trunking:

Providing specified PVC Trunking (Casing capping) and erecting as per approved Method of Construction, on surface of wall / ceiling, etc. including entries made with PVC conduit through walls / slabs / flooring as per requirement with all necessary hardware, accessories such as inner / outer Elbows, Tees, Junction boxes, etc. and duly finishing, removing debris from site.

Material:

PVC Trunking (casing capping):

PVC Trunking (casing capping) ISI mark, 1.2 mm thick, minimum 20 mm width and above depending on No. of wires to be drawn (Refer Table No 1/3 for the size of trunking and number of wires to be drawn); with double locking arrangement, 1.8mm thick push-fit joints/ accessories for PVC trunking such as couplers, elbows, internal / external angles, junction boxes of required ways of the same make.

Hardware:

Sheet Metal (SM) screws of sizes specified in Method of Construction, washers, rawl / PVC / fill type plugs, wooden gutties, etc.

Method of Construction:

Erection of PVC Trunking for surface type wiring:

Erection shall be done as per the final approved layout. The Trunking shall be in perfect level and plumb. Screws of minimum 35x8 mm and suitable plugs shall be used for fixing. In case of stonewalls wooden gutties shall be grouted in wall for fixing of screws of Trunking. Distance between 2 screws shall not be more than 600 mm. Size of Trunking shall be correct depending on number of wires to be drawn as per Table No 1/3 but not less than 20mm. Separate Trunking shall be used for each phase in single phase distribution and for power and light distribution and also for wiring of other utilities like data, telephone, TV cabling and distance of 300 mm shall be maintained between the Trunking or anti electrostatic partition to be provided. Double locking shall be checked while fixing capping. Adequate use of accessories shall be made at joints and at required locations.

2. Conduits (Concealed type)

Specification No (WG-MA/CC)

Concealing PVC Conduits in RCC work

Scope:

Providing specified PVC conduit and laying / erecting in RCC work, such as slab, beam, column before casting as per approved Method of Construction along with of all required material including hardware, binding wire, fish wire; accessories such as deep / long neck PVC junction boxes, PVC / MS junction / draw-in boxes, check-nuts, flexible PVC pipe, drawing fish-wires and making all piping rigid, removing debris from site and supervising the work during casting to confirm rigidity, continuity and avoid damages.

Material:

PVC Conduit:

PVC pipe of minimum 20mm dia and above depending on No. of wires to be drawn (refer Table No.1/2); ISI mark, HMS grade (2mm thick), accessories for PVC pipes of the same make that of pipe; Couplers, long Bends, deep Junction boxes of required ways and resin / adhesive to make all joints rigid.

Junction boxes / Draw-in boxes:

Junction box shall be 5 sided with removable top plate and of suitable size to accommodate No. of entries; PVC or fabricated from 16g CRCA sheet steel with earth terminal duly treated with antirust treatment and painted with two coats of red oxide paint. There shall be knockout holes in required numbers and dia. for entry of conduit pipes and arrangement to fix cover plates on it.

Hardware:

'U' nails, plumbing and general use nails of required sizes, washers, check-nuts, steel binding wire, steel fish wire etc.

Method of Construction:

Concealing of PVC conduits:

General:

Work shall be done in co-ordination with civil work and to suite final approved layout. Size of conduit shall be correct depending on number of wires to be drawn. (Table No 1/2 for PVC conduits) Separate pipe shall be used for each phase in single phase distribution and for power and light distribution and also for wiring for other utilities like data, telephone, TV cabling, etc. The distance between pipes shall not be less than 300 mm or anti electrostatic partition is to be provided. Adequate use of conduit accessories shall be made at required locations. Entries in wall shall be at level of corresponding conduit with colour coding as per Table No. 1/4. (For Visual identification) Flexible conduits shall be used at expansion joints. Erection shall be done as per the layout finalized, with minimum sharp bends, with junction boxes at angular junctions and for straight runs at every 4.25m, in such manner so as to facilitate drawing of wires. All PVC conduit bending shall be done with Bending Spring. All joints shall be made rigid with resin.

Concealing of PVC conduits:**In RCC work:**

Work shall be commenced after fixing of steel re-enforcement on centering material. Conduits shall be firmly fixed on steel of RCC work by binding wire. Fixing of conduits shall be such that it will remain rigid during casting of slab, beam, and column even after use of vibrator. Deep junction boxes and other draw-in boxes shall be such that their open end and centering material will not have gap in between so as to avoid concrete entering inside even after fixing covers to steel re-enforcement; and be filled with dry sand. Open ends of conduits; to be concealed in walls, shall be provided with couplers / sockets at ends and be flush with bottom of beam, and located at the center of the beam. As far as possible bunching / grouping of conduits shall be avoided so that it will not affect strength of RCC work especially in beams. Suitable steel fish wire shall be drawn through in the conduits for drawing of wires later on.

Concealing PVC Conduits in walls / flooring**Scope:**

Providing specified PVC conduit and erecting / laying in wall, flooring by making chases / grooves / entries as per approved Method of Construction along with of all required material including hardware such as 'U' nails, binding wire, fish wire; accessories such as PVC / MS junction boxes / inspection boxes, check-nuts, flexible PVC pipe, glands, drawing fish-wires and making all piping rigid, refinishing the surface with cement mortar, removing debris from site.

Material:

PVC Conduit:

PVC pipe minimum 20mm dia and above depending on No. of wires to be drawn (refer Table No.1/2), ISI mark, HMS grade (2mm thick), accessories for PVC pipes of the same make that of pipe; Couplers, long Bends, Junction boxes of required ways, type and resin / adhesive to make all joints rigid.

Junction boxes / Draw-in boxes:

Junction box shall be 5 sided with removable top plate and of suitable size to accommodate No. of entries; PVC or fabricated from 16g CRCA sheet steel with earth terminal duly treated with antirust treatment and painted with two coats of red oxide paint. There shall be knockout holes in required numbers and dia. for entry of conduit pipes and arrangement to fix cover plate on it.

Hardware:

'U' nails, plumbing and general use nails of required sizes, washers, check-nuts, steel binding wire 20g, steel fish wire, etc.

Other material for Surface finishing: Cement, sand, putty, and water.

Method of Construction:

Concealing of PVC conduits: (General)

Work shall be done in co-ordination with civil work to suite final approved layout. Size of conduit shall be correct depending on number of wires to be drawn. (Table No 1/2 for PVC conduits) Separate pipe shall be used for each phase in 1-ph distribution and for power and light distribution and also for wiring for other utilities like data, telephone, TV cabling, etc. for which the distance between pipes shall not be less than 300 mm or anti electrostatic partition is to be provided. Adequate use of conduit accessories shall be made at required locations. Entries in wall shall be at level of corresponding conduit with colour coding as per Table No.1/4. (For Visual identification) Flexible conduits shall be used at expansion joints. Erection shall be done as per the layout

finalized, with minimum sharp bends, with junction boxes at angular junctions and for straight runs at every 4.25m, in such manner so as to facilitate drawing of wires. All bending of conduits shall be done with Bending Spring. All joints shall be made rigid with resin.

Concealing of PVC Conduits In walls / flooring:

Chases shall be made in walls of adequate width, with cutter and chiseling through it. Necessary finishing of the wall surface shall be done. Work in flooring shall not disturb RCC work, Conduits of adequate size shall be erected with use of appropriate accessories, and 'U' nails. All joints shall be made rigid with resin. Draw-in / inspection boxes shall be fixed with check-nut, flush with surrounding surface and earthed.

Junction boxes / Draw-in boxes:

Junction box shall be 5 sided with removable top plate and of suitable size to accommodate No. of entries; PVC or fabricated from 16 SWG CRCA sheet steel with earth terminal duly treated with antirust treatment and painted with two coats of red oxide paint. There shall be knockout holes in required numbers and dia. for entry of conduit pipes and arrangement to fix cover plates on it.

Hardware:

'U' nails, plumbing and general use nails of required sizes, washers, check-nuts, steel binding wire 20g, GI fish wire, etc.

Wires: Mains / Sub-mains / Circuit mains (comprising phase and neutral wires):

PVC insulated wire of specified size, minimum FR grade insulation, copper conductor of electrolytic tough pitch (ETP) grade, having insulation of 1.1 kV grade, ISI marked, of required colour coding as per Table No 1/5

Earth Continuity Wire: PVC insulated wire minimum FR grade insulation copper conductor of electrolytic grade, having insulation of 1.1 kV grade, of green / green-yellow colour, ISI marked, of specified size but not less than 1.5 Sqmm as per Table No 1/5

Lugs: Copper lugs of required size & type

Other material: Rubber grommet, bush, harnessing material, flexible conduit etc.

3. LED Fittings (ESD-LED)

A) Surface / Recessed Mounting LED Luminaries

Scope:

Specification No (ESD-LED/IDF)

Supplying & erecting approved make, Surface / recessed mounting indoor fitting of specified wattage to provide specified lux level at specified height with p.f. > 0.95, complete as per manufacturer's specification, with appropriate driver.

Material:

Fitting: Scientifically designed highly polished & anodized Aluminum reflector ensures precise light control with optimum light utilization either with clear glass / frosted glass cover with ring or as per manufacturer's specification, leading to substantial savings in energy cost and excellent ambient conditions. Frame is fabricated from CRCA/MS sheet and epoxy powder coated white. Percolated frame ensure corrosion free life. Retaining clips for recess mounting fittings to facilitate mounting in false ceilings. Luminaries comprises of a deep drawn MS sheet canopy along with LED's with 100 lumens per watt mounted on top of aluminum heat sink of appropriate size for excellent thermal dissipation. The constant current driver circuit should be inside the luminary and can be driven between 80V to 260V AC. It should conform to class 1 of IS: 10322. Fitting shall be wired with multi stranded copper wire terminating on suitable connectors.

Driver: The constant current driver driven at 600mA of constant current should have short circuit protection, thermal protection & should work in the range of 80V to 260Volts.

LED's: The LED's of approved make having life of minimum 50000 burning hours, must have a color temperature between 5000 - 7000 and of 100 lumens per watt.

Metal Core PCB's: The PCB should be of metal core, copper clad laminate composed of 1 oz Electro deposit copper and 1.5mm 5052 Aluminum Alloy Laminated by 60 um high thermals conductive adhesive of modified epoxy.

Hardware: Sheet Metal (SM) screws, washers, plugs / wooden gutties, etc.

Method of Construction:

The fitting shall be fixed firmly in the designated place (False ceiling / unspecified ceiling) with the help of swinging bracket, and making the connection. In case where fittings are to be installed flush with /on false ceiling; layout shall be given to civil wing and work shall be done in co-ordination with civil wing e.g. making recesses in false ceiling.

Mode of Measurement: Executed quantity shall be counted on number basis. (i.e each)

B) Bulk Head type LED Luminaries

Scope:

Specification No (ESD-LED/BHF)

Supplying & Erecting LED bulkhead Fitting of appropriate size with 8 W with minimum 50-70 lux level at ground level with p.f. > 0.95 with frosted glass.

Material:

Fitting:

Luminaries comprises of a deep drawn MS sheet body with clear acrylic cover of 3mm thickness or as per manufacturer's specification, along with LED's with 100 lumens per watt mounted on top of aluminum heat sink of appropriate size for excellent thermal dissipation. The constant current driver circuit should be inside the luminary and can be driven between 80V to 260V AC. It should conform to class 1 of IS: 10322 The surface of the canopy should be powder coated / stove enameled. Fitting shall be wired with multi stranded copper wire terminating on suitable connectors.

Driver:

The constant current driver driven at 600mA of constant current should have short circuit protection, thermal protection & should work in the range of 80V to 260Volts.

LED's:

The LED's of approved make having life of minimum 50000 burning hours, must have a color temperature between 5000 - 7000 and of 100 lumens per watt. The angle of illumination of each LED should be 90degrees and should be mounted on star type of metal core PCB's.

Metal Core PCB's: The PCB should be a metal core, copper clad laminate composed of 1 oz Electro deposit copper and 1.5mm 5052 Aluminum Alloy Laminated by 60 um high thermals conductive adhesive of modified epoxy.

Wooden board: As per (WG-PW/PW) 1.6 specified in chapter for Point wiring.

Hardware: Sheet Metal (SM) screws, washers, plugs / wooden gutties, etc.

Method of Construction:

The complete fitting with all the above accessories shall be erected as directed by Site engineer, duly connected and giving necessary testing.

Mode of Measurement: Executed quantity shall be counted on number basis. (i.e each)

C) LED Street Light / Flood Light Luminaires

Scope:

Specification No (ESD-LED/ODF)

Supplying & erecting Street Light fitting of specified wattage to provide specified lux level at specified height, complete with acrylic cover and gaskets, with appropriate driver circuit and erected on provided bracket.

Material:

Fitting: Luminaries comprises of a deep drawn MS sheet canopy with clear acrylic cover of 3mm thickness, along with LED's with 100 lumens per watt mounted on top of aluminum heat sink of appropriate size for excellent thermal dissipation. The constant current driver circuit should be inside the luminary and can be driven between 80V to 260V AC. It should conform to class 1 of IS: 10322 and Ingress Protection IP-55. The surface of the canopy should be powder coated / stove enameled. Fitting shall be wired with multi stranded copper wire terminating on suitable connectors.

Driver: The constant current driver driven at 600mA of constant current should have short circuit protection, thermal protection & should work in the range of 80V to 260Volts.

LED's: The LED's of approved make having life of minimum 50000 burning hours, must have a color temperature between 5000 - 7000 and of 100 lumens per watt. The angle of illumination of each LED should be 90degrees and should be mounted on star type of metal core PCB's.

Metal Core PCB's: The PCB should be a metal core, copper clad laminate composed of 1 oz Electro deposit copper and 1.5mm 5052 Aluminum Alloy Laminated by 60 um high thermals conductive adhesive of modified epoxy.

Method of Construction:

The complete fitting with all the above accessories shall be erected with provided bracket, on wall/street light pole or at any place as directed by Site engineer, duly connected and giving necessary testing.

Mode of Measurement: Executed quantity shall be counted on number basis. (i.e each)

PVC/XLPE Cables (CB)
Armoured Cables (HT & LT)

General

All material shall conform to relevant standard as per BIS and shall carry ISI mark. If any particular category of material for which ISI mark is not available in market, it shall be as included in approved list.

Work shall be carried out as per the method of construction specified by BIS. If there is no reference for particular method of construction in IS, such work shall be carried out as per the approved method of construction specified in chapter 16 of P.W. Dept. Handbook.

Material and Work not qualifying to any provision mentioned above shall be to the satisfaction of the Engineer in Charge.

Cables: (Armoured)

The following list records those Indian Standards in force, which are acceptable as good practice, and accepted standards.

- | | | | |
|-------------------------|---|--|-----|
| SP 30: 1984 | : | National Electrical Code | |
| SP 7 (Group 4): 2005 | : | National Building Code | |
| IS 1255: 1983 | : | Code of practice of Installation & Maintenance of armoured cables up to 33 kV. | |
| IS 3961: Part 2: 1967 | : | Recommended current ratings of PVC cables. | |
| IS 1554: Part 1; 1988 | : | PVC Insulated (Heavy duty) Electric Cables; Part 1 for working voltages up to and including 1100 Volts. | |
| IS 1554: Part 2; 1988 | : | PVC Insulated (Heavy duty) Electric Cables; Part 1 for working voltages up to and including 3.3 kV to 11 | kV. |
| IS 10810: Part 63; 1993 | : | Method for Test of cables, Part 63 Smoke density of electric cables under fire condition. | |

Scope: (Armoured cables)

Specification No. (CB-LT/AL, CB-LT/CU, CB-HT)

Providing armoured cable of specified voltage level, size & specified conducting material (Aluminum / Copper) as per **Table no. 7/3** including required material, hardware's for erection and erecting on wall, ceiling, RCC slab or drawing the same through pole, pipe, laying in provided conduit, trench, ducts, trays as per approved method of construction including glands, lugs, etc.

Material:

Cables:

Cables shall be XLPE for LT/MP and XLPE for HT as per Table no. 7/3 and of required construction, colour, shall carry ISI mark, IS No, manufacturer's name, size, duly embossed / screen printed at every metre and having the total count of progressive length in meter at each mark.

Earth wire: Galvanized Iron (G I) wire of appropriate gauge as per Table No 7/1.

Glands: As per specification (CB-GL)

Lugs: As per specification (CB-CL/AL, CB-CL/CU)

Saddles: Saddles fabricated from GI sheet of required gauge and size depending on dia of cable either galvanized or painted with superior quality enamel black paint with necessary shearing mechanical strength, semicircular shaped with extended piece having suitable holes for fixing.

G I Strip: 22 g x 25 mm width G I Strip.

Clamps: MS Clamps fabricated of required length and shape, having the size of 3/6 mm thick mild steel having 25/50 mm width (as per size of cable), rounded ends with wooden / resin cast grip for holding the cable.

Identification tags: For identifying root, connection position GI strip with identification mark / name embossed / painted with arrangement to tie should be fix on cable or arrangement of ferrules to be done.

Hardware: Sheet Metal (SM) screws of required sizes, plugs / wooden gutties, etc.

Method of Construction:

General:

- a) Irrespective of method of construction the cable ends shall be terminated with appropriate size & type of glands with lugs duly crimped, as directed by Site engineer.
- b) Wherever the cable has to be bent, the turning radius shall be as mentioned in Table No 7/2. Grouping of cables shall be done with adequate distance between cables as mentioned in IS so as to minimize de-rating. Cables shall be tagged/ferruled with identification name / mark at the point from where distribution starts and at ends. Bare earth wire of appropriate size as per Table no. 7/1 shall run along with the cable. Earth wire running with the cable shall be terminated at the earth terminal nearest to cable termination.

Erection of Cable on Surface:

Erection shall be done as per the routes and layout finalized, in perfect level and in plumb. Before fixing the cable shall be straightened as far as possible for good aesthetics look, continuous bare GI earth wire of required gauge as per Table No 7/1 shall be run. Cable with G I wire shall be fixed by saddles firmly clipped on cable and shall be fixed to wall with minimum 50 x 8 mm SM screws with plugs/wooden gutties, etc. (Distance between two supports / saddles shall be maximum 450 mm). Wooden gutties shall be used wherever required (Especially for stone wall). The entries made in wall, floor slab, etc for laying the cable shall be made good by filling and finishing with plastering the same.

Erection of Cable on Trusses:

Cable along with bare GI earth wire, while erecting on trusses, shall be firmly clamped by wrapping GI strip of 22 g, 25 mm width of required length fixed to truss with nuts and bolts.

Erection of Cable on Pole:

Cable along with bare GI earth wire, while erecting on pole, shall be firmly clipped by suitable wooden / epoxy resin cast grips, clamped with 25 x 3 mm or 50x6 mm MS strip of required length and fixed to pole with nuts and bolts.

Laying of Cable in provided Trench/Pole:

While laying Cable along with bare GI earth wire, utmost care shall be taken to prevent damage to the insulation of the cable and to the open end. Cable shall be brought out from trench vertically straight (minimum 1.0 metre above G L). Care shall be taken to inspect the trench so that depth of cable shall not be less than as shown in Table No 7/4. Suitable size of cable loops shall be provided near termination point at adequate depth.

Erecting cable in constructed Trench / duct:

Erection of cable/s in constructed trench / duct, shall be as per guide lines of IS 1255.

Erection of cable/s on trays:

Cable/s shall be tied with PVC tags on GI trays. At bending point care shall be taken so that sharp edges of sheet will not damage insulation of cable.

Mode of Measurement: Executed quantity shall be measured on the basis of running metre per run of cable.

Dismantling

Cable laid underground, or fixed on any surface shall be dismantled carefully without damaging complete with all its accessories, making coil and stored as directed. The surface of the dismantled cable shall be made clear by removing of unwanted material, cement mortar, etc. When cable is dismantled from trench refill back the trench and making the surface proper.

Mode of Measurement: Executed quantity shall be measured on the basis of running metre per run of cable.

Table No 7/1**Size of Bare GI Earth wire to be used with LT Cables upto 1.1 kV**

S.No.	Size of cable	Size of bare GI Earth wire to be used with cable
1	2.5 Sqmm to 50 Sqmm of all cores.	12 SWG
2	70 Sqmm to 95 Sqmm of all cores.	10 SWG
3	120 Sqmm and above of all cores.	8 SWG

Table No 7/2**Minimum bending Radius for Cables**

S.No.	Voltage level of cables	Single core	Multi core Unarmoured	Multi core Armoured
1	Up to 11 kV	20 D	15 D	12 D
2	Up to 22 kV	25 D	20 D	15 D
3	Up to 33 kV	30 D	25 D	20 D

Note: D diameter of cable.

Wherever possible, 25 percent larger radii than the specified above should be used.

Table No 7/3**Current Rating (In Ground) for PVC/ XLPE Insulated 1.1 kV Grade Cables**

Nominal area of conductor	Aluminum Conductor				Copper Conductor			
	Single Core		Multi Core		Single Core		Multi Core	
	PVC	XLPE	PVC	XLPE	PVC	XLPE	PVC	XLPE
Sqmm								
10	51	55	46	50	65	71	60	65
16	66	74	60	68	85	95	77	87
25	86	98	76	90	110	125	99	115
35	100	118	92	108	130	150	120	138
50	120	137	110	126	155	175	145	161
70	140	172	135	158	190	220	175	202
95	175	204	165	187	220	260	210	239
120	195	234	185	215	250	301	240	276
150	220	262	210	240	280	336	270	308
185	240	298	235	273	305	381	300	350
240	270	344	275	316	345	441	345	405
300	295	387	305	355	375	496	385	455
400	325	458	335	420	400	586	425	538

500	345	495	-	-	425	635	-	-
630	390	555	-	-	470	710	-	-
800	440	625	-	-	-	-	-	-
1000	490	685	-	-	-	-	-	-

Rating Factors for Variation in Ambient Air Temperature

Air Temperature (°C)	40	45	50
Rating Factor (XLPE)	1.00	0.94	0.88
Rating Factor (PVC)	1.00	0.90	0.81

Table No 7/4

Minimum laying Depth of cables (IS: 1255)

S.No.	Voltage level of cables	Minimum depth from top of the cable
1	Up to 1.1 kV	750 mm
2	3.3 kV to 11 kV	900 mm
3	22 kV to 33 kV	1050 mm
4	At road crossing	1000 mm
5	At railway crossing (from Bottom of sleepers to Top of pipe)	1000 mm

Notes below Table No 7/4:

1.	PVC Insulated electrical cable for voltage grade up to 1.1 kV is based on 8 volts drop.			
2.	The distances are given in meters and after rounding.			
3.	The distances are given in meters and after rounding.			
For Temperature Correction please see as detailed below:				
Ground temp.	20 degree C	25 degree C	30 degree C	35 degree C
Rating factors:	0.95	0.90	0.85	0.80

Table No 7/5

Distance up to which different sizes of UG Aluminum Conductor Cables 1.1 kV grade, can be used for different current ratings of 8 Volts drop. (PVC insulated, PVC Sheathed, 3 cores or 4 cores)

Maximum Conductor temperature – 70 degree C

S. No	Current Amp	Distance in meters for the following cable sizes in Sqmm												
		6	10	16	25	35	50	70	95	120	150	185	240	300
1	5	165	260	415	725	895	1300	1925	2360	3065	3555	4300	5770	6460
2	10	80	130	205	360	450	650	960	1180	1530	1775	2150	2885	3230
3	15	55	85	140	240	300	430	640	785	1020	1185	1430	1920	2155
4	20	40	65	100	180	225	325	480	590	765	890	1075	1440	1615
5	25	30	50	80	145	180	260	385	470	610	710	860	1150	1290

6	30	25	40	70	120	150	215	320	390	570	590	715	960	1075
7	40	20	30	50	90	110	160	240	295	380	445	535	720	805
8	50	-	25	40	70	90	130	190	235	305	355	430	575	645
9	60	-	-	35	60	75	110	160	195	255	295	355	480	535
10	70	-	-	30	50	65	90	135	165	215	255	305	410	460
11	80	-	-	-	45	55	80	120	145	190	220	265	360	405
12	90	-	-	-	40	50	70	105	130	170	195	235	320	360
13	100	-	-	-	35	45	65	95	115	150	175	215	290	320
14	110	-	-	-	-	40	60	85	105	140	160	195	260	290
15	120	-	-	-	-	35	55	80	95	125	145	180	240	270
16	130	-	-	-	-	-	50	75	90	115	135	165	220	250
17	140	-	-	-	-	-	45	70	80	110	125	150	205	230
18	150	-	-	-	-	-	-	65	75	100	115	140	190	215
19	160	-	-	-	-	-	-	60	70	95	110	130	180	200
20	170	-	-	-	-	-	-	55	70	90	105	125	170	190
21	180	-	-	-	-	-	-	50	65	85	100	120	160	180
22	190	-	-	-	-	-	-	-	60	80	90	110	150	170
23	200	-	-	-	-	-	-	-	60	75	90	105	145	160
24	225	-	-	-	-	-	-	-	-	65	80	95	125	145
25	250	-	-	-	-	-	-	-	-	-	70	85	115	130
26	275	-	-	-	-	-	-	-	-	-	-	80	105	115
27	300	-	-	-	-	-	-	-	-	-	-	70	95	105

Cable Joints & End Termination Kits (LT/HT Cables) (JT/LT/HT)

Scope:

Specification No (CB-JT/LT/HT)

Providing straight through cable jointing kit of approved make and jointing cable as per the manufacturer's instructions and duly marking name of joiner and date.

Material:

Joint kit: Kit manufactured by reputed manufacturer with PVC moulds made in two parts, with epoxy compound, earth continuity lead of appropriate cross section having lugs at both ends, aluminum ferrules of the size of the cable, cross shaped epoxy spacer, MS clips for holding the moulds, adhesive for pasting the moulds.

Method of Construction:

Straight through joint Kit: LT/HT Cables

Before providing joint to the cable, the cable ends of the equivalent length of the joint moulds, shall be prepared by removing the outer PVC insulation along with the steel armouring. The ferrule shall then be inserted over the bare core of the cable, and shall be crimped with hydraulic / mechanical type heavy duty crimping tool. The crimped portion shall be

wrapped first with the PVC insulation tape and then with the insulation tape used for wrapping HT conductor. The above method shall be carried out for all the cores strictly following the colour code. The leads of the both the cables now shall be placed into the mould by using the epoxy spacer, for having sufficient gap in-between the leads. The earth continuity lead shall be clamped to the both ends of the cable. After covering the cable leads with the PVC moulds, the edges shall be clipped after applying the adhesive on the inside face of the moulds. The pasting of moulds shall be rigid and as far as possible leak proof, so that the epoxy compound shall not spill out. Now the duly stirred epoxy compound shall be poured and fill till the compound rises through the risers provided on the moulds.

After completing the above procedure, the joint shall be allowed to dry out for at least 8 to 10 hours (for epoxy compound to get hardened) depending upon the size of cable. Before connecting to supply, the dry and hardened joint shall be tested for its insulation level with 1000 V/ 5000 V Meggar.

The cable should be fixed or laid in such manner that there should not be pressure on end of moulds or on jointing position of cables

Outdoor/Indoor end termination Kit: LT/HT Cables

Before providing end termination kit to the cable, the cable end of the equivalent length of the moulds, shall be prepared by removing the outer PVC insulation along with the steel armouring. The ferrule shall then be inserted over the bare core of the cable, and shall be crimped with hydraulic / mechanical type heavy duty crimping tool. The crimping shall be done in such a manner that there shall be no air gap. Then the crimped portion shall be wrapped first with the PVC insulation tape and then with the insulation tape used for wrapping HT conductor. The above method shall be carried out for all the cores strictly following the colour code. The leads of the cable now shall be placed into the mould by using the epoxy spacer, for having sufficient gap in-between the leads. The earth continuity lead shall be clamped to the ends of the cable. After covering the cable leads with the PVC moulds, the edges shall be clipped after applying the adhesive on the inside face of the moulds. The pasting of moulds shall be rigid and as far as possible leak proof, so that the epoxy compound shall not spill out. Now the duly stirred epoxy compound shall be poured and fill till the compound rises through the risers provided on the moulds.

After completing the above procedure, the joint shall be allowed to dry out for at least 8 to 10 hours (for epoxy compound to get hardened) depending upon the size of cable. Before connecting to supply, the dry and hardened joint shall be tested for its insulation level with 1000 V/ 5000 V Meggar.

Mode of Measurement:

Executed quantity will be measured on number basis. (i.e. each).
Cable Glands (GL)

Scope:

Specification Nos (CB-GL)

Termination of cable ends with cable glands for preparing and fixing the cable leads for connection. Cable glands shall be of Flange type.

Material:

Cable glands: Flange type heavy duty. Made of high purity brass metal, with brass washers, rubber rings, threaded stud with washers and nuts.

Method of Construction

Before erection of gland, the cable end shall be prepared by removing the outer PVC insulation up to the point where gland to be fixed, by assessing the length of leads required. Bottom portion of gland shall be inserted over the steel armouring, and then armour strips shall be bent for the length of collar of gland, remaining length of armouring shall be cut. The cable end shall then be, inserted through the entry of plate where the cable is to be terminated. The top portion of gland with washer shall be then inserted in such a manner that the bent armour strip should be touching the surface of the entry. The nuts shall be tightened with spring washers over the projected stud portion. Fixing of gland shall be at right angle

to the gland plate. Tightening shall assure continuity of earth. Hole to the gland plate shall be punched / knocked out, of correct diameter with respect to gland size.

Mode of Measurement:

Executed quantity will be measured on number basis. (i.e. each).

Cable Indicator Plate (CIP)

Scope:

Specification No (CB-CIP)

Providing and fixing of cable indicator plate along the route of underground cable.

Material:

Cable indicator plate: Circular plate made of cast iron having 100 mm dia. and 6 mm thick.

Iron rod for fixing of cable indicator plate: 700 mm long galvanized iron rod of 12 mm dia., and 150 mm long cross bar welded at bottom or hook to be made with same continuous bar.

Method of Construction:

Cable indicator plate fixed/welded to the 700 mm long iron rod or angle, with 150 mm cross bars welded at bottom as fasteners or bent in 'J' shape to hook the cable in the bent portion, shall be buried along the route of cable in the trench made for laying the cable. For clear visibility, the Cable indicator plate shall be buried in such a manner that the plate should be minimum 200 mm above the ground level and shall be provided at every 15-25 metre in straight run, at both ends of road crossing and immediate before and after turning point of cable.

Mode of Measurement:

Executed quantity will be measured on number basis. (i.e. each).

Street Light Boxes (SB) Cable Lugs (Aluminum & Copper)

Scope

Specification Nos (CB-CL/AL, CB-CL/CU)

Crimping of lugs, and fixing to the terminals with nuts and bolts, etc.

Material:

Lug: Lug shall be of high purity aluminum / copper / bimetallic of required type, with required size of hole and smooth finished both from inside and outside.

Hardware: Brass or Cadmium plated mild steel nuts and bolts, bimetallic washers.

Anti-Oxide paste: Paste of superior quality manufactured by reputed manufacturer.

Method of Construction:

Before fixing of lugs to the cable end, the cable end to the equivalent length of the lug shall be prepared by removing the outer PVC insulation along with the steel armouring and then, the inner PVC insulation. The paste shall be applied to the cable lead and inside the lug prior to the inserting of lug on the cable lead. The lug shall then be crimped with hydraulic / mechanical type heavy duty crimping tool. The crimping shall be done in such a manner that there shall be no air gap. Then the crimped portion shall be wrapped with the PVC insulation tape. (Colour of tape shall be of that of cable lead) The above method shall be carried out for all the cores. The cable end with lug shall then be terminated into the terminal and then be tightened with either brass nuts or Cadmium plated nuts as directed by Engineer in-charge.

Mode of Measurement:

Executed quantity will be measured on number basis. (i.e. each).

CABLE TRAY & ACCESSORIES

Scope

Scope of these specifications covers the design, material selection, fabrication, testing at manufacturer's works, insurance, packing, transportation, loading/unloading, supply at site and installation of cable trays, trunking(Raceway) and accessories covered herein.

Material and construction (Cable tray)

Cable trays and accessories shall be manufactured to comply with the specifications of National Electrical Code (NEC) and National Electrical Manufacturers' Association (NEMA).

Cable trays and accessories shall be fabricated using mild steel sheets and hot dip galvanized in accordance with B.S.729 after fabrication. All bolts, nuts and washers shall also be galvanized. The zinc coating shall be uniform, smooth and free from imperfections such as flux & ash, black spots, blisters etc. Cable trays and accessories shall undergo a process of degreasing, pickling in acid & cold rinsing prior to galvanization.

Cable trays shall be of the following type:

- i. Ladder type with rungs
- ii. Perforated type.

Perforated cable trays shall be generally of channel type and the perforations shall be 10x30 mm oval holes. Perforated cable trays shall also be galvanized. Galvanizing shall be in accordance with that specified above for ladder type cable tray.

Ladder type cable trays shall be made from min 1.6mm thick sheet formed in 'C' section of 75/100mm height and inward flanges of 15mm as side runners and 30mm wide x 10mm high rungs ('C' shaped) from a 1.5mm thick sheet. Perforations as mentioned above shall be provided in the width of the rungs. Pitch of the rungs shall not exceed 250 mm center to centre. Rungs shall be tack welded to the side members.

The thickness of sheet steel for perforated trays shall be 1.2 mm and they shall be of the formed channel shape.

Cable trays shall be of following dimensions as specified in BOQ.

Accessories

Following accessories and hardware, as required, shall be supplied with cable trays :

- | | |
|---|----------------------|
| ¾ | Coupler plates |
| ¾ | bends |
| ¾ | Tees |
| ¾ | Reducers |
| ¾ | 4-way cross |
| ¾ | Fasteners (Hardware) |

Testing at manufacturers work

The material for cable trays and accessories shall be offered for stage inspection by the Owner as follows:

- | | |
|---|---|
| ¾ | Prior to fabrication and galvanizing. |
| ¾ | After fabrication but before galvanizing. |
| ¾ | After galvanizing but prior to dispatch. |

During inspection, thickness of sheets, dimensions and weight of zinc coating will be measured. Items not conforming to specifications shall be rejected.

A) Cable Trench (CTR)

General

This part of specification deals with the preparation of trenches in soft soil, hard murum, BT road, and laying of cables inside the trench, etc as per IS: 1255.

Scope:

Specification No (CW-EXN/CTR)

Excavating in all types of soil strata and making trench for laying cable/cables, providing sand bed for laying the cable, covering cable with specified material as per requirement, and finishing the same by making the surface proper with crown on top of the trench.

The following list shows Indian Standards, which are acceptable as good practice, and accepted standards.

SP 30: 1984	:	National Electrical Code
SP 7 (Group 4): 2005	:	National Building Code
IS 1255: 1967	:	Code of practice of Installation & Maintenance of armoured cables up to 33 kV.

Material:

Bricks: Solid Clay bricks of minimum size 225x110x62.5 mm (L x B x H), burnt in the kiln, of good quality.
Sand: Screened sand of good quality.

Method of Construction:

Trench in Soft soil / Hard Murum / Tar road: Single run of cable

Before excavating the soil for preparing trench, route of cable laying shall be got finalized from the site in-charge. Trench of minimum 300 mm width shall be excavated up to minimum depth below the ground surface as per Table No 17.1/1 Bottom of the trench should be carefully levelled and freed from stones. Cable duly straightened shall be laid flat and embedded in the 200 mm layer of screened sand at the bottom of the trench. Bricks shall be laid all over the run of cable as specified below:

Lengthwise for cable up to and including 10 Sqmm of all cores.

Width wise for cable above 10 Sqmm of all cores.

Remaining portion of the trench shall be back filled with the excavated material after removing stones and sharp / hard material, and making the surface proper. Crown of 150 mm shall be provided over the trench. The remaining excavated material shall be removed from site and dumped in scrap yard of Local authorities or at suitable place.

Trench in Soft soil / Hard Murum / Tar road: Two or more cables run of cable

Before excavating the soil for preparing trench, route of cable laying shall be got finalized from the site in-charge. Trench of minimum required width more than 300mm. shall be excavated up to minimum depth as per Table No 5, below the ground surface. Bottom of the trench should be carefully levelled and freed from stones. Cables duly straightened shall be laid flat and embedded in the 200 mm layer of screened sand. The inter-axial distance between two cables shall be between 230 and 400 mm. at the bottom of the trench. Bricks shall be laid all over the run of cable as specified below:

Lengthwise for cable up to and including 10 Sqmm of all cores.

Width wise for cable above 10 Sqmm of all cores.

Remaining portion of the trench shall be back filled with the excavated material after removing stones and sharp / hard material, and making the surface proper. Crown of 150 mm shall be provided over the trench. The remaining excavated material shall be removed from site and dumped in scrap yard of Local authorities or at suitable place.

Trench in Soft soil/Hard Murum/Tar road with half round Hume pipe:

(For cables of size 25 Sqmm. and above shall be covered by min. 150 mm. dia. of RCC Hume pipe)

Before excavating the soil for preparing trench, route of cable laying shall be got finalized from the site in-charge. Trench of minimum required width more than 300mm. shall be excavated up to minimum depth as per Table No 5, below the ground surface. Bottom of the trench should be carefully levelled and freed from stones. Cables duly straightened shall be laid flat and embedded in the 200 mm layer of screened sand. The inter-axial distance between two cables shall be between 230 and 400 mm. at the bottom of the trench. Inverted 150mm. dia. Half round RCC Hume pipe shall be laid above full length of cable. For more than one cable higher size or more number of Hume pipes are to be provided.

Remaining portion of the trench shall be back filled with the excavated material after removing stones and sharp / hard material, and making the surface proper. Crown of 150 mm shall be provided over the trench. The remaining excavated material shall be removed from site and dumped in scrap yard of Local authorities or at suitable place.

As per 3.1 above, in place of bricks, the cable of size 25 sq.mm and above shall be covered with 150 mm dia. half round Hume pipe.

Mode of Measurement:

Executed quantity shall be measured on the basis of running meter per run of cable.

Table No 17.1/1

Minimum laying Depth of cables (IS: 1255)

S.No	Voltage level of cables	Minimum depth from top of the cable
1	Up to 1.1 kV	750 mm
2	3.3 kV to 11 kV	900 mm
3	22 kV to 33 kV	1050 mm
4	At road crossing	1000 mm
5	At railway crossing (from Bottom of sleepers to Top of pipe)	1000 mm

LV PANEL BOARD

Rated Insulation Voltage Ui	:	Upto 1000 V
Frequency	:	50 Hz
Frequency variation	:	±3% of the nominal value
System design fault level (sym.)	:	50KA for 1 sec
System earthing	:	Solidly Earthed
Rated Impulse Withstand voltage Uimp :	:	12kV/8kV
Degree of Protection	:	IP65

Applicable standards

The equipment proposed in this offer has been designed, manufactured, and tested according to the relevant IEC recommendations.

IEC 61921 / IS 16636 – 2017 - Low-voltage power factor correction banks

IEC 61439-1/2 Low voltage switchgear & control gear assemblies – Part 2 Power switchgear and control gear assemblies

IEC 61641-ed 3 Enclosed low voltage switchgear and control gear assemblies Guide for testing under conditions of arcing due to internal fault

IEC 60529 Degrees of protection provided by enclosures

IEC 60947-2 Low voltage switchgear & control gear – part 2 Circuit breakers

IEC 60947-3 Low voltage switchgear & control gear – Part 3 Switches, disconnectors, switch-disconnectors & fuse combination units

IEC 60068 Environmental testing

IEC 61140 Protection against electric shock – Common aspects for installation and equipment – Basic safety publication

IEC 60947-4-1 Contactors and motor starters LV Equipment Mandatory Specifications

Mandatory Safety Standards and tests

- To ensure safety of the persons and equipment, each rating of the switchboard must be type tested recently in accordance with IEC 61921, IS 16636: 2017, IEC 61439 - 1 & 2. The testing must have been performed in the independent laboratories witnessed by competent authorities of international repute.
- All the performance type tests must be done with the device mounted inside the switchboards and shall be considered applicable for that particular make only. In case the make is changed separate test must be conducted. Test certificates must be available for inspection before the quotation is made
- This is a Mandatory specification for low voltage switchboard dedicated for large installations comprising of LV Main distribution boards and Sub - distribution applications and motor control Centers. The specifics of site conditions and special applications are mentioned separately in the annexures This equipment is desired to be installed indoors in the substation or the specific rooms or shop floor. The LV Equipment shall be flexible, made of several type of panels to be coupled with each other for various applications with specifically rated horizontal busbars and vertical busbars for particular vertical section. For personal and equipment safety against accidental touch, each feeder must have Pre-designed finger proof metallic or molded barriers. FRP/Hyles shrouds will not be acceptable under any circumstances.
- Pre-designed Metallic barriers between feeder chambers, Busbar chambers and cable compartment. All the openings between these compartments must be properly sealed and shrouded.
- As per IEC 61921, IS 16636:2017 type tested design metallic partitioning in ensure safety of during operation and maintenance. Metallic partitions on the cable termination must be designed for easy termination of the cable sizes mentioned in the BOQ/ SLD. It should easily possible to reassemble the form partitions after terminations of the cable.
- Differentiated locks (& Keys) for Feeder compartment, Cable compartment and Busbar compartment.
- Several interlocking systems as mentioned elsewhere in this specification or special requirement to prevent inadvertent operation.
- If, specific environmental conditions are mentioned (e.g. Corrosive, conductive, highly humid or outdoor), supplier must submit the processes to be followed to avoid adverse effect on the working of the switchboard.
- Manufacturing Unit - Systems, Safety and Green Initiatives. The Supplier manufacturing unit must have statutory and quality system standards certification
- ISO 9001 Quality Management Systems (QMS)
- ISO 14001 Environment Management Systems (EMS)
- OHAS18001 Certification for occupational health and safety.
- LV equipment shall be modular, metal enclosed pre-engineered, comprehensively type tested as per IEC 61921, IS16636:2017, IEC61439-2, to house switchgear devices of reputed makes as specified and as per the BOQ/SLD.

General

- The switchboard shall be metal enclosed, free standing, floor mounting, compartmentalized, extendable on both sides, modular type, suitable for indoor installation with dust & vermin protected.
- The switchboard shall comply to latest edition of IEC 61439-1&2, Test certificate shall be issued by a reputed authority.
- The equipment shall be suitably constructed for safe, proper and reliable operation without undue wear, corrosion, heating or other operating trouble.

- Panel builder shall produce valid licensed agreement made with original manufacturer.
- The weatherproof housing shall be manufactured from Hot Galvanized Iron conforming to international specification and suitable for mounting on a flat concrete base or pier 300 mm above ground level.
- The enclosure frame shall be from OEM. The frame shall be of bolted design made of Galvanized iron with 9-fold structure for better rigidity and strength with 275GSM. No welding frame to be considered.
- All the load bearing members shall be made of GI sheet steel and it shall be of a totally enclosed design with cables entering from the Top/bottom and secured by cable cleats or glands and maintains equipotentiality of the switchgear.
- The housing shall be arranged for front access/Rear access by means of hinged doors which shall be screwed to secure them.
- All openings/corners shall be smooth without burrs, smooth. The openings for passing control wires and cables shall be smoothed or provided with suitable rubber gaskets. Doors and covers shall be provided with gasket to ensure specified IP degree.
- All hardware shall be treated to achieve resistance to corrosion. Joints and connections shall be made using high quality 8.8 grade steel bolts, nuts & washers. Specific washers shall be used to ensure effective continuity.
- The switchboards shall be formed using distinct vertical panels comprising of different compartments
- Full metal sheet shall be provided between two adjacent vertical panels running up to full height of the switchboards.
- All the meters, CTs, auxiliaries pertaining the feeders will be housed together in the same compartment respecting the connection rules, clearances recommended by standards and the manufacturers guidelines. For the ACB feeders however, the protection relays, other auxiliaries like control/selector switches, meters etc. shall be mounted in a separate compartment near to the breaker compartment with proper labelling
- The rated impulse withstand voltage of the system shall be 8kV for ACB & MCCB feeders for total panel.
- The Electrical Panel shall have a rated short time withstand current of 50 kA for 1 second
- The busbar will be designed for mounting on insulated supports that are sufficient in number to accept the flow of peak short circuit current upto 254kA.
- The switchboard Main distribution panel shall restrict the internal arcs faults within the compartment to ensure maximum safety to the operating personnel and also to minimize the downtime for replacement and repairs. Type test certificate shall be carried out to verify the arc containment within the compartment for 50kA, 0.3sec as per IEC 61641.
- The Switchboard shall have Seismic withstand of Zone –IV.
- Even under extreme condition of short circuit or Mal-operation there will be no danger in the vicinity of the assembly.
- The switchboard shall be with Outer glass door with gasket to prevent from accidental / unauthorized operation of switchgears.
- The glass should be of minimum 4mm thick which should comply Mechanical impact of IK-09.
- The doors should be with pre-assembled handle (reversible) with 4 closing points must be used, double tongue standard type with locking system must be chosen.
- No hylam sheets to be used for segregation, GI sheet is preferable.

Quality assurance

- The panel manufacturer should have ISO 9001 certification. And shall have a minimum experience of 10 years in the field of switchgear assembly. Enclosure system and switchgear components shall be from the same manufacturer
- The entire switchboard shall be of bolted design to avoid welding cracks in case of welded design.
- The switchboard shall be of modular kit design for easy transportation and assembling at site by which Quick and error free assembly can be achieved.
- Finger touch proof design ensures highest safety to maintenance personnel.

Enclosure manufacturing

- The switchboard shall be factory manufactured by OEM or manufactured by authorized Franchisee of OEM based on design given by OEM.
- The switchboard shall be complete design verified assemble as per IEC 61439-1&2.
- The enclosure protection shall not be less than IP-52 unless other specified in BOQ.
- The switchboard shall be modular, extendable cubicle, fully compartmentalized and floor mounting.
- The form of separation shall be Form-4, a modular individual mounting arrangement shall be used and the internal separation shall be carried out using GI sheets with 275GSM.
- The switchboard frame (Uprights) shall be pre-punched and bent with minimum 1.5mm thickness and fitted with a multipurpose hinge, used to assemble the door and to couple the structures, both laterally and rear.
- Base/top steel sheet painted (epoxy polyester RAL 7035 orange peel), with inlet/outlet for cables. They are supplied pre-mounted by means of a three-way joint, which is able to provide considerable structural rigidity.

- The switchboard construction should be with universal width which can be used for both Incoming vertical as well as outgoing feeder vertical.
- Zinc coating will be provided on the sheets which will prevent rust formation during storage and handling for processing, in addition to giving corrosion protection to the finished product.
- The GI sheet used in the enclosure shall be 275gsm.
- The sheet steel used for the enclosure manufacturing will pass through the pretreatment process for surface treatment.
- The outer doors and cover shall be Poly urethane gasket to prevent from ingress of duct.
- The glass should be of Tempered glass to avoid sharp edges in case of damage.
- External and internal painting with electrostatic application of thermosetting powder enamel with epoxy polyester binders. Grey orange peel RAL 7035 colour, total thickness of min 80 micron.
- The painting should pass the resistance test to saline fog (min 193 hours)
- The switchboard shall have integral base frame.
- The doors and covers shall be made of CRCA sheet steel of thickness as per OEM standard

Switchboard Configuration

- The switchboard shall be configured with Moulded case circuit breaker, MPCB, MCB, Contactors and other equipment's as per BOQ.
- The MCCBs shall be arranged in multi-tier formation. The incoming Air Circuit breaker shall be arranged in single tier formation only but double tier formation can be arranged to facilitate operation and maintenance which is applicable to only outgoing ACBs only.
- The switchboards shall be adequate size with a provision of spare space to accommodate possible future additional switchgear.
- Special care has to be taken to ensure effective earthing of the frame and doors if the switchboard.
- All panels and covers shall be properly fitted. The unused holes in the panel shall be closed with suitable grommet.
- The panel has to be provided with "Danger" label confirming to relevant standard.

Switchboard Compartmentalization

- The switchboard shall have separate totally enclosed compartment for main horizontal busbar, vertical busbars, ACBs, MCCBs and Cable chamber.
- The switchboard shall be with Form 4b construction.
- Insulated shutters shall be provided between draw out and fixed portion of the switchgear such that no live parts are accessible with equipment drawn out. Degree of protection within compartments shall be atleast IP 2X.
- Sheet steel hinged lockable doors for each separate compartment shall be provided and duly interlocked with the breaker "ON" and "OFF" position.
- For incoming vertical separate and adequate compartments shall be provided for accommodation instruments, indicating lamps, control contactors and control MCB etc.
- Outgoing MCCBs "ON" and "OFF" operation can be performed only after opening the door.
- Each switchgear cubicles shall be fitted with label in front and back identifying the circuit, switchgear type, rating and duty. All operating device shall be located in front of switchgear only.
- A suitable wire wat with cover shall be provided to take interconnecting control wiring between vertical section.
- In case of dead front access panel separate cable chamber and vertical chamber to be provided for easy maintenance.
- In case of rear access panel cable compartment can be provided in the rear only for outgoing vertical with sufficient space for easy termination. The incoming and outgoing cables can either entering from bottom or top depending on the site requirement.
- Proper cable support shall be provided in cable compartment to support and clamping the cable.

Switchboard Busbar

- Busbar shall be made of high conductivity Aluminium of ETP grade busbar and shall be of rectangular cross section.
- The busbar shall be suitable for full load current for phase busbar and half/full rated current for neutral busbar or as stipulated in BOQ.
- The busbar system shall be designed as per the pre-defined guidelines provided by the original manufacturer.
- The fault level rating of the busbar system shall be as per the drawings however the minimum short circuit withstand capacity shall be 50KA RMS for 1second.
- The busbar system shall be type tested by the manufacturer at reputed laboratory for short circuit withstand capacity. The neutral and earth busbars shall also be type tested for the short circuit withstand capacity.
- The busbar system shall be supported adequately at regular intervals as per OEM guidelines based on the type test results on a

specially designed busbar supports. The supports shall be independently fixed to structure to strengthen the busbar arrangement. Wherever required additional intermediate supports shall be provided between the busbars.

- All vertical droppers shall also be adequately supported as per the manufacturer guidelines and the test results. The Vertical busbars shall be connected to the main busbars by suitable sized and graded bolt & nut and contact washers.
- The busbar shall be supported on Non-breakable, glass reinforced polyamide 6.6 insulated supports able to withstand operating temperature of 140°C.
- The busbar support should qualify glow wire test of 690°C.
- The supports shall comply UL 94 safety of Flammability Plastic Materials for Parts.
- The busbar support should withstand the impulse voltage of 12kV.
- The material and busbar support spacing should be same as per the type tested assembly.
- The minimum clearance to be maintained for enclosed indoor air insulated busbar shall be as per IEC guidelines.
- The dimensioning of the busbar system shall be as per the rated current of the main switching device, the short circuit current, the maximum rated permissible temperature at permanent operation and the ambient temperature around the busbars. The selection of busbars shall be supported by calculations and recommendations from the OEM.
- The neutral busbar shall run along with the phase busbars. Neutral busbar running at bottom or in the cable chamber/alley will not be accepted in case of Form-4 construction.
- Earth busbar shall be running throughout the panel fitted directly on to the structure for
- connection of the protective conductors to provide equipotential bonding of exposed conductive parts. Earth busbar shall be located at the bottom of the panel in case of bottom entry and top of the panel in case of Top entry.
- All non-current carrying metallic components shall be permanently connected to earth.
- Hardware used for busbar connections shall be zinc plated, yellow passivated / bichromated steel of 8.8grade. Tightening of busbar bolts shall be done as per manufacturer recommendations and pre-defined guidelines using calibrated torque wrenches.
- Auxiliary buses for control power supply, space heater power supply or any other specified service shall be provided. These buses shall be insulated, adequately supported and sized to suit specific requirement. The material for auxiliary supply bus will be insulated electrolytic copper. Wires.
- With aluminium bus bars, only aluminium wire/solid bar connections shall be made for incoming/outgoing mountings on the switchboards.
- With copper bus bars, only copper wire/solid bar connections shall be made for incoming/outgoing mountings on the switchboards.
- The cross section of the neutral bus bar shall be the same as that of the phase bus bar for bus bars of capacities upto 200A; for higher capacities, the neutral bus bar must not be less than half the cross-section of that of the phase bus bar.
- Each bus bar shall be suitably insulated with PVC sleeves/tapes. The insulation of the rising mains shall be capable of withstanding the voltage of 660V of A.C
- Bus bar has to be as per TTA design of OEM.
- Bus bar support insulators shall be class *F insulators made of non- hygroscopic, non-combustible, track resistant and high strength FRJP/ SMC/DMC material, and shall be of suitable size and spacing to with stand the dynamic stresses due to short circuit currents. The spacing between two insulators should not exceed 250 mm.
- The minimum clearance to be maintained for enclosed indoor air insulated bus bars for medium voltage applications shall be as follows:
 - Between Min. Clearances
 - Phase to earth 26mm
 - Phase to phase 32mm
- For strip connection from bus bars to switchgear, the above clearances don't apply.
- Bus bar joints shall be thoroughly cleaned and suitable oxidizing grease shall be applied before making the joint.
- High tensile bolts, plain and spring washers shall be provided to ensure good contact at the joints.
- The overlap of the bus bars at tie joints shall be not less than the area of the cross section of the bus bars.
- Bus bars and main connections shall be marked by color or letter as per table shown below.

Sr. No	Busbar and main connections	Colour	Letter/Symbol
i)	ThreePhase	Red,Yellow,Blue	RY.B.
	TwoPhase	Red,Blue	R.B.

Sr. No	Busbar and main connections	Colour	Letter/Symbol
	SinglePhase	Red	R
ii)	Neutralconnection	Black	N
iii)	Connectiontoearth	Green	E
iv)	Phase variable (such as connectionstoreversiblemotors)	Grey	Gy.

Instruments

- Instruments shall be digital flush mounting type. Digital Load Managers shall be provided for the parameters as indicated in the SLD and B.O.Q. Energy meters shall be suitable for 3 phase 4 wire unbalanced load. Energy meters shall be mounted flush and gaskets shall be used for making the door cut-out dust tight.
- All meters unless otherwise specified shall be with RS485 port and necessary software for parameter display at remote PC shall be provided by vendor along with the panels/meters.
- Electrical indicating / measuring instruments shall be of 96 x 96 mm Digital MFM unless otherwise specified. These shall be mounted semi-flush with only flanges projecting. All meters shall be 1 accuracy class unless otherwise specified.

Current Transformer

- Current transformers as specified in drawing shall be provided for each circuit conforming to relevant IS: 2705. CTs shall be epoxy resin cast with bar primary or ring type and shall be mounted on fixed portion of the switchgear cubicle. Facilities shall provide for short circuiting and earthing of CT secondary leads at the terminal blocks. Also test links, shall be provided in CT secondary leads to carry out current and phase angle measurement tests with CTs. in service.
- Class I accuracy for metering and Class 1 and 5P10 for protection with rated burden of 15/30 VA on secondary.
- Error limit to specific class of accuracy.
- Current transformers shall be designed to withstand the thermal and mechanical stresses resulting from fault currents equal to the maximum interrupting and momentary current ratings respectively of the circuit breakers.
- Insulation level of the CTs shall correspond to the voltage level of the switchgear. CTs shall have polarity marks indelibly marked on CT terminals and at the associated terminal blocks.
- The arrangement of mounting and supporting the CTs shall be such as to take care that tracking along insulator surface from busbars to CT supporting metal clamps, cleats and bolts resulting - over shall be avoided.

Meters and Indicators

- The meters and relays shall comply the following: -
- MISC type with Class – I accuracy.
- Ammeters, Voltmeters, with 96 x 96 mm size flush mounting type with selector switches and back up fuses
- Maximum Demand electronic meters with integration time of 30 minutes, wherever specified.
- Indicating lamps shall be LED type with control MCB. All indicating lamps shall be colour coded.

Relays

- Relays shall conform to IS: 3231 and shall be mounted semi flush with only flanges projecting on the front. All protective relays shall be in drawout cases with built - in test facilities. Necessary test plugs shall be the contractor. Test blocks and switches when supplied separately, shall be located immediately below each relay for testing. Auxiliary relays and timers shall be in non-drawout cases. All protective relays shall be provided with externally hand reset, positive action, and operation indicators.
- Wherever the relays external to ACBs are specified, they shall comply the following features:
- Inverse time characteristic with minimum time over current having 50 – 200% setting.

- Instantaneous earth fault having 20-80% setting.
- Direct acting trip coil to suit 5A CT secondary and with time delay dash pot or TC fuses.
- Shut trip coils to have necessary DC power source with associated charger.
- Discrimination of operating characteristics for trips and delay elements with up and down streams switchgear.
- Testing of relays by primary injection and secondary injection.
- Enclosed in dust proof flush mounting drawout type cases.
- Accessible for setting and resetting from the front.
- Provided with positive acting hand-reset flag indicators visible from the front.
- Access to setting devices shall be possible only after the front covers are removed. Access to resetting shall be external to the case.
- Auxiliary relays shall be rated to operate satisfactorily between 70% and 110% rated voltage.
- Each relay shall be provided with at least two separate voltages from contacts. Make and type of relays shall be as approved by the Engineer.

Control & Selector Switches

- Control and instrument switches shall be of the rotary type provided with plates engraved with switch operating positions and suitable for semi - flush mounting with only the switch front plate and operating handle projecting out. The contact assembly at the back of the switch shall be fixed and accessible from the back.
- Control switches shall have momentary contacts, spring return to center with pistol grip handles. Instrument and selector switches shall have stay put contacts with oval knurled handles. Three number of contacts, their rating and their operation in each switch shall be as per the requirement of the connected circuit and the control schematics. Controls supply 240 V, 1 \emptyset A.C. for vacuum contactor and control circuit shall be tapped after main switch but before power fuses and P. T. shall be provided for each meter feeder with necessary protection.

Annunciators

- Annunciators when specified shall have audible alarm and visual display through translucent plastic window of 50mm x 65mm (minimum) size engraved with appropriate function in block letters on each windows. "Acknowledge" "Reset" and "Lamp Test" pushbuttons with alarm buzzer shall be provided common for the annunciation system in the relay compartment of switchgear.
- On receipt of an alarm impulse, audible alarm shall be sounded and lamps inside appropriate window shall start flickering. On pressing of "Acknowledge" button the audible alarm shall stop sounding and lamp shall glow steady. By pressing the "Reset" button, the trouble lamp shall not reset unless the alarm condition has disappeared. Annunciator shall provide sealed in lamp indication and audible alarm shall be ready to operate for any new alarm condition immediately after audible alarm is reset for a previous alarm condition.

Cable Termination

- For power cables, cable boxes with cable pot heads/sealing ends shall be provided in the switchgear in a separate compartment to suit the types, sizes of cables shown in cable schedule. Connecting leads of adequate size with terminal clamps/lugs, shall be supplied for connecting cable box terminals to switchgear power terminals.
- For control cable entry to each switchgear cubicle, separate removable type gland plate shall be provided with cable through to lead these cables upto the control terminals. Gland plate and control cable through shall be adequately sized for the number of control and instrument cables emanating from the cubicles.

Space Heater & Receptacle

- Each switchgear cubicle shall be provided with space heater rated for 230 V, single phase, A.C. Supply. The capacity and location of these space heater inside switchgear cubicles shall be such that temperature throughout the cubicle section is maintained at least 5 deg. C above dew point by common thermostats to prevent any moisture condensation. MCB shall be provided inside each switchgear cubicle to control the power supply to the space heaters.
- Each switchgear cubicle shall be provided with one, 3pin receptacle - plug with on-off switch rated for 5 Amps, 240V, 1 phase A.C. supply along with 10W lamp

Internal Wiring

- Switchgear shall be supplied completely wired internally to equipment and terminals and ready for external cable connection at the terminal blocks. All wiring for controls and instruments shall be carried with 1100/660 volts' grade PVC insulated copper conductor wires of minimum size 2.5 Sq.mm. Wire terminations shall be made with solder less, crimping type & copper lugs which firmly grip the conductor and insulation. Engraved core identification yellow colour plastic ferrules marked to correspond with switchgear wiring diagram shall be fitted at both end - terminations of all the cubicle internal wiring.
- Spare contacts of relays, control switches, auxiliary contacts of circuit breakers etc. Shall be wired to terminal blocks. At least 10%

of the terminals shall be provided as spare for future use. Terminal blocks shall be 650 V grade, rated for minimum 15 Amps and complete with insulating barriers, terminal stud, washers, nuts and lock nuts and identification marks. Each terminal shall be suitable to receive 6.0 sq.mm. conductor.

- Control and space heater supplies will be provided at one point in switchgear cubicle for each line up to switchgear. In each cubicle and running the entire length of line up of switchgear, control wiring through shall be provided to carry the interconnecting wires between cubicles and the common control and space heater buses. Also inter-cubicle wiring for interlocks and controls shall be carried out through this wiring through. These wires shall be suitable terminated and tagged between transport sections.
- Potential free contacts shall be provided for each breaker for ON / OFF Trip signal for IBMS system as standard.

Earthing

All vertical panels shall be connected to a copper /GI earth bus bar running throughout the length of the switchboard. The minimum earth bus size shall be 50x6 mm. All doors and movable parts shall be earth educing flexible copper connections to the fixed frame of the switchboard. Provision shall be made to connect the earthing busbar to the platform earthing grid at two ends. All non-current carrying metallic parts of the mounted equipment shall be earthed. The washer used for earthing connection shall be specific type to ensure & good earthing connection.

Name Plate

Suitable engraved white on black name plates and identification labels of metal for all Switchboards and Circuits shall be provided. These shall indicate the feeder number and feeder designation.

Painting

All metal surfaces shall be thoroughly cleaned and degreased to remove mill scale, rust, grease and dirt. Pre-treatment shall be done using 9-11 tank process. The content of the tank shall be regularly checked for concentration and ph value records of this shall be subject to inspection. After pretreatment sheet shall undergo Powder coating to achieve Uniform thickness of 70-120 microns.

Interlocks

It shall not be possible to push "in " a drawn out circuit breaker in closed condition or withdraw a circuit breaker in closed condition.

It shall be possible to operate a circuit breaker only in the defined "Full in" or "Service" and "Test" position inside the panel. It shall not be possible to operate the breaker in intermediate positions while inserting or withdrawing circuit breaker.

Tests

Inspection and shop testing for all panels as per IS Standard shall be offered to consultant/owner's representatives. The tests to be done shall include: Physical checking, Megger/insulation resistance, (1000V Megger), H.V. test Functional tests including control and interlock functions, Automatic operation simulation etc. Any such tests required by local authorities, Electricity Boards and for complying statutory requirements.

MCCB

- MCCBs shall be of microprocessor based with RS 485 port or thermal magnetic as per SLD
- All MCCB's shall be universal mounting line load interchangeable and with door interlock & handle. All MCCB's on Distribution Panels shall be provided with variable setting.
- Door handles will be provided with pad locking arrangement.
- All MCCB's on Main panel shall be provided with shunt release and 2No. + 2NC Auxiliary contact block. All MCCB's shall be provided with suitable spreader links on both sided for bus bar and cable connections.

- All MCCB's shall have clear ON, OFF & TRIP positions.
- MCCB's should comply with IS 13947 part -2, IEC (6094) and IEC 60947-3 & IEC 60947 part – 2.
- The MCCB shall be suitable for universal mounting i.e. the load/line shall be interchangeable with shrouded incoming contacts.
- The MCCB shall be suitable for minimum operating voltage of 415V.
- The thermal setting shall be adjustable from 64 % to 100% of its normal current.
- The magnetic setting shall be adjustable from 3.5 to 10 In (normal current).
- Trip reset should be available Manual / Automatic.
- Isolator switches for electronic circuits to open the MCCB automatically.
- The MCCB's must have transparent label holder to ensure circuit identification.
- The MCCB's must have fully insulated safety shutters.
- Overload Zone adjustable from 0.4 to 1 in with line (For 630 amp & above MCCB)
- Short circuit Zone adjustable from 1.5 to 10 In with time.
- MCCBs encapsulated poles double roto active mechanism to lower the thermal dynamic stresses in the installation.

DATA SHEET (MCCB)

	MLTP Incomer & Breaker in Synchronizing Panel.	MLTP Outgoing Feeder	Other Panel Incomer	Other Panel Outgoing Feeder
Release Type	Microprocessor Based	Based / Thermal Magnetic Based (as per SLD)	Microprocessor Based	Microprocessor Based / Thermal Magnetic Based (as per SLD)
Breaking Capacity	Microprocessor Based	Microprocessor Based	Microprocessor Based (315A to 800A)	TMD
Nos. of Pole	Ics=100% of Icu,	Ics=100% of Icu,	Ics=100% of Icu,	Ics=100% of Icu,
	4 Pole (100 % neutral)	4 Pole (100 % neutral) / 3 Pole (With Neutral CT) as specified SLD	4 Pole (100 % neutral)	4 Pole (100 % neutral) / 3 Pole (With Neutral CT) as specified SLD
	Note: Neutral CT should be provided in case of Ground Protection			
Protection	LSIG	LSIG / TMD as specified SLD	LSIG	LSIG / TMD as specified SLD
Communication Module over Modbus TCP/IP.	RS-485/Modbus TCP/IP Port to monitor	RS-485/Modbus TCP/IP Port to monitor	RS-485/Modbus TCP/IP Port to monitor	RS-485/Modbus TCP/IP Port to monitor (IF REQUIRED)
	1. Cause of Tripping	1. Cause of Tripping-	1. Cause of Tripping	1. Cause of Tripping
	2. Mech. Cycle	2. Mech. Cycle-	2. Mech. Cycle	2. Mech. Cycle
	3. Electrical Cycle	3. Electrical Cycle-	3. Electrical Cycle	3. Electrical Cycle
	4. Contact Wear (%)	4. Contact Wear (%)-	4. Contact Wear (%)	4. Contact Wear (%)
	5. Trip History	5. Trip History-	5. Trip History	5. Trip History
Other	PFC for ON/OFF/TRIP	PFC for ON/OFF/TRIP as	PFC for ON/OFF/TRIP	PFC for ON/OFF/TRIP as

		specified SLD	as specified SLD	specified SLD
Mounting	Universal	Universal	Universal	Universal
Circuit Breakers shall confirm to Electrical Standards	IEC60947-I & II, IS 13947	IEC60947-I & II, IS 13947	IEC60947-I & II, IS 13947	IEC60947-I & II, IS 13947
Rated Operational Voltage: Ue	433V, +10%	433V, +10%	433V, +10%	433V, +10%
Current Rating(In) of Circuit Breaker shall be declared at	500C	500C	500C	500C
Utilisation Category	Class A	Class A	Class A	Class A
Suitable for Isolation	Yes	Yes	Yes	Yes
Operating Principle	Current Limiting	Current Limiting	Current Limiting	Current Limiting
Method of Installation	Fixed	Fixed	Fixed	Fixed
No. of Poles	As mentioned in SLD	As mentioned in SLD	As mentioned in SLD	As mentioned in SLD
Rated Insulation Voltage: Ui at 50 Hz	690V	690V	690V	690V
Rated Impulse withstand Voltage at Main Circuits	8kV	8kV	8kV	8kV
Rated Impulse withstand Voltage at Aux. Circuits	4kV	4kV	4kV	4kV
Short Circuit Making Capacity-Max. Prospective Peak Current	Shall be equal to (Icu X 2.1)	Shall be equal to (Icu X 2.1)	Shall be equal to (Icu X 2.1)	Shall be equal to (Icu X 2.1)
Mechanical Features:				
Three Distinct Positions ON/OFF/TRIP on MCCB	Yes	Yes	Yes	Yes
Flexibility of Connecting load either on TOP or BOTTOM	Yes	Yes	Yes	Yes
Possibility of Interchanging the protection release of MCCB on site	Yes	Yes	Yes	Yes
Extended Rotary Handle with Padlocking Facility	Yes	Yes	Yes	Yes
Door Interlock	Yes	Yes	Yes	Yes

Release Functions				
True RMS Sensing	Required	Required	Required	Required
Overload (L) Protection With Setting	Adjustable	Adjustable	Adjustable	Adjustable
Instantaneous Protection (I)	Adjustable	Adjustable	Adjustable	Adjustable
Integral Test facility for testing healthiness of Release	Required	Required	Required	Required
LED Indication to show % Loading of the release	Required	Required	Required	Required
Thermal Memory	Required	Required	Required	Required
Interlock	As specified in SLD	As specified in SLD	As specified in SLD	As specified in SLD
a) Bowden Wire	-	-	-	-
b) Castel lock provision	Yes	Yes	Yes	Yes
Under Voltage Coil with Continuous Rating and front Accessible	Yes	-	Yes	-
Shunt trip Coil with Continuous Rating and front Accessible	Yes	Yes	Yes	No

Miniature Circuit Breakers (MCB)

- MCB's shall be of current limiting type, ISI marked confirms to IS 8828 – 1996.
- The power loss per pole shall be low and shall be in accordance with IS 8828 – 1996.
- All cable entries shall be either from bottom or top.
- MCB's shall be of C - curve characteristic & shall have quick make & break non-welding self-wiping silver alloy contacts for 10 kA short circuit both on the manual & automatic operation & Should have indication on front face
- All the active, live parts of MCB's should be out of human reach, ensuring safety & confirms to IP: 55 degree of protection.
- The MCB's must house transparent label holder to ensure circuit identification.
- The MCB's must have fully insulated safety shutters.
- The MCB's shall have lockable switching lever.
- The Minimum electrical endurance shall be 20,000 operations.
- The housing of the MCB shall be mounted self-extinguishing DMC (Dough Moulding Compound).
- The short circuit Current shall be brought to zero within 4 to 5 milliseconds from the time they are established.
- All MCB's shall have a minimum short circuit Capacity of 10kA RMS.
- Single Pole / Single pole with Neutral / Double Pole / Triple pole / Four pole: MCB, ISI marked as per IS 8828: 1996 (IEC 60898) with hammer trip and watch mechanism 15 arc plates, 10 KA capacity with nominal rating of 240/415V.

Distribution Board suitable for MCB's (MCBDB)

- Horizontal / Vertical type DB's
- MCBDB suitable for 230 V / 415 V, horizontal/vertical, with door of specified ways (poles), shall be phase segregated type having residual current protection in each phase, surface / flush mounting to house incoming and outgoing MCB's, and erected on iron frame.
- DB's shall be prewired and shall be fabricated as per IS: 8623.

- Suitable for flush mounting & surface mounting, with 100 A copper bus bar (or as specified) (For Horizontal type DB), neutral bar, earth bar & cable ties for cable management.
- In case of Vertical DB, the bus bar shall be of 250 A rating (or as specified)
- DB's shall be of IP – 43 degree of protection with double door arrangement.
- All the MCB distribution boards shall be fabricated out of 18 SWG thick sheet steel duly rust inhibited through a process of degreasing, pickling, phosphating & powder coating to an approved colour over primer & shall be of the totally enclosed dust proof type suitable for wall mounting.
- All components shall be mounted on DIN rails & covered totally with a sheet steel cover rendering it finger-safe. Access to the internal connections shall be only through removing the cover sheet.
- All DB's shall be internally prewired using copper insulated high temperature PVC wires.
- Bus bars & neutral bar shall be fully insulated with standard colour code.
- Bus bar withstanding capacity shall be 10kA.
- DB's must have facility of reversing door without modification, pan assembly for ease of installation & convertible locking.

Residual Current Circuit Breaker (RCCB)

- RCCBs shall be ISI marked as per IS 12640 (part 1) – 2000 and Confirming to IEC 61008-1.
- It shall work on residual current energy, having 30 milliamp sensitivity (or as specified) and shall protect against earth leakage. Tripping time shall be maximum 30 milliseconds (or as specified).
- Breaking capacity shall be 20 kA with hammer trip and watch mechanism 15 arc plates.
- RCCB shall operate for rated leakage at nominal Ten volts AC, and also in both, Neutral Open & Snapping condition.
- RCCBs shall have trip free mechanism with quick make & break non-welding self-wiping silver alloy contacts for 20 KA short circuit current both on the manual & automatic operation. Test knob facility shall be provided.
- All the active, live parts of RCCBs should be out of human reach, ensuring safety & confirms to IP20 degree of protection.
- The RCCBs must house transparent label holder to ensure circuit identification.
- The RCCBs must have fully insulated safety shutters.
- The Minimum electrical endurance shall be 20,000 operations.

Residual Current Circuit Breaker with over voltage cut Off (RCBO)

- RCBO's with integral combination of RCCB+MCB, shall be ISI marked as per IS 12640 (part 1) – 2000 and Confirming to IEC 61008-1. It shall work on residual current energy, having 30 milliamp sensitivity (or as specified) with protection against earth leakage and over voltage upto 290 Volts.
- Tripping time shall be maximum 30 milliseconds (or as specified).
- Breaking capacity shall be 20 kA with hammer trip and watch mechanism 15 arc plates.
- RCCB shall operate for rated leakage at nominal Ten volts AC, and also in both, Neutral Open & Snapping condition.
- RCBO's shall have trip free mechanism with quick make & break non-welding self-wiping silver alloy contacts for 10 kA short circuit both on the manual & automatic operation. Test knob facility shall be provided.
- All the active, live parts of RCBO's should be out of human reach, ensuring safety & confirms to IP20 degree of protection.
- The RCBO's must house transparent label holder to ensure circuit identification.
- The RCBO's must have fully insulated safety shutters.
- The Minimum electrical endurance shall be 20,000 operations.

Surge Protection Devices

- Surge Protection Devices shall compliance according to IEC 61643-11:2012 and EN 61 643-11:2012 electrical installations must be protected against direct lightning and surge impulses with din rail Class I+II/Type 1+2 (10/350 μ s) surge arresters.
- SPDs use MOV technology to allow for high lightning discharge currents, pluggable types avoid ejection of the cartridge during the discharge of the current and non-blow out technology avoids fire risks.
- The SPD must provide either common protection in TNC network or common and differential mode protection in TT and TNS networks according to IEC 61643-11:2012 recommendations.
- Supply, install and connect Surge Protective Devices with the following technical characteristics:
 - Technology: Metal oxide varistors
 - Impulse current wave form 10/350 μ s : $I_{imp} = 25$ kA
 - Maximal discharge current wave form 8/20 μ s : $I_{max} = 60$ kA
 - Nominal discharge current wave form 8/20 μ s : $I_n = 25$ kA
 - Voltage protection level: $U_p \leq 1.5$ kV
 - Nominal voltage: $U_N = 230$ V

- Maximum continuous operating voltage: $U_c = 255 \text{ V}$
- Short circuit withstand = 50 kA
- Integrated thermal disconnecter
- Pluggable cartridge for an easy and quick intervention
- Visual state indicator
- Safety system
- Auxiliary contact
- No electrical consumption on visual state indicator
- Back up protection with Fuse or Circuit breaker: $\leq 125 \text{ A}$;
- Certified standard IEC 61643-11 and EN 61643-11.

Testing & Inspection

- During fabrication, switchgear maybe subject to inspection. Manufacturer shall furnish all necessary information.
- All routine verification and acceptance tests shall be carried out as per IEC 61921, IS 16636:2017, IEC 61439 at manufacturer's work under his care and expense.
- If specifically agreed heat run test may be performed at manufacturer's works. Heat run test shall be performed at least on one incomer and two outgoing vertical panels of the ordered switchboard., shall include the following sections of the bus duct as a minimum:
- Acceptance tests shall be as a general visual check shall be carried out. This shall cover measurement of overall dimension, location, number and type of devices, terminal boxes, location and connection of terminals etc.,
- Manual and electrical operation of Circuit Breakers. / relays shall be checked under the worst conditions of auxiliary supply voltage.
- Dry insulation test with power frequency voltage shall be conducted for the main and auxiliary circuits Insulation resistance of the main and auxiliary circuits and bus duct shall be checked before and after High voltage withstand test.
- Operation check shall be carried out on selected typical feeder/sfor control function /interlock as per the schematic diagrams by manually simulating fault conditions and operation of control switches/relays etc.
- Relays shall be tested with secondary injection test equipment. Breaker trip unit shall be tested using specific breaker test kit.
- For equipment bought from other sub-suppliers, certified test reports of tests carried out at the manufacturers works shall be submitted. Normally all routine tests as specified in the relevant standards shall be conducted by the sub-supplier at his works.

Certification

- All offered equipment shall be of same design as per the type test report and shall have same constructional features and materials as per the type test reports as per IEC 61921, IS 16636:2017-
- Shall have been type tested and witnessed by an authority of international repute, approved by the purchaser. Type test reports shall submitte during technical bid evaluation or during inspection at FAT.
- Shall have been in continuous satisfactory service for similar application.

Manufacturing Facilities

- To ensure timely delivery and adherence to project schedule supplier must have following
- Adequate assembly area to assemble 500 switchboard cubicle in one month.
- CNC press and bending machines in the same facility.
- Paint shop along with permanent 9 – 11 tank pretreatment Plant.
- Adequate Loading & Unloading area.
- Suppliers have routine test equipment
- In-house temperature rise test facilities.
- Quality control documentation and system and processes shall be available for inspection for all the previous and running work orders.

Specific requirements

Vendor is required to make his proposal based on these documents. If there is any deviation or any alternatives must be specifically mentioned in the proposal.

TECHNICAL DATA SHEET

SR No	Parameter	Specification	To be Filled By Contractor
1	Type of Panel	Compartmentalized	
2	Type of Mounting	Free standing Floor Mounted	
3			
4	Fault kA	36kA–1sec	
5	Thickness of CRCA sheets	Structural members - 3mm Covers and doors - 2mm Base channel - ISMC75 Gland plate - 3mm	
6	Painting / Process	Epoxy paint / As per 9 tank process	
7	Paint shade	interior & Exterior: RAL 7032	
8	Details of busbar	Electrolytic grade Aluminium of specified rating	
9	Cable Entry	Bottom / Top as specified in respective drawings	
10	Enclosure Protection / Ventilation	IP –65 with louvers for Ventilation	
11	Control Wiring/ Power Wiring	Insulated 660 Volts Cu wire. Voltage Circuit : 1.5sqmm Current Circuit :2.5sqmm	
12	Cable Lugs / Cable glands	Asr equired	
13	Operating Height	1800mm max	
14	Mounting height of Relays / Meters Control Switches	Range 350mm to 1900mm	
15	Type of C.T.	Cast resin	
16	Reference Ambient Temperature	40 Deg. C	
17			
18	Makes of the components to be used	As per approved make list	
19	Components to be used	As per SLD & specifications	

MAKE OF MATERIAL

SR.NO.	ITEM	STANDARD MAKE
1	LT PANEL BOARDS	APJ ELECTRICAL / ABAK ENGG / ZENITH ENGG.
2	DISTRIBUTION BOARDS	LEGRAND / HAGER / SCHNEIDER
3	MEDIUM VOLTAGE CABLE	RRCABLE / FINOLEX / POLYCAB
4	CABLE TRAY	INDIANA/OBO BETTERMAN/LEGRAND/PROFAB
5	LT SWITCHGEAR (ALL RANGE)	L&T / ABB / SCHNEIDER ELECTRIC / SEIMENS
6	LT MCCB	L&T / ABB / SCHNEIDER ELECTRIC / SEIMENS
7	LT MCB, ELCB	LEGRAND / ABB / L&T / SCHNEIDER ELECTRIC / SEIMENS
8	LT SFU	L&T/ ABB / SCHNEIDER ELECTRIC / SEIMENS
9	LT CONTACTORS	L&T/ ABB / SCHNEIDER ELECTRIC / SEIMENS
10	CHANGE OVER SWITCH	SOCOMEK / HPL / ASCO / ABB / HAGER
11	METERS (DIGITAL)	AE / ENERCON / SCHNEIDER / MECO / NIPPEN
12	LOAD MANAGER	ENERCON / NIPPEN/ L & T
13	RELAYS	SIEMENS / SCHNEIDER ELECTRIC / GE / L & T
14	INDICATING LAMPS	SIEMENS / SCHNEIDER ELECTRIC / L & T / ABB
15	ELECTRIC TIMER	SIEMENS / L&T/ ABB
16	SELECTOR SWITCH	KEYCEE / SALZER / AE
17	LUGS	DOWELLS / JAINSON / COMET
18	TERMIAL BLOCKS	ELMEX/WAGO/CONNECTWELL
19	CABLE GLAND	DOWELLS / JAINSON / COMET
20	PVC CONDUITS AND ACCESSORIES	ASTRAL / PRECISION / DIAMOND / AKG

MAKE OF MATERIAL

SR.NO.	ITEM	STANDARD MAKE
21	M.S. CONDUIT AND ACCESSORIES	AKG / BEC / STEELCRAFT
22	MODULAR SWITCHES, SOCKETS & OTHER ACCESSORIES	MK-HONEYWELL / LEGRAND / SCHNEIDER
23	METAL CLAD SOCKET WITH MCB	MDS / SIEMENS / LEGRAND
24	PVC JUNCTION BOX	SINTEX / CLIPSAL / SPELSBERG
25	WIRES FOR INTERNAL WIRING	POLYCAB / FINOLEX / RRKABLE
26	FLEXIBLE WIRE	POLYCAB / FINOLEX / RRKABLE
27	LIGHT FIXTURES	HAVELLS / WIPRO / CROMPTON