Technical Specification

Civil Works

NOTE: INCASE OF ANY VARIANCE OF TECHNICAL SPECIFICATIONS WITH THE LATEST BIS CODES, RELEVANT LATEST BIS CODES SHALL BE APPLICABLE.

Scope:

This part of the specifications deals with general requirements for earthwork in excavation in different materials, site grading, filling in areas shown in drawings, back filling around foundations, plinths and approach ramps, conveyance and disposal of excess excavated soil or stacking them properly including shoring as directed by the Engineer-in-Charge and all operations covered within the intent and purpose of these specifications.

Applicable Codes:
The provisions of the latest Indian Standards listed below in addition to those mentioned in bid document, but not restricted to, shall form part of these specifications:

IS: 1200: Method of measurement of building and civil engineering Works Part 1: Earth work

IS: 1498: Classification and identification of soil for general Engineering Purposes.

IS:2720 : Method of test for soils (All Parts)

IS:2809 : Glossary of terms and symbols relating to soil engineering

IS:3764 : Safety code for excavation work

IS:4988 : Glossary of terms and classifications of earth moving Machinery (All Parts)

Drawings:
The contractor will furnish wherever in its opinion such drawings are required to show the areas to be excavated/filled, sequence of priorities etc. The Engineer-in-charge will approve the same. The contractor shall follow such drawings strictly.

Classification of earth:

For purpose of earth work, soil shall be classified as under

Loose/soft soil: Any soil which generally yields to the application of picks and shovels, phawras, rakes or any such ordinary excavating implements or organic soil, gravel, silt, sand turf, loam, clay, peat etc. fall under this category.

Soft rock / weathered rock: Any soil which generally, requires the close application of picks, or jumpers or scarifies to loosen it. Stiff clay, gravel and cobble stone etc. fall under this category.

(Note: Cobble stone is the rock fragment usually rounded or semi-rounded having maximum diameter in any one direction between 80 & 300 mm)

Mud: Mud is mixture of ordinary soft soil and water in fluid or weak solid state.

Soft/Disintegrated rock: (Not requiring blasting). This shall include the type of rock and boulders which may be quarried or split with crow-bars. Laterite and hard conglomerates also come under this category.

Hard Rock: (Requiring blasting). This shall include the type of rock or boulder which for quarrying or splitting requires the use of mechanical plant or blasting. (Note: Boulders is a rock fragment usually rounded by weathering, disintegration or abrasion by water or ice having a maximum dimension in any direction of more than 300 mm.

Hard Rock: (Requiring blasting but where blasting is prohibited) Under this category shall fall hard rocks which though normally requires blasting for their removal but blasting is prohibited and excavation has to be done by chiseling, wedging or other suitable method

General:
The contractors shall furnish all tools, plant, instruments qualified supervisory staff, labour, materials, any temporary works, consumables and everything necessary, whether or not such items are specifically stated herein, for completion of the job in accordance with the requirements of specifications.

The contractor shall carry out the survey of the site before excavation and set out properly all utility and service lines and establish levels for various works such as earthwork in excavation for grading, foundations, plinth filling, drains, cable trenches, water pipelines, culverts, retaining walls etc. These will be checked by the Engineer-in-charge or its representative and thereafter recorded plan duly signed by the contractor shall be furnished to the Engineer in charge for its approval before starting actual foundation excavations.

The excavation shall be done to correct lines and levels. This shall include where required, proper strutting & strong shoring to maintain excavation and impart safety against collapse of soil, and erection and maintenance of sand barricades around excavations with warning signs displayed during night for safety purposes. The warning signs shall be with reflectory type paints.

The rates quoted shall include for stacking of excavated material in regular heaps, bunds, rip rap with regular slopes as directed by the Engineer-in-charge within all leads and leveling the same so as to provide natural drainage. Soil excavation shall be properly stacked as directed by the Engineer-in-charge. As a rule all softer materials shall be laid along the centre of the heaps, the harder and more resistant materials, forming the casing on the sides and the top.

Clearing:
The area to be excavated/filled shall be cleared of all fences, trees, tree guard, M.S. grill above road divider and filled up earth in between road divider, plants, logs, stumps, bush, vegetation, grass, brush wood, trees and saplings of girth up to 30 cm measured at a height of 1m above ground level rubbish, slush, road, pavement structure if any required etc. and other objectionable matter. If any roots or stumps of trees are met during excavation, they shall be removed. The material so removed shall be disposed off as directed by the Engineer-in-charge. Where earth fill is intended, the area shall be cleared of all loose or soft patches, top soil containing objectionable matter/materials before filling commences. No separate payment shall be made for such clearing works.

Precious objects, Relics, Objects of Antics etc.
All gold, silver, oil, minerals, archeological and other findings of importance or other materials of any description and all previous stones, coins, treasure traces, relics, antiquities, and similar things which may be found in or upon the site shall be the property of the corporation and the contractor shall dully preserve the same to the satisfaction of the Engineer in charge and from time to time, deliver the same to him.
Excavation for Structures:

Description:
Excavation both manual and mechanical means for structures shall consist of removal of materials for the construction of the foundations of approach structures retaining walls, head walls, and other similar structures in accordance with the requirements of this specification on the lines and dimensions shown on the drawings or as directed by the Engineer-in-charge. The work shall include all necessary sheathing, strutting, shoring, bracing, draining, pumping out of water both manual and mechanical ; proper supporting underground service lines like gas, water pipe, drainage line, electric cables, telephone cables as directed by Engineer-in-charge, and the removal of all logs, stumps, shrubs and other deleterious matter and obstructions etc. necessary for placing the foundations, trimming bottoms of excavation.

Setting out:
After the site has been cleared, the limits of excavation for foundations shall be set out true to lines, and sections as shown oft the drawing or as directed by the Engineer-in-charge. The contractor shall provide all labour, survey instruments and materials such as string, pegs, nails, bamboos, stones, lime mortar, concrete etc., required in connection with the setting out. He shall be responsible for the maintenance of bench marks and other marks and stakes as long as they are required for the work in the opinion of the Engineer-in-charge.

Excavation:

In firm soils, the sides of the trenches shall be kept vertical upto a depth of 2 metres from the bottom. For greater depths, the excavation profiles shall be widened by allowing steps of 50 cms on either side after every 2 metres from the bottom. Alternatively, the excavation can be done so as to give slope of 1:4 (1 horizontal: 4 vertical). Where the soil is soft, loose or slushy, the width of steps shall be suitably increased or sides sloped or the soil shored up as directed by the Engineer-in- Charge. It shall be the responsibility of the contractor to take complete instructions in writing from the Engineer-in-Charge regarding the stepping, sloping or shoring to be done for excavation deeper than 2 metres.

Excavation shall be taken to the width of the lowest step of footing and the sides shall be left plumb where the nature of the soil allows it. Where the nature of the soil or the depth of excavated trench/pit does not permit vertical sides, the contractor at its own expense shall put up necessary shoring, strutting and planking or cut slopes to a safe angle or both with due regard to the safety of personnel including laborers etc. and the works and to the satisfaction of the Engineer-in-charge. Non-compliance of these requirements would amount to negligence on the part of the contractor.

Excavation in hard rock in foundation should be including dressing of area and without blasting but with chipping, chiseling and cutting by jack hammer or by Pneumatic machine.

Dewatering and Protection:
All foundations shall be laid in dry condition. Where water is met with in excavation due to seepage, rain or other reasons, the contractor shall take adequate measures such as bailing, pumping, construction of diversion channels, drainage channels, bunds and any other necessary works to keep the foundation trenches/pits dry to lay foundation and to keep the green concrete/all foundations shall laid in dry protected against damage by or undermine its strength including erosion. In this regard and other details thereof, it shall be left to the choice of the contractor but subject to the approval of the Engineer-in-charge. Approval of the Engineer-in-charge shall however, not relieve the contractor of its responsibility for the adequacy of dewatering and protection arrangements and the safety of the works.

Pumping from inside of any foundation enclosures shall be done in such a manner as to preclude the possibility for the movement of water through any freshly placed concrete. No pumping shall be permitted during the placing of concrete or for any period of at least 24 hours

thereafter. Unless it is done from a suitable sump separated from the concrete work by a water tight wall or similar means.

At the discretion of the contractor and at its cost, cement grouting or other approved methods may be used to prevent or to reduce seepage and to protect the excavation area. The contractor shall take all precautions in diverting channels and in discharging the drained water so as not to cause damage to the works or to adjoining property or hindrances to moving traffic on adjoining roads.

Preparation of Foundation:
The bottom of the foundation shall be leveled both longitudinally and transversely and stepped as directed by the Engineer-in-charge. Before the footing is laid, the surface shall be slightly watered and rammed. In the event of the excavation having been made deeper that than shown on the drawing or as otherwise ordered by the Engineer-in-charge, the extra depth shall be made up with concrete, foundation shall laid in dry of the foundation grade at the cost of the contractor. Ordinary soil filling shall not be used for the purpose to bring the foundation to level as per the design. When rock or other hard strata is encountered it shall be freed of all loose and soft materials cleaned and cut to a firm surface either level, stepped or serrated as directed by the Engineer in charge.

If there are any slips or blows in the excavation these shall be removed by the contractor at his own cost.

Measurement

Will be done in Cubic meter.

Backfilling:
To the extent available, selected surplus soils from the excavation shall be used as backfill as may be directed by the Engineer in charge and after obtaining its concurrence before actually taking any action in the re-use of this excavated stuff from foundation. Fill material shall be free from clods of earth shall be broken or removed. When the excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size mixed with properly graded finer materials consisting of murum or earth to fill up the voids and mixture used for filling.

If any selected fill material is required to be borrowed the contractor shall make arrangement for bringing the material from outside borrow pits. The material sources shall be subject to the prior approval of the Engineer in charge. The contractor shall make necessary access roads to such borrow areas at its own cost, if such access roads do not exist.
Backfilling of the foundation trenches/pits shall be done as soon as foundation work has been completed to the satisfaction of Engineer in charge and measured but not earlier than the full setting period of the concrete or masonry work. Backfilling shall be carried out in such a manner as not to cause undue thrust on any part of the structure. Annular space around foundations shall be back filled with coarse sand after clearing it of all debris and in layers of 200 mm. loose thickness, watered and compacted by vibratory roller to the satisfaction of the Engineer in charge and up to the original surface level. Watering, consolidating, compacting to achieve not less than 97% Modified Proctor density conforming to relevant IS. The remaining back filling shall be done in like manner as aforesaid, using excavated earth if approved or by borrowed earth from approved source.

Measurement
Will be done in Cubic meter.

Disposal of Surplus Excavation Materials:

Item includes disposal of material outside the plot to any lead and lift. Contractor will have to take permission from government authorities for disposal outside the plot in areas assigned by the government. Works include leveling at site of disposal as per requirement of government authorities and to that satisfaction of them.

Measurement
Will be done in Cubic meter.

Measurement and Rates:
The measurement shall be generally conforming to IS:1200 Part I, unless otherwise specified. Measurement for excavation of foundation footings shall be as required for the exact width, length and depth as shown or figured on the drawings or as may be directed by the engineer in charge. If taken to a greater width, length or depth than shown or required, the extra work occasioned thereby shall be done at the contractor's expenses.

The dimensions of the trenches and pits shall be measured correct to the nearest cm. and cubical contents worked out in cubic meters, correct to two places of decimal. Measurements of filling excavated earth or sand in foundations shall be measured for the purpose of payment in cubic meter. The dimensions of the filling shall be measured correct to the nearest centimeters and cubical contents worked out in cubic meters correct to two places of decimal.

Joint measurement for levels taken for all steps like earth, murum, soft rock, hard rock should be available dully signed by contractor and engineer in charge, same to be attached along with bill.

Rate for earth work shall include the following:

(a) Excavation backfilling and disposing surplus earth to desired location as per permission taken from statutory authorities.
(b) Setting out works', profiles etc.
(c) Site clearance such as cleaning of vegetation, shrubs, brushwood etc.
(d) Leaving "Deadmen" or "Tell Tales" and their removal after measurement.
(e) Bailing/pumping out water in excavation from rains, sub soil water etc.
(f) Protection works, temporary supports for safety, by underpinning if need be to existing services, i.e. drains, water mains, cables and other utility services met within the course of excavation. Removal of electricity and / or telephone cables, posts etc. as necessary, shall be arranged by the Engineer in charge.
(g) Forming (or leaving) steps inside deep trenches and their removal:
(h) Removing slips or falls in excavation.
(i) Fencing and/or other suitable measures for protection against risk of accidents, as approved by the Engineer in charge.
(j) Excavation for insertion of planking and strutting where, required.
(k) Backfilling the trenches by selected excavated material available at site.

Measurements:-
Will be done as per IS 1200 - Part 1
Measurement to be done in Cubic meter

	Soil description
1	Soft / Lose soil is soil that can be excavated using pawdra
2	Hard / Dense soil is soil that need pixel or tikau to be used
3	Soft / Disintegrated Rock (Not Requiring Blasting) - Rock or boulders which may be quarried or split with crowbars.

4	Hard rock blasting prohibited required chiseling
5	Hard rock using blasting

	Measurement addition for working space
1	600 mm to be added on each face for working space. If there is any treatment like box type water proofing take measurement from treatment face.
2	For pre-stressing work add 1.5 M on each face
3	For depth exceeding 1 m, an allowance of 50 mm/m depth for each side of trench shall be added to the specified width.

Safety during excavation

Excavation where directed by the Engineer-in-Charge shall be securely barricaded and provided With proper caution signs, conspicuously displayed during the day and properly illuminated with red lights and/or written using fluorescent reflective paint as directed by engineer in charge during the night to avoid accident.

The Contractor shall take adequate protective measures to see that the excavation operations do not damage the adjoining structures or dislocate the services. Water supply pipes, sluice valve chambers, sewerage pipes, manholes, drainage pipes and chambers, communication cables, power supply cables etc. met within the course of excavation shall be properly supported and adequately protected, so that these services remain functional. However, if any service is damaged during excavation shall be restored in reasonable time at the cost of contractor.

Excavation shall not be carried out below the foundation level of the adjacent buildings until under pinning; shoring etc. is done as per the directions of the Engineer-in-Charge for which payment shall be made separately.

Any damages done by the contractor to any existing work shall be made good by him at its own cost. Existing drains pipes, culverts, overhead wires, water supply lines and similar services encountered during the course of execution shall be protected against damage by the contractor. The contractor shall not store material or otherwise occupy any part of the site in manner likely to hinder the operations of such services.

Blasting

Blasting is prohibited and will not be permitted under any circumstances.

Shoring:-

Where ever excavation is done close to adjoining existing structure shoring should be done as per direction of engineer in charge. This is to avoid the existing plinth filling to slide. Shoring to be done by contractor where ever required at its own cost.

CLEANING FOR AREA DEVELOPMENT

- Clearing cutting, removing including uprooting of rank vegetation, grass, brush wood, trees and
- saplings of girth up to 30 cm measured at a height of 1m above ground level and
- Disposing to area allotted by government authorities including debris of any king, brick batts, construction debris, etc
- Including taking all necessary local permission.

Measurement

Will be done in SQ Meter.

FILLING WITH GOOD EARTH OR MURUM

Scope:

This part of the specifications deals with general requirements for earthwork and filling of different materials, filling in areas shown in drawings, back filling around foundations, plinths and approach ramps, conveyance and disposal of excess soil if any or stacking them properly as directed by the Engineer-in-Charge and all operations covered within the intent and purpose of these specifications.

Applicable Codes:

The provisions of the latest Indian Standards listed below in addition to those mentioned in biddocument, but not restricted to, shall form part of these specifications:

IS: 1200:	Method of measurement of building and civil engineering works Part 1: Earth work
IS: 1498:	Classification and identification of soil for general Engineering purposes.
IS:2720 :	Method of test for soils (All Parts)
IS:2809 :	Glossary of terms and symbols relating to soil engineering
IS:3764 :	Safety code for excavation work
IS:4988 :	Glossary of terms and classifications of earth moving Machinery (All Parts)

Filling in with Good Earth or Murum

The earth or murum, whenever required to be supplied by the Contractors for filling in the low lying ground and wells or in the embankment of the road, shall be dry, friable, and free from mud sludge's, vegetable matter or rotten material of any kind, or material likely to decay and of a quality to be approved by the Engineer. All big lumps or clod shall be broken before spreading the earth or murum on the ground. Testing to be done for material used for filling as per IS and approval to be taken from engineer in charge.

The filling in of wells and low-lying grounds shall be done in such layers as may be directed from time to time by the Engineer, and no fresh layer shall be allowed to be put on unless the previous one is properly spread, trimmed, leveled, and thoroughly consolidated by rammers or rollers, as the case may be, or as may be ordered by the Engineer.

The embankment shall be raised in regular layers slightly concave in section, beginning from the bottom and gradually raised to the full height, layer by layer not exceeding 230 mm. in thickness in a loose state. Each layer shall be thoroughly consolidated by watering where necessary and rolling it with an approved steam or diesel roller before the next layer is put on. The rolling and consolidation should be done to the entire satisfaction of the Engineer and no

rubble packing or metal should be laid on it until the Engineer is satisfied that the earthwork has been thoroughly consolidated and written certificate is given to them effect by the Engineer.

The rates for embankment or filling in with Contractors earth or murum shall include the cost of materials, fencing, lighting, watching haulage, spreading, leveling, watering, rolling and consolidating.

All extra filling above the required level will have to be removed by the contractor free of cost.

Compaction on Earth or Murum

1. Compaction is carried out using rolling. For ordinary consolidation of soft stone, 8 to 10 tonnes roller is good.

2. Rolling should commence at the edges and progress towards the center except in super elevated portions where it should proceed from the inner edge to outer. Each pass of the roller should uniformly overlap not less than one third of the track made in the preceding pass. The number of passes required of a roller to give good compaction of any material should also be determined by actual test at site.

3. The types of roller that can be used are pneumatic tyred, vibratory rollers etc and should be operated at the minimum speed while consolidating base and soling courses.

4. For clayey soils, sands the weight of rollers that can be used are 8 to 10 Tonnes, 20 cm will be the maximum thickness of loose material that can be compacted while 10 to 18% moisture content has to be maintained. Watering, consolidating, compacting to achieve not less than 97% Modified Proctor density conforming to relevant IS.

Tests on Earth or Murum

1. The density / moisture content of a soil needs to be determined using various tests.
2. The water content of the soil is determined by methods like oven drying, Pycnometer, sand bath methods etc.

Range of Optimum Water Content

Sand	Sandy Silt or silty sand	Silt	Clay
6 to 10 %	8 to 12 %	12 to 16 %	14 to 20 %

1. There are many field methods used for measuring compaction such as Core cutter method, Sand replacement method etc.
2. Proctor Density test is made to determine the moisture content at which the soil should be compacted to obtain the maximum dry density and the dry density likely to be achieved by compaction in the field. The dry unit weight achieved in the field using field tests are is compared with the maximum dry unit weight obtained in the standard proctor test. The dry unit weight of the order of 95% of the maximum dry unit weight of the standard proctor test needs to be achieved.
3. The methods of tests carried out for soils shall be strictly as per the IS 2720.

Frequency of compaction test

Contractor to carry one sample of 3 specimens for every 200 Sq. m for each layer.

Measurement

Will be done in Cubic Metre and initial and final levels will be duly signed by contractor and engineer in charge.

WET MIX MACADAM (WMM) SUB-BASE/BASE

Scope

This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared subgrade/sub-base/base or existing pavement as the case may be in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as necessary to lines, grades and cross-sections shown on the approved drawings or as directed by the Engineer-in-charge.

The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75 mm. When vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the subbase course may be increased to 200 mm upon approval of the Engineer-in-charge.

Materials

Aggregates

Physical requirements

Coarse aggregates shall be crushed stone. If crushed gravel/shingle is used, not less than 90 per cent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements set forth in Table **16.46** below.

If the water absorption value of the coarse aggregate is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS:2386(Part-5).

TABLE 16.46 PHYSICAL REQUIRMENTS OF COARSE AGGREGATES FOR SUB-BASE/BASE COURSES

	Test	Test Method	Requirement
1.	Los Angeles Abrasion value or	IS:2386 (Part-4)	40 per cent (Max.)
	Aggregate impact value	IS:2386 (Part-4) or IS:5640	30 per cent (Max.)
2.	Combined Flakiness and Elongation indices (Total)	IS:2386 (Part-1)	35 per cent (Max.)*

* To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total non-flaky particles. The value of flakiness index and elongation index so found are added up.

16.63.2.1.2. Grading requirements :

The aggregates shall conform to the grading given in Table **16.47 below**.

TABLE 16.47 GRADING REQUIREMENTS OF AGGREGATES FOR WET MIX MACADAM

IS Sieve Designation	Per cent by weight passing the IS sieve
53.00 mm	100
45.00 mm	95-100

26.50	mm	---
22.40	mm	60-80
11.20	mm	40-60
4.75	mm	25-40
2.36	mm	15-30
600.00	micron	8-22
75.00	micron	0-5

Materials finer than 425 micron shall have Plasticity Index (PI) not exceeding 6.

The final gradation approved within these limits shall be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa.

Construction Operations

Preparation of base :

The surface of the sub grade / sub base / base to receive the Wet Mix Macadam shall be prepared to the specified lines and crossfall (Camber) as necessary and made free of dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled with 80-100 kN smooth wheeled roller until firm surface is obtained if necessary by sprinkling water. Weak places shall be strengthened, corrugations removed and depressions and pot holes made good with suitable materials, before spreading the aggregate for WMM.

Where the existing surface over which the sub base of WMM is to be laid is black topped, to ensure effective internal drainage, furrows 50 mm x 50 mm (depth of furrows increased to reach bottom of bituminous layer where necessary) at one metre intervals shall be cut in the existing bituminous surface at 45 degrees to the central line of the carriageway at one metre intervals in the existing road before the WMM is laid.

Provision of lateral confinement of aggregates:

While constructing wet mix macadam, arrangement shall be made for the lateral confinement of wet mix. This shall be done by laying materials in adjoining shoulders along with that of wet mix macadam layer.

Preparation of mix:

Wet Mix Macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled, addition of water and forced/positive mixing arrangement like pugmill or pan type mixer of concrete batching plant. For small quantity of wet mix work, the Engineer may permit the mixing to be done in concrete mixers.

Optimum moisture for mixing shall be determined in accordance with IS:2720 (Part-8) after replacing the aggregate fraction retained on 22.4 mm sieve with material of 4.75 mm to 22.4 mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limits.

The mixed material should be uniformly wet and no segregation should be permitted.

Spreading of mix :

Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared subgrade/sub- base/base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread either by a paver finisher.

The paver finisher shall be self-propelled of adequate capacity with the following features:

(i) Loading hoppers and suitable distribution system. So as to provide a smooth uninterrupted material flow for different layer thickness from the tipper to the screed.

(ii) Hydraulically operated telescopic screed for paving width upto 8.5 metre and fixed screed beyond this. The screed shall have tamping and vibrating arrangement for initial compaction of the layer.

(iii) Automatic leveling control system with electronic sensing device to maintain mat thickness and cross slope of mat during laying procedure. In exceptional cases where it is not possible for the paver to be utilized mechanical means like motor grader may be used with the prior approval of the Engineer-in-charge. The motor grader shall be capable of spreading the material uniformly all over the surface.

The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate may be required. The layer may be tested by depth blocks during construction. No segregation of larger and fine panicles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

The Engineer-in-charge may permit manual mixing and / or laying of Wet Mix Macadam, where small quantity of WMM is to be executed. Manual mixing / layhing in inaccessible / remote locations and in situations where use of machinery is not feasible can also be permitted. Were manual mixing / laying is intended to be used, the same shall be done with the approval of the Engineer-in-charge.

Compaction:

After the mix has seen laid to the required thickness, grade and crossfall/camber the same shall be uniformly compacted, to the full depth with suitable roller. If the thickness of single compacted layer does not exceed 100 mm, a smooth wheel roller of 80 to 100 kN weight may be used. For a compacted single layer upto 200 mm, the compaction shall be done with the help of vibratory roller

of minimum static weight of 80 to 100 kN with an arrangement for adjusting the frequency and amplitude. An appropriate frequency and amplitude may be selected. The speed of the roller shall not exceed 5 km/h.

In portions having unidirectional cross fall/superelevation, rolling shall commence from the lower edge and progress gradually towards the upper edge. Thereafter, roller should progress parallel to the centre line of the road, uniformly over-lapping each preceding track by at least one-third width until the entire surface has been rolled. Alternate trips of the roller shall be terminated in stops at least 1 m away from any preceding stop.

In portions in camber, rolling should begin at the edge with the roller running forward and backward until the edges have been firmly compacted. The roller shall then progress gradually towards the centre parallel to the centre line of the road uniformly overlapping each of the preceding track by at least one-third width until the entire surface has been rolled.

Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good.

Along forms, kerbs, walls or other places not accessible to the roller, the mixture shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin patching of an area without scarifying the surface to permit proper bonding of the added material shall not be permitted.

Rolling should not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the sub-base/base course or subgrade. If irregularities develop during rolling which exceed 12 mm when tested with a 3 metre straight edge, the surface should be loosened and premixed material added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and crossfall. In no case should the use of unmixed material be permitted to make up the depressions.

Rolling shall be continued till the density achieved is at least 98 per cent of the maximum dry density for the material as determined by the method outlined in IS: 2720 (Part-8)

After completion, the surface of any finished layer shall be well-closed, free from movement under compaction equipment or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and recompacted.

Setting and drying: After final compaction of wet mix macadam course, the road shall be allowed to dry for 24 hours.

Horizontal Alignment

Horizontal alignments shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriage way as constructed shall be correct within a tolerance of ± 10 mm there from. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be ± 25 mm.

Surface Levels

The levels of the Sub-base / base course as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer-in-charge beyond the tolerances mentioned as below:

TOLERANCES IN SURFACE LEVELS OF WMM

Sub-base	
(a) Flexible pavement	± 10 mm
(b) Concrete pavement	± 06 mm
Base course flexible pavement	
(a) Bituminous Base / Binder Course	± 06 mm
(b) Granular	
(i) Machine laid	± 10 mm
(ii) Manually laid	± 15 mm

For checking compliance with the above requirement for sub-base / base courses, measurements of the surface levels shall be taken on a grid of points placed at 6.25 m longitudinally and 3.5 m transversely.

The longitudinal profile shall be checked with a 3 metre long straight edge / moving straight-edge as desired by the Engineer-in-charge at the middle of each traffic lane along a line parallel to the centre line of the road.

Measurements

Wet Mix Macadam shall be measured as finished work in position in cubic metres. The length and breadth shall be measured to the nearest centimetre. The depth of consolidated layer shall be computed to nearest half centimetre by taking average of depths at the centre and at 30 cm from the left and right edges at a cross section taken at 100 metre interval or less as decided by the Engineer in-Charge by making small pits. The consolidated cubical contents shall be calculated in cubic metres correct to two places of decimal.

Rates

The contract unit rate for Wet Mix Macadam shall be payment in full for carrying out the required operations including all labour, tools, equipment's machinery and incidentals to complete the work to the specification as described above.

PASSIVE ROCK ANCHORS (15 TONS CAPACITY) FOR UPLIFT RESISTANCE

1.0. Drilling of Anchor Holes

Drilling of 150mm diameter hole for 2.5m long anchors in rock swill be completed pneumatic methods (DTH method with air compressor) as per installation pattern, sizes and lengths provided in drawings. Drilling will commence from top of PCC level.

Borehole sides shall be adequately protected against side collapse by use of temporary Casing up to hard rock.

The deviation of the anchor hole entry angle from its verticality shall be no greater than + 3 degrees.

2.0. Anchor Reinforcement

1 nos. of CRS steel bars of 32mm diameter (Fe 500) conforming to IS 1786 as per drawings will be cut to length of complete anchor including that required for development length (60D) in raft/footing portion. These 2 bars shall be bundled by providing tack welding at every 1m c/c. Bars are to be taken up to top of raft/footing.

Centralizers or spacers shall be utilized to position the CRS steel bar so a minimum cover of 40mm to reinforcement bar is achieved.

3.0. Primary Grouting of Anchors

The grout shall entirely fill the annular space between the CRS steel bar and the borehole wall.

Gravity grouting through grout pipe (min. 25mm dia.) will be done with neat cement grout with non-shrink compound CEBEX 200 or equivalent.

Minimum grout strength of 25N/mm2 at 28 days shall be achieved.

Three (3) grout cubes (7.06cm x 7.06cm x 7.06cm) will be cast for each day of grouting. One cube will be tested at 7 days while the remaining cubes will be tested at 28 days.

4.0. Testing of Anchorage

At least 1.5% of the total rock anchors shall be proof tested to 1.1 times the design load. The load will be held at the final test load for at least 10 minutes.

A jack of adequate capacity should be utilized for testing the anchors. Elongation should be measured at final load.

The anchor can be deemed acceptable upon proof testing if the below condition is satisfied:

i) Total drop in pressure is less than 10% at final load in 10 minutes of holding time.

EXPANSION JOINT BOARD

Scope

Providing and fixing 25 mm thickness of Pre-molded compressible filler board (Dura board HD 100) in black color, conforming to highway clause 1015 having minimum density of 100±5 Kg/m3, water absorption less than 0.09Kg/m2 and compression recovery of 93%. The product should be non-deteriorating and non-staining.

Material

Material should be of Supreme or equivalent make sample to be approved by the engineer in charge.

Procedure

- The area where the board is to be fixed should be thoroughly cleaned
- The boards are to be cut as per the thickness and fixed at the desired location using liquid bitumen by applying the same to the surface and then sticking the board to it.
- The top of the board is to be kept 10 to 15mm below the concrete surface.
- This gap is to be filled by using polysulphide sealant.

Measurement

Measurement to be done in Square Meter.

GP2 GROUTING

Scope

Grouting gap between structural steel base plates of column and RCC column pedestal and also grouting of anchor bolts with GP2 of Fosroc or equivalent make.

Application

All surfaces should be free from dirt, dust, grease, oils, and other contaminants.

Surfaces should be pre-wetted/ saturated with clean water for 4 to 6 hours; free surface water should be removed before grouting with GP2.

Mixing

Add GP2 powder to potable water in the ratio recommended for its consistency. Approximate ratios are as per below

Flow able Grout: Water/25kg grout bag 4.25 L
Plastic Grout: Water/25kg grout bag 3.25 L

-Manual mixing is not at all recommended. Use mechanical mixer like paddle or revolving drum type. Full 5 minutes mixing to get homogeneous consistency is required. Fluid grout should be placed within 20/30 minutes. In gelled material no further addition of water is allowed and should be discarded.

Placement
Pouring head should be used for base plate grouting. For holding down bolt in 10 cm and above diameter hole or grout bed exceeding 80 mm thickness well graded clean aggregate from 5 mm to 15 mm in saturated surface dry condition may be used along with grout up to 25 to 30% of grout weight.
Edge finish/Curing
Plastic grout may be used for edge finish. Exposed edges after 8 hours of grouting should be kept under steel plate up to 24 hours and then normal curing with wet hessian or ponding may be carried out.

Measurement
Measurement will be done in KG and contractor to maintain consumption records. All records to be dully signed by the engineer in charge.

STRUCTURAL STEEL

Material Specification

Scope
Providing, fabrication and fixing of steel work in M.S. angles channel, Pipes. box section, R.S. beams, flats, plates , insert plates, etc. as per details at any height including all labor and material with hoisting in position, fixing with bolts and nuts or by welding, scaffolding, applying two coat of zinc chromate primer and two coat synthetic enamel paint etc. complete as directed by engineer in charge.

General requirements relating to supply of structural steel shall conform to IS 8910.

All finished materials shall be well and cleanly rolled to the dimensions, sections and masses specified. The finished material shall be reasonably free from surface flaws; laminations; rough/ jagged and imperfect edges and all other harmful defects.

Minor surface defects may be removed by the manufacturer/supplier by grinding provided the thickness is not reduced locally by more than 4 percent below the minimum specified thickness.

Material quality
Only TATA, SAIL or JINDAL steel to be used for structural steel work no re rolled steel will be allowed.

Testing of material
The structural steel each lot should be tested for all chemical and physical tests from external government approved laboratory apart from the test certificates received for the vendor. The cost for sample preparation and testing to be included in the rates quoted no extra payment will be done for the same
Rivets and bolts needs to be tested for slip test.

Testing frequency
Testing to be carried out for every truck load for all different material received three numbers of each material received to be tested for both Physical and chemical test form a NABL certified laboratory

Rivets and bolts needs to be tested for each lot received at site.

Rivets
Rivets shall be made from rivet bars of mild steel as per IS 1148.

Bolts
These are of two types namely turned and fitted bolts and black bolts. Turned & fitted bolts are turned to exact diameter in automatic lathe. For these bolts, whether reamed or drilled bolts, the same unit stresses are allowed as for rivets. In case of black bolts which are not finished to exact sizes, a lower working stress other than for turned bolts is adopted. They shall conform to IS 1367 – Technical supply conditions for threaded steel fasteners.

Electrodes
The electrodes required for metal arc welding shall be covered electrodes and shall conform to IS 814. Make to be Advani, Essar only.

Laying Out
A figure of the steel structure to be fabricated shall be drawn on a level platform to full scale. This may be done in full or in parts, as shown on drawings or as directed by the Engineer-in-Charge. Steel tape shall be used for measurements.

Fabrication using rivets and bolts
Fabrication shall generally be done as specified in IS 800. In major works or where so specified, shop drawings giving complete information for the fabrication of the component parts of the structure including the location, type, size, length and details or rivets, bolts or welds, shall be prepared in advance of the actual fabrication and approved by the Engineer-in-charge. The drawings shall indicate the shop and field rivets, bolts and welds. The steel members shall be distinctly marked or stenciled with paint with the identification marks as given in the shop drawings.

Great accuracy shall be observed in the fabrication of various members, so that these can be assembled without being unduly packed, strained or forced into position and when built up, shall be true and free from twist, kinks, buckles or open joints.

Wooden or metal sheet templates shall be made to correspond to each member, and position of rivet holes shall be marked accurately on them and holes drilled. The templates shall then be laid on the steel members, and holes for riveting and bolting marked on them. The ends of the steel members shall also be marked for cutting as per required dimensions. The base of steel columns and the positions of anchor bolts shall be carefully set out at the required location.

The steel section shall be straight or to be straightened or flattened by pressure unless required to be of curvilinear form and shall free from twists. These shall be cut square either by shearing or sawing to correct length and measured by steel tape. No tow pieces shall be welded or joined to make up for the required length of member.

Making Holes
Holes through more than one thickness of materials for members, such as compound stanchion and girder flanges shall, where possible, be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, provided the holes are punched 3mm less in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall be not greater than 16 mm.

Rivet Holes
The diameter for rivets and black bolts holes shall be taken as the nominal diameter of a rivet/ black bolts plus 1.5 mm for rivets/ bolts of nominal diameter less than or equal to 25 mm" and 2.0 mm for rivets of nominal diameter exceeding 25 mm, unless specified otherwise. Holes for turned and fitted bolts shall be drilled or reamed large by 0.2 to 8 mm depending upon the dia. of bolts.

Holes shall have their axis perpendicular to the surface bored through. The drilling or reaming shall be free from burrs, and the holes shall be clean and accurate. Holes for rivets and bolts shall not be formed by gas cutting process. Holes for counter sunk bolts shall be made in such a manner that their heads sit flush with the surface after fixing.

Assembly
Before making holes in individual members, for fabrication and steel work intended to be riveted or bolted together shall be assembled and clamped properly and tightly so as to ensure close abutting, or lapping of the surfaces of the different members. All stiffeners shall be fixed (or placed) tightly both at top and bottom without being drawn or caulked. The abutting joints shall be cut or dressed true and straight, and fitted close together.

Web plates of girders, which have no cover flange plates, shall have their ends flush with the tops of angles unless otherwise required. The web plate when spliced, shall have clearance of not more than 5mm. The erection clearance of cleated ends of members connecting steel to steel shall preferably be not greater than 1.5 mm. The erection clearance at the ends of beams without web cleats shall not be more than 3 mm at each end but where for practical reasons, greater clearance is necessary, seating designed suitably shall be provided.

Column splices and butt joints of struts and compression members requiring contact for stress Transmission shall be accurately, machined and close butted over the whole section. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc. after riveting together shall be accurately machined so that the parts connected, butt against each other over the entire surfaces of contact. Connecting angles or channels shall be fabricated and placed in position with great accuracy so that they are not unduly reduced in thickness by machining.

The ends of all bearing stiffeners shall be machined or grounded to fit tightly both at top and bottom.

Riveting:
Rivets shall be used, where slip under load has to be avoided.

Preliminaries before Riveting:-
Members to be riveted shall have all parts firmly placed and held together before and during riveting, and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

Process of Riveting
The riveting shall be carried out by using machines of the steady pressure type. However, where such facilities are not available hand riveting may be permitted by the Engineer-in-charge. The rivets shall be heated red hot, care being taken to control the temperature of heating so as not to burn the steel. Rivets of diameter less than10mm may be driven cold. Rivets shall be finished neat with heads full and of equal size. The heads shall be central on shanks and shall grip the assembled members firmly.

All loose, burnt, or badly formed rivets with eccentric or deficient heads shall be cut out and replaced. In cutting out rivets, care shall be taken so as not to injure the assembled members. Caulking and recapping shall not be permitted.

For testing rivets, a hammer weighing approx. 0.25 kg shall be used and both heads of the rivet (Specially the machine head) shall be tapped. When so tested, the rivets shall not give a hollow sound and a jar where so specified, other tests shall be carried out to ensure the soundness of rivets. All rivets heads shall be painted with approved steel primer paint within a week of their fixing.

Bolting

The nominal length of the bolt shall be the distance from the underside of the head to the further end of the shank. The nominal diameter of the bolt shall be the diameter at the shank above the screwed threads. Bolts, nuts and washers shall be thoroughly cleaned and dipped in double boiled linseed oil, before use. All bolts heads and nuts shall be hexagonal unless specified otherwise. The screwed threads shall conform to IS 1363 and the threaded surface shall not be tapered. The bolts shall be of such length as to project at least two clear threads beyond the nuts when fixed in position, and these shall fit in the holes without any shake. The nuts shall fit in the threaded ends of bolts properly.

Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project through the nut at least two thread. In all cases where the full bearing area of the bolt is to be developed, the bolt shall be provided with a washer of sufficient thickness under the nuts to avoid any threaded portion of the bolt being within the thickness of the parts bolted together.

Where there is a risk of the nuts being removed or becoming loose due to vibrations or reversal of stresses, these shall be secured from slackening by the use of lock nut, spring washers as directed by the Engineer-in-charge.

Erection

Steel members shall be hoisted and erected in position carefully, without any damage to itself, other structures and equipment and injury to workmen. The method of hoisting and erection proposed to be adopted by the contractor shall be got approved from the Engineer-in-charge in advance. The contractor however shall be fully responsible for the work being carried out in a safe and proper manner without unduly stressing the various members and proper equipment such as derricks, lifting tackles, winches, ropes etc. shall be used.

The work of erection may be done in suitable units as may be directed by the Engineer- in charge.

Fabricated members shall be lifted at such points so as to avoid deformation or excessive stress in members. The structure or part of it placed in position shall be secured against over-turning or collapse by suitable means. During execution, the steel members shall be securely bolted or otherwise fastened when necessary temporarily braced to provide for all loads including those due to erection equipments and its operation to be carried safely by structure during erection. The steel members shall be placed in proper position as per approved drawing, final riveting or permanent bolting shall be done only after proper alignment has been checked and confirmed.

Trusses shall be lifted only at nodes. The trusses above 10 m in span shall not be lifted by slinging at two mid points of rafters, which shall be temporary braced by a wooden member of a suitable section. After the trusses are placed in position, purlins and wind bracings shall be fixed as soon as possible.

The end of the truss which faces the prevailing winds shall be fixed with holding down bolts, and the other end kept free to move. In case of trusses of spans upto 10m the free end of the truss shall be laid on lead sheet or steel plate as per design, and the holes for holding down bolts shall be made in the form of oblong slots so as to permit the free movements of the truss end. For larger spans the truss shall be provided with proper bearing as per design.

Columns and stanchions shall be erected truly vertical with the necessary cross bracing etc. and the base shall be properly fixed with the foundation concrete by means of anchor bolts etc. as per drawing.

Anchor bolts to be placed in the concrete foundation should be held in position with a wooden template. At the time of concreting anchor bolt locations shall be provided with suitable timber mould or pipe sleeve to allow for adjustment which shall be removed after initial setting of concrete. The spaces left around anchor bolts shall be linked to a stopping channel in the concrete leading to the side of the pedestal and on the underside of the base plate to allow the spaces being grouted up after the base plate is fixed in the position along with the column footing. Grouting shall be of cement mortar 1:3 (1 cement: 3 coarse sand) or as specified.

Bedding of Column, Stanchions etc

Bedding shall not be carried out until the steel work has been finally leveled, plumbed and connected together. The stanchion shall be supported on steel wedges and adjusted to make the column plumb. For multi storied buildings, the bedding shall not be done until sufficient number of bottom lengths of stanchions have been properly lined, leveled and plumbed and sufficient floor beams are fixed in position. The base plates shall be wedged clear of the bases by M.S. wedges and adjusted where necessary to plumb the columns. The gap between the plate and RCC should be grouted using GP2.

Welded Joints

Welding shall generally be done by electric arc process as per IS 816 and IS 823. The electric arc method is usually adopted and is economical. Where electricity for public is not available generators shall be arranged by the contractor at its own cost unless otherwise specified. Gas welding shall only by resorted to using oxyacetylene flame with specific approval of the Engineer-in-charge. Gas welding shall not be permitted for structural steel work Gas welding required heating of the members to be welded along with the welding rod and is likely to create temperature stresses in the welded members. Precautions shall therefore be taken to avoid distortion of the members due to these temperature stresses.

The work shall be done as shown in the shop drawings which should clearly indicate various details of the joint to be welded, type of welds, shop and site welds as well as the types of electrodes to be used. Symbol for welding on plans and shops drawings shall be according to IS 813. As far as possible every effort shall be made to limit the welding that must be done after the structure is erected so as to avoid the improper welding that is likely to be done due to heights and difficult positions on scaffolding etc. apart from the aspect of economy. The maximum diameter of electrodes for welding work shall be as per IS 814. Joint surfaces which are to be welded together shall be free from loose mill scale, rust, paint, grease or other foreign matter, which adversely affect the quality of weld and workmanship.

Precautions
All operation connected with welding and cutting equipment shall conform to the safety requirements given in IS 818 for safety requirements and Health provision in Electric and gas welding and cutting operations.

Inspection
Inspection and testing of welds shall be as per IS 822.

Assembly
Before welding is commenced, the members to be welded shall first be brought together and firmly clamped or tack welded to be held in position. This temporary connection has to be strong enough to hold the parts accurately in place without any disturbance. Tack welds located in places where final welds will be made later shall conform to the final weld in quality and shall be cleaned off slag before final weld is made.

Erection
While erecting a welded structure adequate means shall be employed for temporary fastening the members together and bracing the frame work until the joints are welded. Such means shall consists of applying of erection bolts, tack welding or other positive devices imparting sufficient strength and stiffness to resist all temporary loads and lateral forces including wind. Owing to the small number of bolts ordinarily employed for joints which are to be welded, the temporary support of heavy girders carrying columns shall be specially attended.

Different members which shall be fillet welded, shall be brought into as close contact as possible. The gap due to faulty workmanship or incorrect fit if any shall not exceed. 1.5 mm if gap exceeds 1.5 mm or more occurs locally the size of fillet weld shall be increased at such position by an amount equal to the width of the gap.

Cleaning
In the workshop of the contractor: blast cleaning with sand of grit.
On site, when plant is in normal operation: blast cleaning is not admitted unless if method of blasting is dust free. The production of lubricants cannot admit that sand dust or grid dust is absorbed in the product.

Alternative cleaning methods should be applied (water cleaning or hydro jetting, wire rushing, disc sanding, Needle hammering)

On all blasted surfaces shall a primer coating been applied and this within a maximum delay of 4 to 6 hours after blasting. During blasting and until the primer is applied the relative humidity shall not exceed 85 %.

Special requirement for pipes, flanges: the interior of the pipes shall be free of any sand or grid or other foreign matters after applying of the primer on the exterior of the pipes. In practices, the contractor shall take measures to avoid the entrance of any sand or grid or other foreign matters in the interior of the pipes during blasting.

Painting
All surfaces which are to be painted, oiled or otherwise treated shall be dry and thoroughly cleaned to remove all loose scale and loose rust. Surfaces not in contact but inaccessible after shop assembly, shall receive the full specified protective treatment before assembly. This does not apply to the interior of sealed hollow sections. Part to be encased in concrete shall not be painted or oiled.

Two coat of zinc chromate primer and two coat synthetic enamel paint.

Paint make should be of Asian paints or Berger or equivalent. Make to be approved by Engineer in charge before purchasing by contractor.

Measurement:
Measurement will be in KG or MT. Unit weight of members to be taken from IS steel table only.

Rate will be including procurement, welding, bolting, riveting, Erecting and painting complete.

STEEL REINFORCEMENT

BENDING OF REINFORCEMENT

Scope

Providing and fixing in position CRS steel conforming to IS : 432 / 1786 reinforcement of any dia. and grade Fe 500 or FE 500 D for all RCC members as per detailed drawings and schedules including cutting, bending, hooking the bars binding with wires as required including

all lead and lift etc. complete. (Binding wire shall be of 1.6 mm diameter or 16 SWG Annealed wire) soft drawn, annealed with chair supports including cost of transporting, decoiling and straightening of bars as per specifications. Including welding of bars where ever required. Binding wire shall not be measured for payment)

No re rolled steel will be allowed for construction.

Note:- Reinforcement for all heights. All reinforcement should be free of dust

Material

Corrosion Resistant Steel (CRS) Bars.

The CRS to be used in reinforced concrete work shall be of tested quality and shall comply with the requirements of Indian Standard Specification No. IS: 1139 or 1786 as amended from time to time. If the result of the test made in accordance with the provisions of the IS does not comply with the specifications the Consultants will reject the lot or lots from which the sample or samples were taken and the same shall not be used in the works, but, shall be removed there from and the work already executed with such powers may be ordered to be demolished. All other requirements for these reinforcement bars shall be same as these mentioned for mild steel reinforcement from approved source.

Reinforcing steel shall conform accurately to the dimensions shown on relevant drawings and Only TATA or SAIL material to be used. No re rolled steel would be allowed. HYSD steel conforming to IS: 432 / 1786 reinforcement of any dia. and grade Fe 500 of FE 500 D for all RCC members to be used.

Bars shall be bent cold to the specified shape and dimensions or as directed by the Engineer-in-charge using a proper bar bender, operated by hand or power to attain proper radii of bends. Bars shall not be bent or straightened in a manner that will injure the material. Bars beat during transport or handling shall be straightened before being used on work; they shall not be heated to facilitate bending. Unless otherwise specified, a U type hook at the end of each bar shall invariably be provided. The hook shall be of required as specified in IRC code of practices. In case of deformed or bars which are not round, the diameter shall be taken as the diameter of a circle having an equivalent effective area. The deformed bar shall have standard L hooks when under tension. The hook shall be suitably encased with adequate concrete cover to prevent any splitting of the concrete.

Before cutting and bending a full scale sketch shall be drawn on a leveled platform and lengths measured before cutting.

Testing of material

The structural steel each lot should be tested for all chemical and physical tests from external government approved laboratory apart from the test certificates received for the vendor. The cost for testing to be included in the rates quoted no extra payment will be done for the same

Testing frequency

Testing to be carried out for every truck load for all different diameter of steel received 3 nos of each bars to be tested for both physical and chemical test from NABL certified laboratory.

PLACING OF REINFORCEMENT

All reinforcing bars shall be accurately placed in the exact position shown on the drawings, and shall be securely held in position during placing of concrete by annealed binding wire not less than 1.6 mm diameter or 16 SWG Annealed wire and conforming to IS: 280, and by using stays, concrete blocks of same strength of concrete or metal chairs, spacers, metal hangers, supporting wires or other approved devices at sufficiently close intervals. Bars will not be

allowed to sag between supports nor displaced during concreting or any other operation over the work. All devices used for positioning shall be of non-corrodible material Wooden and metal supports will not extend to the surface of concrete, except where shown on the drawings. Placing bars on layers of freshly laid concrete as the work progresses for adjusting bar spacing will not be allowed. Pieces of broken stone, brick or wooden blocks shall not be used. Layers of bars shall be separated by spacer bars, precast concrete blocks of same strength of concrete or other approved devices only.

Reinforcement after being placed in position shall be maintained in a clear condition until completely embedded in concrete. Special care shall be exercised to prevent any displacement of reinforcement in concrete already placed.

To protect reinforcement from corrosion, concrete cover shall be provided as indicated on the drawings. All bars protruding from concrete to which other bars are to be spliced and which are likely to be exposed for an indefinite period shall be protected by a thick coat of neat cement slurry.

In the case of columns and walls, vertical bars shall be kept in normal position with timber templates having slots accurately cut in for bar position. Such templates shall be removed after the concreting has progressed up to a level just below them.

Bars crossing each other, where required, shall be secured by annealed binding wire of size not less than 1 mm and conforming to IS in such a manner that they do not slip over each other at the time of fixing and concreting. As far as possible, bars of full length shall be used. In case this is not possible, overlapping of bars shall be done as directed by the Engineer-in-Charge. Overlapping bars shall be bound with annealed steel wire, not less than 1 mm thickness twisted tight. The overlaps shall be staggered for different bars and located at points along the span where neither shear nor bending moment is maximum. However at any section not more than 50% of bar shall be spliced for FE-415 / 500 grade bar and not more than 25% for Fe-240 grade bars.

WELDING OF BARS

When permitted or specified on the drawings, joints of reinforcement bars shall be butt- welded so as to transmit their full strength. Welded joints shall preferably be located at points where the reinforcement steel will not be subject to more than 75 percent of the maximum permissible stresses and the welded joints should be staggered such that, at any one section, not more than 20 percent of the rods are welded. Only electric arc welding using a process which excludes air from the molten metal and conforms to any or all other special provisions for the work will be accepted. Suitable means shall be provided for holding the bars securely in position during welding. It must be ensured that no voids are left in welding and when welding is done in 2 or 3 stages, the previous surfaces shall be cleaned properly. Ends of the bars shall be cleaned of all loose scale, rust, grease, paint and other foreign matter before welding. Only competent welders shall be employed on the work.

The M.S electrodes used for welding shall conform to IS: 814.

Welded pieces of reinforcement shall be tested. Specimens shall be taken from the actual site and their number and the frequency of tests shall be as directed by the Engineer-in-charge.

Tolerances on Placing of Reinforcement

Unless otherwise specified by engineer-in-charge, the reinforcement shall be placed within the following tolerances:

Details	tolerance

for effective depth 200 mm or less	+- 10 mm
for effective depth more than 200 mm	+- 15 mm

Tolerance for Cover
Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by + 10mm and – 0 mm

MEASUREMENT FOR PAYMENT
Reinforcement shall be measured in length, separately for different diameters, as actually used in the work including overlaps. From the length so measured the weight of reinforcement shall be calculated in tones as per IS. Lengths shall also include hooks at end. Wastage, avoidable overlaps, couplings, welded joints and annealed steel wire for binding shall not be measured and cost of these items shall be deemed to be included in the rates for reinforcement.
Measurement will be taken in MT.

RATE
Rate for reinforcement shall include cost of all steel, its bending, placing, binding and fixing in position as shown on the drawings and as directed by the Engineer-in-charge. It shall also include cost of all devices for keeping reinforcement in approved position, cost of jointing as per approved method, and tests to be carried out. Rate would be per KG or MT.

FLOORING

Scope
Providing and laying M 25 grade or as specified in BOQ Concrete vacuum dewater flooring including adding floor top hardener of nitoflor hard top (Fosroc) or equivalent including topping @ 5 kg/Sq. m including vibration with a poker vibrator and finished with screed board vibrator , vacuum dewatering process and finally finished by floating, brooming with wire brush etc. complete as per specifications and directions of Engineer-in-charge. Curing, machine cut grooves size = 25mm d x 3mm w (Panel Size = 4m x 3m) and its fill with PU sealant Fosroc Make/ Equivalent brand etc. complete. As directed by engineer in charge. The surface tolerance should not exceed 3 mm in three meter length measured by straight edges in any direction complete as per specifications and directions of Engineer-in-charge.

Vacuum Dewatered Flooring (VDF/ Tremix Flooring):

Concrete in specified proportions of mix shall be laid in alternate bays or approved dimensions. The top surface will be finished as specified after surface vibration and shall be leveled. Immediately after surface vibration, a filter pad consisting of two layers shall be placed upon the surface of the wet concrete such that the bottom layer acts as filter and upper layer acts as water duct. Place a tight plastic sheet over the filter pad projecting slightly outside on all sides as the top cover to produce air-tight seal. Connect suction hose to a vacuum pump to extract the excess of water and to compact the concrete. Finish the surface by power floating and trowelling to achieve level, wear resistant floor with minimum dusting. The concrete surface shall be power trowelled at least twice to ensure wear resistance, sealing of capillary pores to reduce permeability and dusting.
Grade should be M 25 Concrete vacuum dewater flooring including adding of nitoflor hard top (Fosroc or equivalent) including topping @ 7 kg/Sq.m including vibration with a poker vibrator and finished with screed board vibrator , vacuum dewatering process and finally finished by floating, brooming with wire brush etc. complete as per specifications and directions of Engineer-in-charge. curing, machine cut grooves size = 25mm d x 3mm w (Panel Size = 4m x 3m) and its fill with PU sealant Fosroc Make/ Equivalent brand)etc. complete. As directed by engineer in charge. The surface tolerance should not exceed 3 mm in three meter length

measured by straight edges in any direction complete as per specifications and directions of Engineer-in-charge.

Consolidating

Vibrating screeds with truss assemblies shall be used to strike off and straightedge the concrete and to provide consolidation. Its use shall be limited to concrete with slump less than 75mm.

Jointing and edging tools

In order to make neat rounded edges next to the forms, edgers shall be used. Use a 3mm radius edger wherever edging is specified for joints subject to regular vehicular traffic. A larger radius will produce a joint that becomes rough and difficult to maintain.

Grooving:

In order to create a weakened section, the groove depth should be about one –fourth of the slab thickness.

25mm deep for a 100mm slab

37.5mm deep for a 150mm slab

Revolving disk floats shall be used to float low slump concrete or slab toppings. They are also used for additional compacting or floating following normal floating operations when the slab is stiff enough to support the machine without damage to the flatness of the slab.

Sequence of steps in making a slab on grade

1. Site Preparation

2. Placing Concrete

3. Finishing concrete

A. Prepare the sub grade	A. Deliver concrete to proper locations(s)	A. Bull float OR use straightedge.
B. Establish grades (elevations)	B. Spread or distribute concrete	B. WAIT for bleed water to disappear.
C. Set edge forms, temporary bulkheads, and screed guides.	C. Vibrate concrete	C. Edge and joint as needed.
D. Install vapor barrier, if any	D. Strike off	D. Float
E. Install reinforcement, if any	(Sometimes 2C and 2D are combined in a single operation)	E. Trowel, if required.
F. Get tools and materials ready		F. Saw joints as needed
		G. Cure

Subgrade Preparation
Slabs on ground are supported by the subgrade on which they are cast. Subgrades should provide uniform support throughout. There should not be any hard spots or soft spots. If the

subgrade is not uniform, a subbase of sand, gravel, crushed stone, or other granular material should be used over it.

All sub bases or subgrade material should be compacted to uniform bearing capacity, and to meet any specific requirements.

Dampen sub grade or sub base before concrete is deposited ONLY if needed to prevent plastic shrinkage or other severe problems. There should be no standing water.

Under severe drying conditions that threaten plastic shrinkage cracking, water can be sprinkled on the subgrade before concreting. However, there should be no free water standing on the subgrade when concrete is placed, nor should there be any muddy or soft spots.

Compaction around buried pipes:

Electrical conduit and pipes should be covered with at least 50mm of sub base so that they do not cause cracking by restraining slab shrinkage or reducing slab thickness. Metal, rigid plastic or wax-impregnated cardboard ducts with watertight joints are recommended for heating ducts. The backfill material should be compacted in layers so that it will not settle and cause the slab to crack.

Placement sequence:

Concrete floors shall be constructed in long strips starting at one side of the floor. Alternate long lanes shall be cast

Two sides of each panel should be left open for at least 2 days to allow expansion to occur.

Reinforcement must be located at or (preferably) above mid-depth of the slab. The best position depends on the design concept and weather exposure, but it must not be allowed below mid-depth.

If it is to be a working joint that is expected to open and provide relief for drying shrinkage, it is best to discontinue all steel at the joint.

Isolation joints used to separate the slab from walls, footings, columns, and other rigid structures, are made with asphalt-impregnated sheets or other suitable joint materials.

The metal keyed joint form is not recommended for slabs subject to heavy wheel traffic.

Here are some of the important dos and don’ts of placing concrete in flatwork:

1. DO deposit the concrete as close to its final location in the slab as possible. The less you have to move it, the better.
2. DO start by depositing concrete in a corner and work away from the corner.
3. If a slab is on a slope, DO start at the low end and work uphill.
4. DO deposit concrete into (instead of away from) previously deposited concrete.
5. DON’T move concrete horizontally with a vibrator. That is a sure way of causing segregation.
6. DON’T vibrate high slump (more than 5 in.) concrete in slabs on grade.
7. DON’T let concrete for slabs drop from a chute or bucket (free fall) more than about 2 ft if the slump is more than 4 in. Limit the drop to about 3 ft when slump is less than 4 in.
8. DO use the proper tools to move concrete horizontally. These tools are square nose shovels or come alongs. Do not use garden tools.

Vibrating (consolidating) the concrete

Surface vibration for consolidating slabs upto 6 in.thick shall be done provided they are unreinforced or contain only light mesh. Low- frequency vibrating screeds – 3000 to 6000 vibrations per minute – are the most common means.

- ✓ DON't use a vibrator to move concrete horizontally ("run the concrete) because the coarse aggregates will separate from the mortar.

- ✓ DON'T leave a vibrator in the concrete too long (over vibrate) in concrete mixes which have a slump of more than about 3 in. If in doubt about the adequacy of compaction, it is generally better to vibrate more in stiffer mixes (slump less than 3.) because the danger of over vibrating stiff mixes is small.

Trowelling

Trowelling follows immediately after floating, and no trowelling should ever be done unless the surface has first been floated.

Joints in a floor on grade
Isolation joints permit the slab to move up or down (very slightly) relative to walls, columns or footings. Contraction (control) joints permit slabs to shrink without excessive cracking between joints. Construction joints are stopping places for a day's work

Isolation joint material must be compressible and thick enough to permit such movement. Joint material ½ in. thick is commonly used. In freeze-thaw regions, caulking may be required for long term joint maintenance.

Isolation joints are made of performed asphalt impregnated fiber sheeting or similar materials. It is important that the joint filler extend the full depth of the joint and not protrude above it. There should be no concrete-to-concrete contact

Isolation joints around column – should be either circular or diamond shaped. If no isolation joints are used around columns, or if the corners of the isolation joint do not meet the contraction joints, radial cracking may occur.

Contraction joints
Contraction joints should be placed on or straddling column lines, with intermediate joints between column lines to keep the maximum distance between joints at 24 to 36 times the slab thickness. The resulting panels should be as nearly square as practical, dividing a large floor area into relatively small panels.

Avoid elongated and L-shaped panels. Never make the long side more than 11/2 times as long as the short side.

The edge forms or bulkheads for slab-on-grade construction joints are generally keyed for 6 in. or thicker slabs so that the slab will have a tongue-and-groove joint after concrete has been cast on both sides.

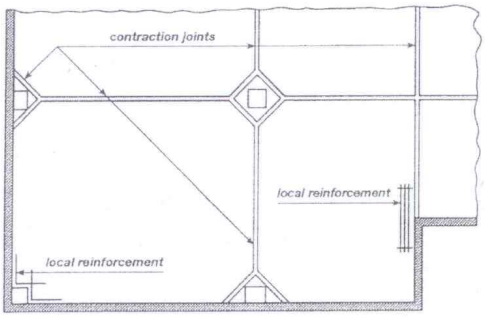
If construction joints occur where neither a contraction joint nor an isolation joint is wanted, tie bars or welded wire fabric may be used across the joint.

When to saw – Joints should be sawed as soon as the concrete is hard enough not to be torn or damaged by the blade, but before random cracks can form in the concrete slab. With wet cut saws, usually this condition occurs from 4 to 12 hr after finishing is complete, although sawing as late as 24 hr may be successful under some conditions.

Sawing techniques require a wait of 4 hours or more and a saw cut one –fourth the depth of the slab in order to get a good contraction joint.

Joint Details

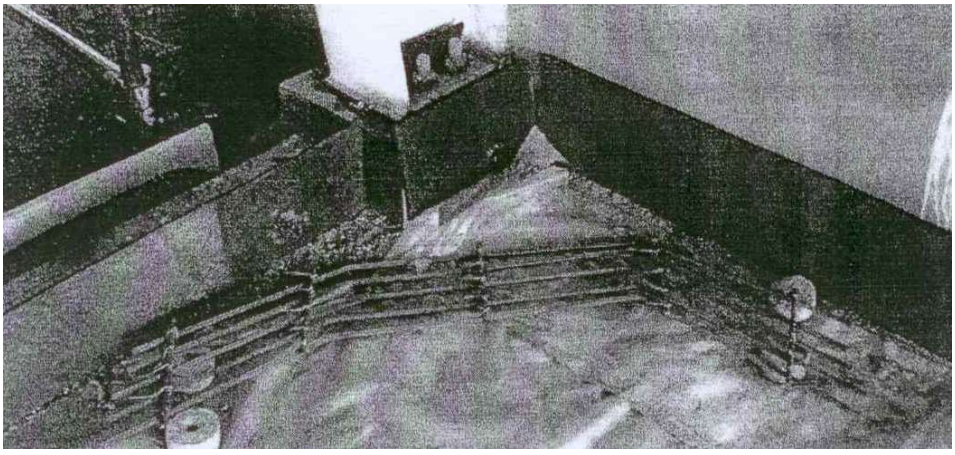
Contraction Joint



Column – Floor Joint Details

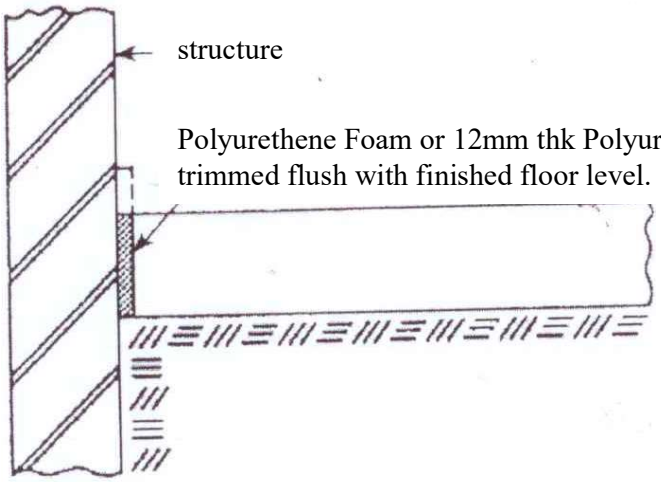
Two State Constructions

One Stage Construction: Column Isolation & Auxiliary Reinforcement



Column Isolation & Auxiliary Reinforcement at Column in

Insulation Joint



Polyurethene Foam : 12mm Thickness & 10mm above Floor level.

Curing:
Concrete should be kept continuously moist for 7 days unless otherwise specified. To avoid crazing and cracking do not allow the concrete surface to become dry during this period.

Ponding – Although seldom used, one of the best methods of curing concrete is to cover the concrete with water

Erect sunshades in hot weather to keep the sun from overheating the concrete surface.

To keep shrinkage to a minimum, apply the following rules:

1. Use the stiffest mix that can be handled and consolidated satisfactorily.

2. Reduce the water demand (total amount of water) of the mix by these practices:

    - Use the largest maximum size of aggregate that is practical.
    - Keep aggregate and cement temperatures low.
    - Use aggregates free of clay and other fines.
    - Plan for the shortest possible travel time between ready mix plant and the job.

Other factors to consider besides shrinkage that influence the amount of curling in a slab included:

- High water tables or wet subgrades – Will cause slab curling because they increase the moisture differential across the slab thickness.
- Slab thickness – thin slabs will curl more than thicker slabs when joint spacing is 15 to 20ft. With joint spacing greater than this range, vertical curling is the same for thin or thick slabs.
- Concrete modulus of elasticity E (*a measure of concrete stiffness)* – Concretes with a low modulus curl less than high-modulus concretes. Lower strength concretes have a lower E and thus curl less.

- Vapor barriers – Avoid if possible. If vapor barriers are necessary they should be covered with a layer of compactable fill. A fill thickness of 2 to 3 in. is common, although some authorities recommend as much as 6 in. to protect the vapor barrier from concrete truck traffic and to maintain a level subgrade.

The amount of bleeding is affected mostly by:

1. Slump – High slump concrete will bleed more than low slump concrete if the slump is caused by excess water and not by admixtures.

2. Air- entrainment – Non-air-entrained concrete will bleed more than air-entrained concrete.

3. Aggregate gradation – Concrete made with gap –graded aggregate or with coarse sands which do not have much material finer than a No.50 mesh sieve will bleed more than concrete made with a sand which has enough fine material.

4. Too little cementitious material in the mix.

The surface should not be damaged by the finishing operations. However, it is usually best to avoid excessive bleeding by adjusting the concrete mix before it is delivered.

Causes of random cracks are due to poor joints.ie.

a. Joints too far apart

b. Sawed or grooved joints not installed soon enough and /or deep enough

c. No contraction joints at re-entrant corners

d. Inadequate isolation joints at walls, columns, footings etc.

Concretes made with small aggregates and overly wet concrete mixes will need closer joint spacings.

Incomplete bond between the topping and base slab in two-course floors shall be avoided. Several precautions can be taken during construction to assure bond between the topping and base slab.

1. Clean the surface of the base slab, removing all dirt, grease, plaster, etc. Use stiff wire brushes or abrasive blast new slabs if necessary. If the base slab is old, mechanical roughening should be used.

2. The surface of the base slab should be slightly damp – not wet

3. Apply a coating of sand-cement grout using a stiff bristle broom.

4. Place the topping before the grout coat dries.

Map cracking and crazing
Fine hairline map cracks occur mostly on troweled surfaces. Like most of the other cracks that occur in concrete, map cracks are caused by shrinkage.

Precautions to avoid map cracking:

Water brought to the surface during floating should be allowed to evaporate before continuing finishing operations. Also water should not be sprinkled on the surface to make finishing easier.

Delayed curing or lack of curing can cause map cracking, particularly if rapid drying of the concrete is likely. Avoid it

Wide map cracks may mean that aggregate are reacting chemically with the alkalies in the cement resulting in alkali-aggregate (or alkali-silica) reactivity.

Shrinkage-compensating concrete slabs

To take advantage of the expansion, enough steel reinforcement is used in the top half of the slab to resist the expansion and prestress of concrete to a low level.

Reinforcement should be at least 0.15 percent by cross sectional area, located in the top half of the slab.

Measurement for industrial flooring

Measurement to done in Cu M if one item taken with all above details. OR Sq m if thickness specified.

If separate item given than concreting can be taken in Cu m

Vacuumed Dewatering can be taken in Sq m.

Cutting and filling poly sulphide sealant can be taken in Rmt.

STORAGE OF MATERIALS

Cement

The contractor shall make arrangements to the satisfaction of the Engineer-in- Charge for the storage of cement to prevent deterioration due to moisture and/or intrusion of foreign matter. Bulk cement shall be stored in approved water-proof bin or silo. Bagged cement shall be stored in a suitable weather tight warehouse in a manner to provide easy access for identification and inspection of each consignment. Stored cement shall meet the test requirements as per IS-269 at any time after storage, when a retest is ordered by the Engineer-in-Charge. Each consignment shall be stacked separately with the date of receipt flagged on it, not more than 12 bags being stacked in height, the bags being arranged with headers and stretchers. Normally consignments shall be used in the order of receipt at site unless otherwise directed. In the case of large concrete pours the Engineer-in- Charge will decide on the batch of cement to be used taking into consideration the quantity of cement with particular reference to the concerned concrete pours. Any additional work in handling and storage of cement contingent upon this requirement shall be to the contractors' account and no extra claim will be entertained. Cement shall be protected from closure to moisture in transit, in storage at the works and until it enters the concrete mixers. The contractor shall keep accurate records of the deliveries of the cement and of its use in the work.

Aggregates

Coarse and fine aggregates shall be stacked separately in such manner as to prevent contamination by foreign materials. All aggregates shall be stored on concrete or masonry platforms, each size shall be kept separate with wooden, steel, concrete, or masonry bulk heads, or shall be stored in separate stacks, taking care to prevent the materials at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept

sufficiently apart. The aggregates shall be stored in easily measurable stacks of suitable heights as may be directed by the Engineer- in-Charge.

Reinforcing Steel

Reinforcing steel shall not be stored directly on the ground. These shall be stored under cover and shall be protected from rusting, oil, grease and distortions as directed by the Engineer-in-Charge.

High Tensile steel

The high tensile shall be stored in humidity controlled godowns and shall not be stored for long period. The procurement of H.T. steel shall be made just before actual use and shall be stacked on wooden platform.

SHUTTERING

All centering, formwork and temporary works shall be constructed according to duly approved drawings and specification. The design criteria and loading for these works shall be as per American Concrete Institute relevant specifications.

As soon as practicable after the acceptance of its bid the contractor shall submit a scheme showing the order of the procedure and methods by which he proposed to carry out the work together with such details as are necessary to demonstrate the adequacy, stability and safety of the methods which the contractor propose to adopt.

The approval to the general scheme of centering as well as design criteria and loading shall be obtained in good time to facilitate all preparatory work. Any delay on this account shall be the responsibility of the contractor.

Notwithstanding the approval given to the design criteria and loading and the general scheme for the centering, the entire responsibility for the satisfactory execution of the centering and all temporary works shall rest with the contractor and he shall be liable to pay all claims and compensation arising from any loss or damage to life and property due to any deficiency, failure or malfunctioning of the centering or all the temporary works.

Reuse of Forms etc

Forms required to be used more than once shall be maintained in serviceable conditions and shall be thoroughly cleaned and repaired before reuse. Where metal sheets are used for lining forms the sheets shall be placed and maintained in the forms with minimum amount of wrinkles, lumps or other imperfections. All forms shall be checked for shape and strength before reuse.

Maximum repetition allowed for water proof marine ply wood shuttering would be 10 times. This number is subjective and may be reduced or increased as per the condition which would be reviewed by the engineer in charge or Employers representative.

Material

In general, all shuttering and formwork to be used shall be water proof ply wood shuttering, unless otherwise stipulated. All props used to be MS props. MS pipes, couplers and H frames where ever required.

Designing of shuttering system

Contractor shall prepare, before commencement of actual work, design and drawings for formwork and get them approved by the Employer's Representative. The form work shall

conform to the shapes, lines and dimensions as shown on the drawings within the allowable tolerances.

Erection and removal of forms

I. Before placing concrete the surface of all forms shall be covered with suitable non staining form releasing agents such as raw linseed oil so as to prevent sticking of concrete and to facilitate removal of forms.

II. The form releasing agent shall cover the forms fully and evenly without excess over drip. Care shall be taken on the surface of the construction joints and on reinforcement bars. Special care shall be taken to cover thoroughly the form strips for narrow grooves, so as to prevent swelling of the forms and the consequent damage to concrete prior to or during removal of forms.

III. Immediately before concrete is placed care shall be taken to see that all forms are in proper alignment and the supports and fixtures are properly secured and tightened.

IV. Where forms for continuous surfaces are placed in successive units, the forms shall lap and fit tightly over the completed surface so as to prevent leakage of cement slurry from the fresh concrete and to maintain accurate alignment of the surface.

V. Forms shall be left in place until their removal is authorized and shall then be removed with care so as to avoid injury to concrete.

VI. Removal of forms shall never be started until the concrete is thoroughly set and hardened adequately to carry its own weight, besides the live load which is likely to come on the work during construction. The length of time for which the forms shall remain in place shall be decided by the engineer-in-charge, with reference to weather conditions, shape and position of the structure of structural member and nature and amount of dead and live loads. In normal circumstances and where ordinary Portland cement is used forms can be allowed to be struck as under :

A	Beam sides, walls, unloaded columns	after	24 hours
B	Slabs and arches (props left under)	after	4 days
C	Props to slabs and arches	after	10 days
D	Beam soffit (props left under)	after	8 days
E	Props to beams	after	21 days
F	Beam concrete (sides)	after	2 days

Note: - Time shall be measured from last batch concrete in respect to the structural member under consideration.
In no case shall forms be removed until there is an assurance that removal can be accomplished without damaging the concrete surface. Heavy loads shall not be permitted until after the concrete has reached its design strength. The forms shall be removed with great caution and without jerking the structure.

Settlement of Formwork and Camber

Due to various reasons such as closure of form joints, shrinkage of timber, dead load deflection, elastic shortening of form members formwork deflection or settlement may occur. The members of the formwork must be rigid enough to prevent excessive deflections the usual acceptable limit being 1/500 of the spans of the formwork. In the absence of any specified

camber on the drawings, soffit of all beams more than 5 m in span and other than prestressed concrete beams shall be laid to a camber the amount of which midspan shall not be less than 1/500 of the span of the structure. The profile of soffit shall be parabolic.

Mock-Ups

The method for pouring difficult zones of concrete will be pre-studied on mock-ups. Mock-ups will be particularly necessary for the following:

i) Zones around penetrations and openings.

ii) Behind anchorages of prestressed members.

iii) Dome and hell in general requiring single and double forms.

iv) Various zones of large thickness for studying placement temperatures in relation to internal temperature build ups.

Work involved in mock-up pours will be paid for at the rates entered under relevant items of work. Materials which are of free supply as mentioned in this document, such as steel, embedment, etc. will also be supplied free for mock-up pours. Sampling and testing of all samples will be done by the contractor. Unsuccessful mock-ups may have to be repeated in full or in part as required by the engineer.

Tolerance

All works will be carried out true to the lines, levels, and grades shown on the drawings and within the tolerances specified below. The contractor shall establish, erect and maintain in an undisturbed condition until final completion and acceptance of the project control points and bench marks necessary and adequate to establish these tolerances.

Departure from established alignment of all elements	:	30 mm
Departure from established grades	:	10 mm
Variation from plumb or specified	:	12 mm in 3 m. (If exposed)
Batter in lines and surface of	:	(25 mm in 3m. if
Back filled columns, piers, walls and in arises)		
Variation from level or indicated	:	12 mm in 3 m (If exposed)
Grade in slabs, beams, horizontal and railing offsets	:	25 mm in 3 m. (If backfilled)
Variation in cross sectional dimensions of columns,		
Piers, slabs, walls, beams and similar parts.	:	6 mm plus 12 mm
Variation in slab thickness	:	-3 mm plus 6 mm
Footings / Plan dimensions	:	-15 mm plus 30 mm
placement of eccentricity	:	-2% of
footing which in the direction of misplacement and		
not exceeding 30 mm.		
Reduction in thickness	:	-5% of specified

Thickness variation in size and locations of slabs, well	:	-12 mm.
Openings		
Pre stressed concrete cables	:	will be laid such

that their profile is a smooth curve unless otherwise specified.

The alignment tolerances shall be as under.

Member with a depth of up to 200 mm	:	+/- d/40
200 – 1000 mm	:	+/- 5 mm
more than 1000 mm	:	+/- 10 mm
Tolerance in direction of width of member the level of tendon		
Up to 200 mm wide	:	+/- 5 mm
200 – 1000 mm wide	:	+/- 10 mm
Slabs and beams of more than 1000 mm width	:	+/- 20 mm

Tendon extensions will be measured up to 1 mm accuracy. The total prestressing force applied to a beam shall not vary more than +3% from the design force specified and measured in terms of the total elongations of all the tendons in that members.

In the case of slabs this variations shall be measured and restricted over a range of 5 consecutive tendons.

The contractor shall be entirely responsible for the sufficiency and efficiency of the shuttering and for the safe removal of the same. The shuttering shall be designed and arrange so that it will not settle or deflect under the load of concrete plant and workmen and can be removed without causing any damage to the concrete. All stuttering design will have to be got approved by the engineer in charge.

Joints shall be tight enough to prevent leakage of liquid and fines from the concrete and shutter shall be lined as may be necessary to provide the desired concrete surface.

Folding wedges if used for final adjustments shall be nailed together and to the struts or battens to prevent loosening during vibration. All chambers and radius trips, liners and cores shall be provided where necessary. All shutters shall be fixed to the proper lines and trued up immediately before depositing the concrete.

Before any concrete is placed all shavings and other harmful matter shall be removed from inside the shuttering. No concrete shall be deposited until the shuttering is inspected and approved.

The formwork shall be so designed and erected that the forms for slabs and sides of the beam, columns and wall are independent of soffit of beams and can be removed without any strain to the concrete already placed or affecting the remaining, formwork. No prop shall be removed without the approval of the Employer's & Consultant's Representative. If formwork is erected with full height of the column, one side shall be left open and built-up in sections as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

In general, all shuttering and formwork to be used shall be wrought, unless otherwise stipulated.

Wrought formwork used for work shall be wooden form work lined with plywood or metal plates without indentation or “Anchor Board” shuttering or equivalent approval by Employer’s Representative.

Unwrought Formwork: Wooden plank used for this type of Formwork shall be available from the saw mill. When this type of formwork is used, the concrete surfaces after the removal of formwork shall be plastered only where necessary, as required by Employer’s Representative.

Plywood shuttering material shall be used where an especially good finish is required. Re-use of plywood shuttering will be undertaken if allowed by the Employer’s & Consultant’s Representative.

The formwork shall be so constructed that it is rigid enough to remain free from any bulging, sagging or any movement during the placing of the concrete, and can be subsequently without damaging concrete. The formwork shall be sufficiently watertight to prevent loss of liquid from the concrete. All formwork shall be fixed to proper elevation. No concreting shall be undertaken by the contractor until the level, size, suitability etc. is approved by Employer’s Representative.

If it is desired by the Employer’s Representative, the Contractor shall prepare, before commencement of actual work, design and drawings for formwork and get them approved by the Employer’s Representative. The form work shall conform to the shapes, lines and dimensions as shown on the drawings within the allowable tolerances.

Note:

Tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel or dowels.

The forms shall have smooth even surface and be sufficiently strong, to carry without deformation the dead weight of the green concrete, working load, wind load and also the side pressure exerted by the green concrete. As far as practicable, clamps shall be used to hold the forms together. Where use of nails is unavoidable minimum number of nails shall be used and these shall be left projecting so that they can be easily withdrawn.

The form work shall be strong enough to withstand the effect of vibrations practically without any deflection, bulging, distortion or loosening of its components.

All horizontal forms shall be designed and constructed to withstand the dead load of the green concrete, reinforcement equipment, material, embedment and a minimum live load of 200 kg/sq. meter.

When forms appear to be unsatisfactory factory building in any way, either before or during the placing of concrete, the work shall be stopped until the defects have been corrected as per the instructions of the Employer’s & Consultant’s Representative.

All comers and agents shall be formed with 45 deg. moldings, to form chamfers or fillets on the finished concrete wherever required. The standard dimensions of chamfers and fillets, unless otherwise detailed or specified shall be 25 x 25 mm. For heavier work chamfers or fillets shall be 50 x 50 mm. Care shall be exercised to ensure accurate moldings. The diagonal face of the moldings shall be planned or surfaced to the same texture as the forms to which it is attached.

Before reuse, all forms shall be thoroughly scrapped, cleaned, examined and when necessary repaired and retreated before resetting. Formwork shall not be reused, if declared unfit or un-serviceable by the Employer’s & Consultant’s Representative.

Staging/scaffolding shall be properly planned and designed by the Contractor. The contractor shall get it reviewed by Employer's & Consultant's Representative before commencement of work. Double scaffolding sufficiently strong so as to withstand all loads likely to come upon it and having two sets of vertical supports, shall be provided. Where two sets of supports are not possible, the inner end of the horizontal scaffolding member shall rest in a hole provided in the header course only. Only one header for each member shall be left out. Such holes however shall not be allowed in pillars under one meter in width or immediately near the skewbacks of arches. The following measures shall be considered while designing and erecting of scaffolding/stating.

- Sufficient sills or under pinning in addition to base plates shall be provided particularly where scaffoldings are erected on soft grounds.
- Adjustable bases to compensate for uneven ground shall be used.
- Proper anchoring of scaffolding/staging at reasonable materials shall be provided in each case with the main structure wherever available.
- Horizontal braces shall be provided to prevent the scaffolding/staging from rocking.
- Diagonal braces shall be provided continuously from bottom to top between two adjacent rows of uprights.
- The scaffolding/staging shall be checked at every stage for plumb line.
- Wherever the scaffolding/staging is found to be out of plumb line, it shall be dismantled and re-erected fresh and effort shall not be made to bring it in plumb with a physical force.
- All nuts and bolts shall be properly tightened.
- Proper and effective supervision of the erection work shall be ensured by the Contractor.
- Erection work of a scaffolding/staging under no circumstances shall be left totally to semi-skilled or skilled workmen and shall rather be carried out in the presence of a technically qualified Civil Engineer of the Contractor.
- Wherever steel tubes are used care shall be taken that all the clamps/ couplings are firmly tightened so as to avoid any slippage.

Wooden forms for reinforced cement concrete shall be at least 25 mm. thick. All rubbish shall be removed from the interior of the forms and the surface of formwork to come in contact with concrete shall be cleaned and thoroughly treated with approved oil, soft soap, or emulsion. The oil shall be applied before the reinforcement is placed, and care shall be taken that no oil comes in contact with steel while it is being placed in position. The joints of forms shall be made watertight by plugging them with good clay and jute or by other approved means before applying oil. The form shall be so fixed that only slight marks are visible on the surface of the concrete after stripping the forms.

No plugs, bolts, ties or any appliances whatsoever for supporting, the shuttering shall be fixed permanently in the structure, nor be placed temporarily in such a manner that damage to the structure would result from their removal at the time of striking the forms and supports.

No forms shall be removed or staging struck until it is safe to do so and approved by Employer's Representative. All vertical-centering members shall be sufficiently braced with stiff members. Bamboo shall not be used as bracing members.

All formwork shall be removed without shock or vibration and without damaging the new concrete. The side forms shall be so fixed that while removing them the supporting forms and

posts are not disturbed to any extent. In no circumstances, should the supporting forms be struck until the concrete reaches strength of at least twice the stress to which the concrete may be subjected at the time of striking. Under normal conditions, the periods shown below are the minimum, which should be allowed between the placing of the concrete and the removal of the forms.

Formwork shall be cambered as described below, unless otherwise shown or specified. Deflection reading of various elements shall be taken as directed.

Type of Member	**Compression steel as percentage of tensile steel**	**Camber co-efficient K.**
Simple Span	0 50%	0.066 0.037
Continuous or restricted span	0	0.032
Cantilever Span	50% 0 50%	0.50 0.020 0.046

$$\text{Camber (in inches)} = \frac{K' L}{D}$$

Where K = Camber co-efficient
L = Length of member in ft.
D = Depth of member in ft.

Special note:-
No binding wire will be used to support the form work by tying to the reinforcement.
No steel bars spacer (katta) to be used for beams side.

Measurement for form work:-

Form Work IS 1200 Part 5

Sr. No.	**Description**
	Unit
1	Form work shall be measured in Square Meter
2	Raking or circular cutting and rounded or moulded edges shall be measured in running meters.
3	Moulded stopping should be measured in numbers
	Measurement
1	No deductions shall be made for each of opening up to 0.4 Square Meter
2	No deduction shall be made for any opening/cutouts when slip form technique is used.

3	Formwork to secondary beams shall be measured up to the sides of main beams, but no deduction shall be made from the formwork of the main beam where the secondary beam intersects it. Formwork to beam shall be measured up to sides of column, but no deduction shall be made from the formwork to stanchion or column casings at intersections of beam.

CONTROLLED CONCRETE

Addition of anti-corrosive add mixture

Polycalk CP 293 Sunanda chemicals to be added as add mixture in concrete for all reinforced concrete works dosage as per manufactures specification

Concrete mix shall be designed for 33% higher strength than the grade of concrete specified.. The proportions for ingredients chosen shall be such that concrete has adequate workability for conditions prevailing on the work in question and can be properly compacted with the means available.

Except where it can be shown to the satisfaction of the Engineer-in-Charge that a supply of properly graded aggregate of uniform quality can be maintained till the completion of work, grading of aggregate should be strictly controlled. The different sizes shall be stocked in separate stock piles. Required quantity of material shall be stock-piled several hours, preferably a day, before use. Grading of coarse and fine aggregate shall be checked as frequently as possible, frequency for a given job being determined by the Engineer-in-charge to ensure that the suppliers are maintaining the uniform grading as approved for samples used in the design mix.

The quantity of both cement and aggregate shall be determined by weight. Water shall either be measured by volume in calibrated tanks or weighed. All measuring equipment shall be maintained in a clean and serviceable condition. Their accuracy shall be periodically checked.

It is most important to keep the specified water-cement ratio constant and at its correct value. To this end, the moisture content in both fine and coarse aggregates shall be determined by the Engineer-in-charge according to the weather conditions. The amount of mixing water shall then be adjusted to compensate for variations in the moisture content. For the determination of moisture content in the aggregates, IS: 2386 (Part III) shall be referred to. Suitable adjustments shall also be made in the weights of aggregates to allow for the variation in weights of aggregates due to variation in their moisture content.

The minimum cement and maximum water cement ratio and minimum grade of concrete is given below:-

For bridges with pre-stressed concrete / RCC decking or those with individual spans greater than 30 mtrs. Or those that are built with innovative design / construction.

[Ref: Table: 5 of IS-456-2000]

Sr. No.	**Exposure**	**Plain Concrete**			**Reinforced Concrete**		
		Minimum Cement Content Kg/m3	**Maximum Free Water-Cement Ratio**	**Min. Grade of Concrete**	**Minimum Cement Content Kg/m3**	**Maximum Free Water-Cement Ratio**	**Min. Grade of Concrete**
1	2	3	4	5	6	7	8
1	Mild	220	0.60	-	300	0.55	M-20
2	Moderate	240	0.60	M-15	300	0.50	M-25
3	Severe	250	0.50	M-20	320	0.45	M-30
4	Very Severe	260	0.45	M-20	340	0.45	M-35
5	Extreme	280	0.40	M-25	360	0.40	M-40

Adjustments to Minimum Cement Contents for Aggregates other than 20 mm Nominal Maximum Size [Ref : Table:6 of IS-456-2000]

Sr. No.	Nominal Maximum Aggregate Size (mm)	Adjustment to minimum Cement Content in above table (kg/m3)
(1)	(2)	(3)
1	10	+ 40
2	20	0
3	40	-30

Limits of Chloride Content of Concrete
[Ref: Table: 7 of IS-456-2000]

Sr. No.	Type or Use of Concrete	Maximum Total Acid Soluble Chloride Content expressed as kg/m3 of Concrete
1	Concrete containing metal and steam cured at elevated temperature and pre-stressed concrete	0.4
2	Reinforced concrete or plain concrete containing embedded metal	0.6
3	Concrete not containing embedded metal or any material requiring protection from chloride	3.0

Condition of Exposure:

1. Severe - Marine Environment:

   Alternate wetting and drying due to sea spray, alternate wetting and drying combined with seezing, buried in soil (having corrosive effect); members in contact with water where the velocity of flow and the bed material are likely to cause corrosion of concrete.
2. Moderate - Condition other than 'severe'

   a) The minimum cement content is based on 20 mm size aggregates. For larger size aggregates, it may be reduced suitably by not more than 10%. Similarly for smaller size aggregates, it may be suitably increased, but not more than 10%.

   b) The cement content shall not exceed 540 kg/cu.m. of concrete.
3. Ordinary / Nominal Concrete:

The ordinary / nominal concrete mix shall also be specified by mass. Proportioning of sand shall be as per its dry volume and in case it is damp, allowance for 'bulking' shall be made as per IS : 2386 (Part III).

Ingredients required for nominal mix concrete containing one 50 Kg. bag of cement for different proportions of mix shall be as given in Table below.

MIX DESIGN

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

- As the guarantor of quality of concrete used in the construction, the Contractor shall carry out 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.
- 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.

- 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 for Grades of Concrete

Group	Grade Designation	Specified Characteristic
		Compressive Strength of 150 mm Cube at 28 days in N/mm2
(1)	(2)	(3)
	M 10	10
Ordinary Concrete	M 15 M 20	15 20
	M 25	25
	M 30	30
	M 35	35
Standard Concrete	M 40 M 45	40 45
	M 50	50
	M 55	55
	M 60	60
	M 65	65
High Strength	M 70	70
	M 75	75
	M 80	80

Notes:

1. 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.
2. 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 specialized literatures and experimental results.
3. No extra charges will be paid to contractor to carry out the tests.

Standard Deviation

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

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.

Assumed Standard Deviation

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.

Assumed Standard Deviation

Grade of Concrete	Assumed Standard Deviation
M 10 M 15	3.5
M 20 M 25	4.0
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 gradings 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.

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

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

Sampling of Concrete

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.

Preparation of Test Specimens

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 obtained, the test specimen shall be immediately molded by one of the following methods.

a. When the job concrete is compacted by ordinary methods, the 1st specimen shall be molded 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.

b. When the job concrete is placed by vibration and the consistency of the concrete is such that the 1st specimen cannot be properly molded by hand Roding as directed under (a) 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.

Method of Testing

The tests shall be made at the age of the concrete corresponding to that for which the strengths are specified. 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 millimetres accurate to 0.5 mm.

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.

The load shall be applied axially without shock at the rate of approximately 140 kg/sq.cm. 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.

Standard of Acceptance

The standard of acceptance shall be as described below:

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.

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.

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.

Six cubes shall be made for a test and 3 out of these shall be tested after 7 days. If the 7 days test gives the specified compressive strength, no further test shall be necessary. In case the 7 days test is not satisfactory, 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.

For Use of PPC cement or fly Ash in concrete 3 extra cubes have to be taken for 56 days test.

Testing of Concrete

Whenever required by the Consultant & Employer the Contractor shall prepare required number of concrete cubes for testing the compression strength of concrete used for the various items of work.

For every big pour of concreting particularly for slab twelve cubes are to be taken. Out of these three cubes will be tested on 3rd day, three on 7th day, three on 14th day and balance three on 28th day.

The moulds should be perfect cubes of 150mm resting on a flat iron plate. The base plate and the sides should be polished smooth and sufficiently oiled to prevent the concrete from sticking. The concrete in the moulds shall be placed in 3 layers, compacting each layer 35 times uniformly with a 16mm dia bar 600mm long, bullet pointed at the lower end. The test specimen covered with sack cloth for 24 hours, after which the specimen should be removed and placed under heap of wet sand or in water tank till the date of test.

Such cubes will be sent for testing to any other approved materials testing laboratory as directed by the Consultant and the cost of such cubes and tests and transport of cubes will have to be borne by the Contractor.

The code of practice to be preferred shall be the Indian Standard Code of Practice for plain and reinforced cement concrete for General Building Construction (Revised) No. I.S. 456 as issued and amended from time to time by the Indian Standard Institution. In the event of unsatisfactory results of the tests, the Contractors shall be required to take such measures as will be directed by the Consultant free of cost to the Employers. One set of 12 cubes of every slab and one set of 6 cubes for columns on different floors will be taken.

STRENGTH REQUIREMENT OF CONCRETE

Grade of Concrete	**Compressive Works Test Strength in N/Sq. mm on 150 mm Cubes after Testing Conducted in accordance with IS : 456**	
	Min. at 7 days	**Min. at 28 days**
M 10	7	10
M 15	10	15
M 20	13.5	20
M 25	17	25
M 30	20	30
M 35	23.5	35

Number of sample to be taken in concreting for compressive strength test

Quantity of concrete in Cum	**Number of samples**
1 – 5	1
6-15	2
16-30	3
31-50	4
5 1 and above	4 plus one additional sample for - each additional 50 m3 or part thereof

Other test to be done

Test	Frequency
Concrete impermeability	1 sample / 1000 m3
RCPT	1 sample / 1000 m3
ISAT	1 sample / 1000 m3

PROPORTION OF NOMINAL MIX CONCRETE

Grade of Concrete	Total quantity of dry aggregates by mass per 50 Kg. of cement, to be taken as the sum of the individual masses of fine & coarse aggregates, (Kg.), Max.	Proportion of fine aggregate to-coarse aggregate by mass.	Qty. of water per 50 Kg. of cement Max. (Ltrs.)
M-7.5	625	Generally 1:2 for fine aggregate to coarse aggregate by volume but subject to a upper limit of 1:1 ½ and a lower limit 1.2 ½	45
M-10	480		34
M-15	330		32

Note No. 1: The proportions of the aggregates shall be adjusted from upper limit to lower limit progressively as the grading of the fine aggregates becomes finer and the maximum size of coarse aggregate becomes larger.

Note No. 2: The amount of water should be kept minimum required for proper workability. The quantity given in Col. 4 is not to be exceeded.

Example For an average grading of fine aggregate (that is Zone the proportions shall be 1:1 ½ , 1:2 and 1:3, for maximum size of aggregates 10 mm, 20 mm and 40 mm respectively.

Note No. 3: A mix leaner than M 10 may be used for non-structural parts if specified on the drawing or provided in the contract. In such case grading of aggregates shall be as specified in the contract or on the drawings. Other requirements for mixing, placing and curing shall be the same as specified in this section.

Quantity of Water

The quantity of water shall be just sufficient to produce a dense concrete of required workability and strength for the job. An accurate and strict control shall be kept on the quantity of mixing water.

In the case of reinforced concrete work, workability shall be such that the concrete surrounds and properly grips, all reinforcements. The degree of consistency, which shall depend upon

the nature of work and the methods of vibration of concrete, shall be determined by regular slump tests. The slump shall be adopted for different types of works shall be as per IS 456, cl. No. 7, pg no. 17.

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Sr. No.	Type of Work	Where Vibrators are Used	Where Vibrators are not Used
i)	Mass Concrete in RCC Foundations, Footings and Retaining Walls	25 mm to 40mm	80 mm
ii)	Beams, Slabs & Columns Simply Reinforced	35 mm to 40 mm	100 – 120 mm
iii)	Thin RCC Section or Section with Congested Steel	40 mm to 50 mm	125 – 150 mm

Note: With use of ordinary concrete the slump requirement specified above would not be applicable.

MIXING CONCRETE

For manufacturing concrete, automatic mixer (mini/mobile batching plant) with a minimum output capacity of 8 cu. m per hour and having minimum / single batching size of 0.35 cu. m with the production capacity of approximately 20 batches per hour shall only be used. There should be two mixers including standby should be provided. The feeding of the concrete ingredients like sand, grit, aggregate and cement may be done manually, but gauges for that should be installed on it, either dial gauge or digital only. It should also have the same kind of arrangements for water flow and admixture dose on it or separately. All those gauges should be clearly indicative, measurable from the one place.

The calibrations of all the gauges shall have to be done at least once a month or at the frequency as directed by Engineer in charge.

All those accessories shall be mandatory and shall be kept in first class working conditions and so maintained throughout the construction. Mixing shall be continued till materials are uniformly distributed and a uniform colour of the entire mass is obtained and each individual particle of the coarse aggregate shows a complete coating of mortar containing its proportionate amount of cement. In no case shall the mixing be done for less than 2 minutes after all ingredients have been put into the mixer. Hand mixing of concrete is not permissible. For mixes lower than M-10, machine mixing may be permitted only under exceptional circumstances with the permission of the engineer in charge in advance. In hand mixing quantity of cement shall be increased by 10% above that specified above but the cost of increased cement quantity shall be borne by the contractor. Mixers, which have been out of use for more than 30 minutes, shall be thoroughly cleaned before putting in a new batch. Unless otherwise agreed to by the engineer in charge, the first batch of concrete from the mixer shall contain only two thirds of the normal quantity of coarse aggregates. The mixing plant shall be thoroughly cleaned before changing from one type of cement to another.

TRANSPORT, PLACING AND COMPACTION OF CONCRETE

The method of transporting and placing concrete shall be approved by the Engineer-in-charge. Concrete shall be transported and placed such that no contamination, segregation or loss of its constituent materials takes place.

All formwork and reinforcement contained in it shall be cleaned and made free from standing water or dust, immediately before placing of concrete.

No concrete shall be placed in any part of the structure until the approval of the Engineer-in-charge has been obtained in writing.

If concreting is not started within 24 hours of the approval being given, it shall have to be obtained again from the Engineer-in-charge. Concreting shall then proceed continuously over the area between construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless it is ensured that there vibration limit of the earlier concrete is not crossed or a proper construction joint is formed.

Concrete when deposited shall have a temperature of not less than 5 deg. C and not more than 40^0 C unless otherwise specified. It shall be compacted in its final position within 30 minutes of its discharge from the mixer unless carried in properly designed agitators, operating continuously, in when this time shall be within 1 hour of the addition of cement to the mix and within 30 minutes of its discharge from the agitator, except where otherwise agreed to by the Engineer-in-charge, concrete shall be deposited in horizontal layers to a compacted depth of not more than 0.45 m when internal vibrators are used and not exceeding 0.30 m in all other cases.

Unless otherwise agreed to by the Engineer-in-charge, concrete shall not be dropped into place from a height exceeding 1.5 metres. When trunking or chutes are used, they shall be kept clean and used in such a way as to avoid segregation.

When concrete is conveyed by chute, the plant shall be of such size and design as to ensure practically continuous flow. Slope of the chute shall be so adjusted that the concrete flows without the use of an excessive quantity of water and without any segregation of its ingredients. The angle of chute from ground should not be less than 45 deg. The delivery end of the chute shall be as close as possible to the point of deposit. The chute shall be thoroughly flushed with water before and after each working period and the water used for this purpose shall be discharged outside the formwork.

When concreting has to be resumed on a surface which has hardened, it shall be roughened, swept clean, thoroughly wetted and covered with a layer of neat cement grout. This shall be followed by a 10 mm thick layer of mortar composed of cement and sand in the same ratio as in the concrete mix itself. This 10 mm layer of mortar shall be freshly mixed and placed immediately before placing of new concrete. A layer of bond coat to be applied on old surface as directed by engineer incharge.

Where concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislodgement of any particles of coarse aggregate. The surface shall then be thoroughly wetted, all free water removed, and then coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 150 mm in thickness, and shall be well rammed against old work, particular attention being given to comers and close spots.

All concrete shall be compacted to produce a dense homogeneous mass with the assistance of vibrators, unless otherwise permitted by the Engineer-in-charge for exceptional cases, such as concrete under water, where vibrators cannot be used. Sufficient vibrators, in serviceable condition, shall be kept at site so that spare equipment is always available in the event of breakdowns.

The performance requirements of vibrators shall conform to relevant IS Codes. Vibration shall not be applied through reinforcement, and where vibrators of the immersion type are used, contact with reinforcement and all inserts shall be avoided as far as practicable.

CONCRETING UNDER WATER

When it is necessary to deposit concrete under water, the methods, equipment, materials and proportions of the mix to be used shall be got approved from the Engineer-in-charge before any work is started. Such concrete shall not be considered as 'Controlled Concrete'.

Concrete shall not be placed in water having temperature below 5^0C. The temperature of the concrete, when deposited, shall be not less than 16^0C., not more than 40^0C.

While carrying out mix design. It shall be considered that Concrete shall contain 10 per cent more cement than that required for the same mix placed in the dry. The materials shall be so proportioned as to produce a concrete having a slump of not less than 100 mm. and not more than 180 mm. The slump shall be tested as per latest IS: 516.

Coffer-dams or forms shall be sufficiently tight to ensure still water conditions if practicable, and in any case to reduce the flow of water to less than 3 metres per minute through the space into which concrete is to be deposited. Coffer-dams or forms in still water shall be sufficiently tight to prevent loss of mortar through the joints in the wells. Pumping shall not be done while concrete is being placed, or until 24 hours thereafter.

Concrete shall be deposited continuously until it has been brought to the required height. While depositing, the top surface shall always be kept as nearly level as possible and formation of seams avoided. For depositing concrete any one of the following methods may be used:

Tremie

When concrete is to be deposited under water by means of tremie, the top section of the tremie shall be a hopper large enough to hold one full batch of the mix or the entire contents of the transporting bucket if any. The tremie pipe shall not be less than 200mm in diameter, and shall be large enough to allow a free flow of concrete and strong enough to withstand the external pressure of the water in which it is suspended, even if a partial vacuum develops inside the pipe. Preferably, flanged steel pipe of adequate strength for the job shall be used. A separate lifting device shall be provided for each tremie pipe with its hopper at the upper end. Unless the lower end of the pipe is equipped with an approved automatic check valve, the upper end of the pipe shall be plugged with a wadding of gunny sacking or other approved material before delivering the concrete to the tremie pipe through the hopper, so that when the concrete is forced down from the hopper to the pipe it will force the plug (and along withit any water in the pipe) down the pipe and out of the bottom end, thus establishing a continuous stream of concrete. It will be necessary to raise slowly the tremie in order to allow a uniform flow of concrete, but it shall not be emptied so that water enters above the concrete in the pipe. At all times after the placing of concrete is started and until all the required quantity has been placed, the lower end of the tremie pipe shall be kept below the top surface of the plastic concrete. This will cause the concrete to build up from below instead of flowing out over the surface, and thus avoid formation of layers of laitance. If the charge in the tremie is lost while depositing, the tremie shall be raised above the concrete surface, and unless sealed by a check valve it shall be re-plugged at the top end, as at the beginning, before refilling for depositing further concrete.

Drop Bottom Bucket

The top of the bucket shall be closed. The bottom doors shall move freely downward and outward when tripped. The bucket shall be filled completely and lowered slowly to avoid

backwash. It shall not be dumped until it rests on the surface upon which the concrete is to be deposited and when discharged shall be withdrawn slowly until well above the concrete.

To minimize the formation of laitance, great care shall be exercised not to disturb the concrete as far as possible while it is being deposited.

CURING OF CONCRETE

PROTECTION AND WATER CURING

Immediately after compaction, concrete shall be protected against harmful effects of weather, including rain, running water, shocks, vibration, traffic, rapid temperature changes and premature drying out. It shall be covered with wet sacking, Hessian or other similar absorbent material approved by the Engineer-in-charge soon after the initial set, and shall be kept continuously wet for a period of not less than 21 days from the date of placement. Masonry work over the foundation concrete may be started after 48 hours of its laying but the curing of concrete shall be continued for a minimum period of 21 days.

STEAM CURING

Where steam curing is adopted it shall be ensured that it is done in a suitable enclosure to contain the live steam in order to minimize moisture and heat losses. The initial application of the steam shall be from two to four hours after the final placement of concrete to allow the initial set of the concrete to take place.

Where retarders are used, the waiting period before application of the steam shall be increased from four to six hours.

The steam shall beat 100% relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. The application of steam shall not be directly on the concrete, and the ambient air temperature shall increase at a rate not exceeding 5 deg. cent. per hour until a maximum temperature of 60 deg. cent. to 70 deg. cent. is reached. The maximum temperature shall be maintained until the concrete has reached the desired strength.

When steam curing is discontinued the ambient air temperature shall not drop at a rate exceeding 5 deg. centigrade per hour until a temperature of about 10 deg. cent. above the temperature of the air to which the concrete will be exposed, has been reached.

WORKING IN EXTREME WEATHER

When depositing concrete in very hot weather, precautions shall be taken so that the temperature of wet concrete does not exceed 38 deg. C while placing. This shall be achieved by stacking aggregate under sheds and keeping it moist using cold water or crushed or flaked ice if specified and permitted by the Engineer, reducing the time between mixing and placing to the minimum, cooling formwork by sprinkling water on the exterior, starting curing before the concrete dries out and restricting concreting, as far as possible, to mornings and evenings.

During hot weather and rains the concrete shall be covered with tarpaulin and transported and placed in the forms and consolidated to final state. Commencement of concrete pours shall be avoided during heavy rains, storms and high winds.

FINISHING

Immediately after the removal of forms, all exposed bars or bolts passing through the reinforced cement concrete member and used for shuttering or any other purpose shall be cut inside the reinforced cement concrete member to a depth of at least 25 mm below the surface of the concrete and the resulting holes be closed by cement mortar. All fins caused by form

joints shall be broken. All cavities produced by the removal of form ties, all holes and depressions, honey-comb spots, broken edges or corners and all other defects shall be thoroughly cleaned, saturated with water and carefully pointed and rendered true with mortar of cement and fine aggregate mixed in the proportions used in the grade of concrete that is being finished of as dry a consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surfaces which have been filled/pointed shall be kept moist for a period of twenty-four hours. Any repair and rectification of defective work is to be undertaken and carried out as directed by the Engineer-in-charge.

If soft pockets/honey-combs, in the opinion of the Engineer-in-charge, are of such an extent or character as to affect the strength of the structure materially or to endanger the life of the steel reinforcement, he may declare the concrete defective and require the removal and replacement of the portions of the structure affected.

All construction and expansion joints in the completed work shall be left carefully tooled and free from any mortar and concrete. Expansion joint filler shall be left closed for its full length with clean and true edges.

CONSTRUCTION JOINTS

Concreting shall be carried out continuously upto the construction joints, the position and details of which shall be as shown on approved drawings or as directed by the Engineer-in-charge. Such joints shall, however, be kept to the minimum.

For a vertical construction joint, a stopping board shall be fixed previously at the pre-determined position and shall be properly stayed for sufficient lateral rigidity to prevent its displacement or bulging when concrete is compacted against it. Concreting shall be continued right up to the board. The board shall not be removed before the expiry of the specified period for removal of vertical forms.

Before resuming work at a construction joint where the concrete has not yet fully hardened, all laitance shall be removed thoroughly, care being taken to avoid dislodgement of coarse aggregates.

When work has to be resumed on a surface which has hardened, the surface shall be thoroughly hacked, swept clean, wetted and covered with a layer of neat cement grout. The neat cement grout shall be followed by a 13 mm thick layer of mortar mixed in the same proportion as in the concrete and concreting resumed immediately thereafter. The first batch of concrete shall be rammed against the old work to avoid formation of any soft pockets, particular attention being paid to corners and close spots.

In all cases, the position and detailed arrangement of all construction joints shall be predetermined and got approved by the Engineer-in-charge.

Measurement of Concrete works

All concrete quantity to be measure in Cubic Meter Shuttering included. Id shuttering is separate it should be measure in Square Meter.

Concrete works IS 1200 Part 2	
Sr. No.	**Description**
	Unit
1	Concrete works to be measured in Cubic meter
	Finishing surface

1	Hacking or making rough surface should be included in description
	Measurement
1	No deduction for the following
a	Ends of dissimilar materials for example, beams, posts, girders, rafters, purlins, trusses, corbels and steps up to 500 square centimeter in cross-section;
b	Opening up to 0.1 square meter
c	Volume occupied by reinforcement
d	Volume occupied by pipes, conduits, sheathing, etc, not exceeding 100 square centimeter each in cross-sectional area or as specified
e	Small voids not exceeding 40 square centimeter each in cross-section
2	Columns shall be measured from top of column base to underside of first floor slab and subsequently from top of floor slab to underside of floor slab above.
3	For Flat slab flare of column shall be included with column for measurement.
4	Beams shall be measured from face to face of columns and shall include haunches, if any, between columns and beams. The depth of beams shall be measured from bottom of slab to bottom of the beam except in case of inverted beam where it shall be measured from top of slab to top of beam.
5	CHAJJA shall be measured inclusive of bearing. When CHAJJA is combined with lintel, beam or slab, it shall be measured as clear projection.
6	Forming Cavity in Wall shall be measured in square meter.
7	Concrete Casing to Beams and Steel Stanchions should be measured in cum and no deduction for beams
8	Boxed stanchions or girders, in which case boxed portion only shall be deducted.
9	Concrete in channel shall be measured in cubic meters. Volume of channel shall be deducted from the concrete. Where shape of cross-section is round, elliptical or oval, area of section shall be taken as three-fourth of the width at top, multiplied by average depth at center.
	Pre-stressing concrete works
1	Grouting work is measured in Running meter

2	Strands is measured in Kilo grams

PLUMBING WORKS

General

General conditions of contract, particular specifications and special conditions of contract will apply in addition to this section.

Basis Of Tendering :-

The tender shall be complete covering the entire work of plumbing system and ancillary services including all building system and outside utilities as shown and specified.

The contractor shall consult specifications, drawings and the schedule of quantities which are instruction on this system.

Drawing :-

The drawings accompanying these specifications are design drawings and generally are schematic. They do not show every offset, T, Cross, Y, junction coupling/flanges etc., which are required for installation in the space provided.

The contractor shall prepare detailed shop drawings by following these drawings, as closely as is practicable, with necessary additional bends, elbows or junctions etc., where required to suit local site conditions, from actual site measurement taken, get the same approved from the Consultants in good time & follow then at site, without additional cost to the Employer.

The Employers reserve the right to make any reasonable change in outlet location prior to roughing in. All connections and appurtenances, shown in the various diagrams, shall be included in the finished job. The contractor shall visit the site prior to bidding, to familiarize itself with all conditions.

It shall be the contractor's responsibility to co-ordinate with all others for proper and adequate installation clearances.

Ordinance, Code And Regulations:-

It shall be the Contractor's responsibility to provide complete system, as indicated and as required by applicable code. Unless, otherwise approved the product shall bear the mark of approval of ISI as required by the Governing bodies, code and ordinances and local authorities, whose permission are required for occupation of the building on completion.

Measurement Lines & Levels :-

Check dimension at the building site and establish lines and levels for the work specified.

All inverts, slopes and manhole elevations shall be established by instruments, working from an established datum point. Elevation markers and lines shall be provided for Employer's use, to determine that slopes and elevations are in accordance with the drawings and specifications and local bylaws.

Established grid and area lines shall be used for location of trenches in relation to building and boundaries. Trenches shall be carried out to the true alignment and to required levels. No refilling will be allowed for the purpose of making up the bed of trenches, but, to make up the same with lean concrete mix 1:4:8 (at contractors cost including cost of cement).

Use of sight rails, boning rods shall be adopted during the whole process of excavation and laying of the pipes

Sight rails shall be fixed at suitable intervals which shall not exceed twenty meters before the excavation is begun. No extra charges will be paid for excess excavation.

Sufficient width shall be provided to the trenches to allow a space of minimum 150 mm on either side of the body of drain to facilitate laying of the drains and jointing. Extra width shall be provided at the joints.

When the trenches are in deep or in bad ground, the sides of the trenches shall be supported with suitable timbering.

All pipes, water mains, or gas mains, telephone and electric cables etc., met within the course of excavation, shall be carefully protected and supported without any extra charge.

Excavation & Backfill:-

General:-

Perform all necessary excavation and backfill required for installation of plumbing work, excavation shall confirm to the limits indicated on the drawings.

All the material shall be new of best quality conforming to specifications and subject to the approval of the Architects. Drainage lines shall be laid to the required gradients and profiles. All drainage work shall be done in accordance with the local municipal by-laws.

Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority. Location of all manholes, catch basins etc.

Shall be finalized and shown in approved shop drawings before the actual execution of work at site. All work shall be executed as directed by the Project Manager.

Alignment & Grade

The sewer and storm water drainage pipes shall be carefully laid to levels and gradients shown in the plans and sections but subject to modifications as shall be ordered by the Architects from time to time to meet the requirements of the works. Great care shall be taken to prevent sand etc. from entering the pipes. The pipes between two manholes shall be laid truly in straight lines without vertical or horizontal undulations. The body of the pipes shall rest on an even bed in the trench for its length and places shall be excavated to receive collar for the purpose of jointing. No deviations from the lines, depths of cuttings or gradients as called for on the drawings shall be permitted without the written approval of the Architect. All pipes shall be laid at least 60cms below the finished ground level or as called for on the drawings.

Setting out Trenches

The contractor shall set out all trenches, manholes, chambers and such other works to true grades and alignments as called for. He shall provide the necessary instruments for setting out and verification for the same. All trenches shall be laid to true grade and in straight lines and as shown on the drawings. The trenches shall be laid to proper levels by the assistance of boning rods and sight rails which shall be fixed at intervals not exceeding 10 meters or as directed by the Project Manager.

Excavation: -

Excavate trenches to the necessary depths and width, removing rocks, roots stumps and shrubs existing old foundations etc. Cost of additional excavation to facilitate utility cross over, additional offsets, etc., shall be not be paid extra. Excavation material is unclassified except rock which will be treated as per tender condition given separately. Width of trench shall be adequate for proper installation of piping.

The trenches for the pipes shall be excavated with bottoms formed to level and gradients as shown on the drawings or as directed by the Project Manager. In soft and filled in ground, the Project Manager may require the trenches to be excavated to a greater depth than the shown on the drawings and to fill up such additional excavation with concrete (1:4:8) consolidated to bring the excavation to the required levels as shown on the drawings.

All excavations shall be properly protected where necessary by suitable timbering, piling and

sheeting as approved by the Project Manager. All timbering and sheeting when withdrawn shall be done gradually to avoid falls. All cavities be adequately filled and consolidated. No blasting shall be allowed without prior approval in writing from the Architect. It shall be carried out under thorough and competent supervision, with the written permission of the appropriate authorities taking full precautions connected with the blasting operations. All excavated earth shall be kept clear of the trenches to a distance equal to 75 cms.

Timbering of Sewer and Trenches

The Contractor shall at all times support efficiently and effectively the sides of all the trenches and other excavations by suitable timbering, piling and sheeting and they shall be close timbered in loose or sandy strata and below the surface of the sub soil water level.

All timbering, sheeting and piling with their walling and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse or subsidence of the walls of the trench shall take place.

The Contractor shall be held responsible and shall be accountable for the sufficiency of all timbering, bracings, sheeting and piling used and also for, all damage to persons and property resulting from improper quality strength placing, maintaining or removing of the same.

Obstruction Road

The contractor shall not occupy or obstruct by its operation more than one half of the width of any road or street and sufficient space shall then be left for public and private transit. He shall remove the materials excavated and bring them back again when the trench is required to be refilled. The contractor shall obtain the consent of the Project Manager in writing before closing any road to vehicular traffic and the foot walks must be clear at all times.

Protection of Pipes

All pipes, water mains, cables etc. met in the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the cables, the removal of which shall be arranged by the contractor with the written consent from the Project Manager.

Removal of Filth

All night soil, filth or any other offensive mater met with during the execution of the works, shall not be deposited on the surface of any street or where it is likely to be a nuisance or passed into any sewer or drain but shall be immediately, after it is taken out of any trench, sewer or cess pool, put into the carts and removed to a suitable place to be provided by the Contractor.

Water: -

Keep all excavation free of stagnant subsoil water. Excavation damaged or softened by water shall be re-excavated and filled back to original level with approved selected natural fill material placed and compacted as specified herein below under item 6.5 at no expenses to the Employers. Provisions for shoring, pumping, bailing out, draining out, dredging and disposal of subsoil water or rain water shall be made at no expense to the Employers.

Bedding: -

Concrete bedding for drain shall be cement concrete having a mix proportioned in parts by volume of 1:3:6. Lay the drains on a bed of concrete 75 mm thick and of specified width benched halfway up on both sides to the crown of the pipe.

Backfill: -

The trenches shall be backfilled using selected excavated materials in 200 mm layers and carefully rammed well and consolidated with the addition of water and compacted to 95% of maximum density at optimum moisture content as determined by the standard penetration tests. For 150 mm all-round the pipe only selected material or in its absence sand or pea gravel will be allowed for backfilling.

Width Of Trench

The Project Manager shall have power by giving an order in writing to the Contractor to increase the maximum width/depth for excavation and backfilling in trenches for various classes of sewer, manholes and other works in certain length to be specifically laid down by him, where on account of bad ground on other unusual conditions, he considers that such increased width/depths are necessary in view of the site conditions.

Grading: - Following backfilling, grade all trenches to the level of surrounding soil. Surplus earth shall be carried away or dumped at site as directed.

Tests:- During the progress of the work for compacted fill, the Employers reserves the right to provide compaction tests made under direction of an independent testing agency.

Contractor to restore settlement and Damages

The contractor shall at its own costs and expenses, make good promptly during the whole period for the works in hand if any settlement occurs in the surfaces of roads, beams, footpaths, gardens, open spaces etc. in the public or private areas caused by its trenches or by its other excavations and he shall be liable for any accident caused thereby. He shall also, at its own expense and charges, repair (and make good) any damage done to building and other property. If in the opinion of the Project Manager he fails to make good such works with all practicable dispatch, the Project Manager shall be at its liberty to get the work done by other means and the expenses thereof shall be paid by the contractor or deducted from any money that may be or become due to him or recovered from him by any other manner according to the laws of land.

The contractor shall at its own costs and charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled, surplus soil shall be immediately removed, the surface shall be properly restored and roadways and sides shall be left clear.

A) GENERAL SPECIFICATION FOR ELECTRICAL WORKS

The general character and the scope of work to be carried out under this contract is Illustrated in Drawings,
Specifications and Schedule of Quantities. The Contractor shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the client's site representative. The Contractor shall furnish all labour, materials and equipment (except those to be supplied by the client) as listed under Schedule of Quantities and specified otherwise, transportation and incidentalnecessary for supply, installation, testing and commissioning of the complete system as described in the Specifications and as shown on the drawings. This also includes any material, equipment, appliances and incidental work not specifically mentioned herein or noted on the Drawings/Documents as being furnished or installed, but which are necessary and customary to be performed under this contract.

The scope of work shall generally comprise, but not limited to the following:

a) Supply, Installation, Testing & Commissioning of Isolation Transformer.

b) Supply, Installation, Testing & Commissioning of 415 V Main LT Panel, Isolator Panel, Outdoor Type Power Panel, etc.

c) Supply,Installation,Testing & Commissioning of LT Cables.

d) Any other items specified in Schedule of Quantities.

1.1 General Condition of Contract

i) The general specification for electrical works (Internal) aims to lay down general guidelines to ensure safe, efficient, reliable and economical use of electricity.
ii) While these Specifications serve as general guidelines, appropriate technical sanctioning authority can depart from such guidelines to meet the particular requirements of any work or for other technical reasons.
iii) This Chapter covers the general and technical requirements applicable to works contract for execution of Internal & External Electrical Installation works.
iv) It is the responsibility of the contractor to coordinate with various utility agencies, the exact location of such point of supply and mode of connection.Power Supply shall be available at one location & agency has to make further arrangement for his work.
vi) The contractor shall get approval for the work, etc from Client/Consultants
vii) Before procuring any new item, the contractor should take approval from the client/consultant.

1.2 Related Documents:

Each work has its own particular requirements. Therefore, in addition to the GeneralSpecifications, governing BIS, I.E. Rules, Standard Contract Conditions etc. therewould be necessity of Additional
conditions/Specifications for a particular work. Incase of any discrepancy such additional conditions/ specifications will overridethese General Specifications.

1.3 Terminology:
The definition of terms shall be in accordance with IS: 732-1989 (Indian Standard Code of Practice for Electrical Wiring), except for the definitions of point, circuit, and sub main wiring, which are defined in this specification.

1.4 Works to be done by the Contractor:
Unless and otherwise mentioned in the tender documents, the following works shall be done by the contractor, and therefore their cost shall be deemed to be included in their tendered cost: -
(i) Foundations for equipment's and components where required, including foundations bolts.
(ii) Cutting and making good all damages caused during installation and restoring the same to their original finish.
(iii) Sealing of all floor openings provided by him for pipes and cables, from fire safety point of view, after laying of the same.
(iv) Painting at site of all exposed metal surfaces of the installation other thanpre-painted items like fittings, fans, switchgear/distribution gear items, cubicle switchboard etc. Damages to finished surfaces of these items while handling and erection, shall however be rectified to the satisfaction of the Engineer-in-charge.
(v) Testing and commissioning of completed installation.

1.5 Electric Power Supply and Water Supply:
Unless and otherwise specified, power supply and water supply will be arranged by the Contractor at the site for installation purpose.
Contractor will take due care to ensure safety of Electrical installation during execution of work.

1.6 Tools for handling and erection:
All tools and tackles required for handling of equipments and materials at site of work as well as for their assembly and erection and also necessary test instrumentsshall be the responsibility of the contractor.

1.7 Co-ordination with other agencies:
The contractor shall co-ordinate with all other agencies involved in the building work so that the building work is not hampered due to delay in his work.

1.8 Care of Buildings:
Care shall be taken by the contractor to avoid damage to the building during executionof his part of the work. He shall be responsible for repairing all damages and restoringthe same to their original finish at his cost. He shall also remove at his costs allunwanted and waste materials arising out of his work from the site.

1.9 Structural Alterations to Buildings:
(i) No structural member in the building shall be damaged/altered, without prior approval from the competent authority through the Engineer-in-charge.

(ii) Structural provisions like openings, cut-outs, if any, provided by the department for the work, shall be used. Where these require modifications, or where fresh provisions are required to be made, such contingent works shall be carried out by the contractor at his cost.
(iii) All such openings in floors provided by the Department shall be closed by the contractor after installing the cables/conduits/rising mains etc. as thecase may be, by any suitable means as approved by the Engineer-in-chargewithout any extra payment.
(iv) All chases required in connection with the electrical works shall be provided and filled by the contractor at his own cost to the original architecturalfinish of the buildings.

1.10 Addition to an installation:
Any addition temporary or permanent to the existing electrical installation shall not be made without a properly worked out scheme/design by a qualified Electrical Engineer to ensure that such addition does not lead to overloading, safety violation of the existing system.

1.11 Drawings:
(i) The work shall be carried out in accordance with the drawings enclosed with the tender documents and also in accordance with modification thereto from time to time as approved by the Engineer-in-charge.
(ii) All General Arrangement Drawing of panels,wiring diagrams shall be deemed to be 'Drawings' within the meaning of the term. They shall indicate the locations,no of runs of various cables and sub mains.

1.12Conformity to IE Act, IE Rules and standards:
All Electrical works shall be carried out in accordance with the provisions of Indian Electricity Act, 2003 and Indian Electricity Rules, 1956 amended up to date (Date of call of tender unless specified otherwise). List of Rules of particular importance to Electrical Installations under these General Specifications is given in Appendix C for reference.

1.13 General requirements of components:

1.13.1 Quality of materials:
All materials and equipments supplied by the contractor shall be new. They shall be of such design, size and materials as to satisfactorily function under the rated conditions of operation and to withstand the environmental conditions at site.

1.13.2 Inspection of materials and equipments: (FACTORY INSPECTION AND TESTING)
The Client may carry out inspection and testing at Manufacturer's works for equipment covered herein. All
such testing and inspection expenses shall be to Contractor's account. Such tests shall generally prove that the equipment to be supplied complies the Specifications and relevant Standards. Tests shall also demonstrate suitability in terms of site conditions, operational and control facilities, circuitry of controls, protection etc.

If performance tests are not satisfactory, the Contractor shall, at his own expenses, rectify the defects observed, and re-conduct the tests to Client's satisfaction. The equipment shall be tested again after removal of defects, found if any, and shall be delivered and installed only after approval by the Client's representative.

Equipment shall be delivered without the consent from Client, in writing.

(a) Materials and equipments to be used in the work shall be inspected by the Departmental officers. Such inspection will be of following categories:
(i) Inspection of materials/equipments to be witnessed at the Manufacturer's premises in accordance with relevant BIS/Agreement Inspection Procedure.
(ii) To receive materials at site with Manufacturer's Test Certificate(s).
(iii) To inspect materials at the Authorized Dealer's Godowns to ensure delivery of genuine materials at site.
(iv) To receive materials after physical inspection at site.

(b) The Departmental officers will take adequate care to ensure that only tested and genuine materials of proper quality are used in work(c) Similarly, for fabricated equipments, the contractor will first submit dimensional detailed drawings for approval before fabrication is taken up in the factory. Suitable stage inspection at factory also will be made to ensure proper use of materials, workmanship and quality control.

(c) The tender specifications will stipulate the Inspection requirements or their waiver for various materials/equipments including norms of inspection in specific cases.

1.13.3 Ratings of Components:
(a) All components in a wiring installation shall be of appropriate ratings of voltage, current, and frequency, as required at the respective sections of the electrical installation in which they are used.
(b) All conductors, switches and accessories shall be of such size as to be capable of carrying the maximum current, which will normally flow through them, without their respective ratings being exceeded.

1.13.4 Conformity to standards:
(a) All components shall conform to relevant Indian Standard Specifications, wherever existing. Materials with ISI certification mark shall be preferred.
(b) A broad list of relevant Indian Standards is given in Appendix D. These Indian Standards, including amendments or revisions thereof upto the date of tender acceptance, shall be applicable in the respective contracts.

1.13.5 Interchangeability:
Similar parts of all switches, lamp holders, distribution fuse boards, switch gears, ceiling roses, brackets, pendants, fans and all other fittings of the same type shall be interchangeable in each installation.

1.14 Workmanship:

1.14.1 Good workmanship is an essential requirement to be complied with. The entire work of manufacture/fabrication, assembly and installation shall conform to sound engineering practice.

1.14.2 Proper supervision/skilled workmen:

The contractor shall be a licensed electrical contractor of appropriate classsuitable for execution of the electrical work. He shall engage suitably skilled/licensed workmen of various categories for execution of work supervised by supervisors / Engineer of appropriate qualification and experience to ensure proper
execution of work. They will carry out instructions of Engineer-in-charge and other senior officers of the Department during the progress of work.

1.14.3 Use of quality materials:

Only quality materials of reputed make as specified in the tender will be used in work.

1.14.4 Fabrication in reputed workshop:

Switch boards and LT panels shall be fabricated in a factory/workshop having modern facilities like quality fabrication, seven tank process, powder/epoxy paint plant, proper testing facilities, manned by qualified technical personnel.

1.15 Testing:

All testes prescribed in these General Specifications, to be done before, during andafter installation, shall be carried out, and the test results shall be submitted to theEngineer-in-charge in prescribed Performa, forming part of the Completion Certificate.

1.16 Commissioning on Completion:

After the work is completed, it shall be ensured that the installation is tested and commissioned.

1.17 Completion Drawings and Completion Certificate:

(i) For all works completion certificate after completion of work shall be submitted to the Engineer-in-charge.

(ii) Completion drawings drawn to a suitable scale and readable size, clear white papers (three sets) indicatingthe following, along with three blue print copies of the same shall also besubmitted.

(a) Single Line Diagram of all Panels

(b)) Name of work, job number, accepted tender reference, actual date of completion and name of the firmwho executed the work with their signature.

1.18 Guarantee

The installation will be handed over to the Department after necessary testing and commissioning. The installation will be guaranteed against any defective design/ workmanship. Similarly, the materials supplied by the contractor will be guaranteed against any manufacturing defect, inferior quality. The guarantee period will be fora period as indicated in the General/Special Conditions of Contract from the date of handing over to the Department. Installation/equipment’s or components thereof shall be rectified/ repaired to the satisfaction of the Engineer-in-charge.

B) TECHNICAL SPECIFICATION FOR LT PANEL

SCOPE OF WORK:

This specification covers Design, Fabrication, Supply, Installation, Testing & Commissioning of Metal enclosed Switchgears.

Applicable Standards:

The switchgear and its components shall conform to the latest applicable standards specified below. In case of conflict between the standards and this specification, this specification shall govern.

Switchgear General Requirements.	IS:13947/BS:5486/IEC:947
Factory Built Assemblies of SWGR and Control gear for voltages upto and including 1000V AC & 1200V DC.	IS:8623/BS:5486/IEC:439
Air Break Switches	IS:13947-P3/BSEN 60947/IEC:947-3
Miniature Circuit Breakers	IS:8828/BSEN:60898
Low Voltage Fuses	IS:13703/BSEN 60947-4/IEC:947-1
Contactors	IS:13947/BSEN 60947-4/IEC:947-1
Starters	IS:13947/BSEN 60947-4/IEC:292-1 TO 4
Control Switches / Push Buttons	IS:6875/BSEN 60947
Current Transformers	IS:2705/BS:7626
Voltage Transformers	IS:3156/BS:7625/IEC:44, 186
Indicating instruments	IS:1248/BS:89/IEC:51
Marking and Identification of Conductors and Apparatus Terminals	IS:11353/BS:159
A.C. Electricity Meters	IS:722, 8530/BS:5685/IEC 145, 211
Degree of Protection	IS:13947/IEC:947-P1
Selection installation and maintenance of switch gear and control gear	IS:10118
Code of practice for phosphate iron and steel	IS:6005/BS:3189

Specification for copper rods and bars for electrical purposes	IS: 613
Control transformers for switch gear and control gear voltage not exceeding1000V AC	IS: 12021
Circuit Breakers	IS-13118, BS-5311, IEC-56 & 694 BSEN-60942 (P-2)
Control Switches	IS-6875/BSEN60947, IEC-947
Wrought aluminum and aluminum alloy bars, rods, tubes and sections for electrical purposes	IS: 5082
Marking and arrangement for switchgear, bus bars main connection and auxiliary wiring.	IS-5578 IS-11353

Construction Details:

The switchgear shall be metal enclosed, modular type suitable for indoor floor mounting and shall have following features.
Shall be fabricated by using Stainless Steel-304, IP-65.
All cubicles / panels shall comprise of rigid welded structural frames made of pressed and formed stainless steel sheet of thickness not less than 2.5 mm. (12SWG) Cladding of the frames and doors shall be made out of 2mm(14SWG) & 1.6 mm.(16SWG) thick sheet steel respectively. All cable gland plates shall be made out of 3 MM (10SWG) thick sheet steel plates.
All cubicles shall be provided with ISMC-75 channel base frame.
Height shall not exceed 2375 mm. Normal operating height shall not exceed 1850 mm.
Shall be single/double front execution as specified in specific requirements and shall be of dead front type. Whenever specified in specific requirements, single front execution panel shall not need rear access for operation or maintenance purpose.
Shall have designation labels both on front and rear sides.
Shall be provided with neoprene gaskets for removable covers, doors, between panels and base frame and all around the perimeter of adjacent panels.
Switchgear panel shall be extensible on both sides.
Switchgear panel shall be suitable for top/bottom, cable/bus bar entry as specified. There shall be adequate space for ease of termination of aluminum conductor multi core cables, selected with 60% derating factor.
Switchgear shall be divided into distinct vertical sections each comprising:
A completely enclosed bus bar compartment running horizontally
Enclosed vertical bus bars serving all modules in vertical section.
A separate horizontal enclosure for all auxiliary power and control buses, if required.
Vertical cable alley of minimum 300 mm wide covering entire height with undrilled detachable gland plate
Minimum feeder section width shall be 450mm & height 250mm
Operating devices shall be incorporated only in the front of switchgear.
Each shipping section shall have metal sheets at both ends.
Cable alley shall be provided with suitable hinged doors.

Rear of single front switchgear shall be provided with removable panels with captive screws. The panel covers shall be provided with suitable arrangement for removing the cover.

All doors shall be with concealed type hinges and captive screws. Doors shall be provided with right angle turn type door lock.
Each vertical section shall be equipped with a space heater controlled by thermostat.
Each switchgear cubicle shall be provided with interior lighting with a 20 W fluorescent tube or 25 W clear glass lamp with pin type holder with on/off MCB control.
A 240 V, 1- phase, AC Industrial type, metal clad plug point shall be provided in the interior of each cubicle with on-off MCB for connection of hand lamps/blowers.

Interchangeability:

All identical equipment and corresponding parts be fully interchangeable without any modifications.
Main and Auxiliary Buses:

(i) Switchgear bus bars shall be of uniform cross section throughout the length and made of high conductivity, Aluminium conductor (Ref SLD).

Bus bars shall be provided with at least the minimum clearances in air as specified.
All bus bars, bus taps shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free heat shrunk PVC insulation of high dielectric strength to provide a permanent high dielectric non-aging and non-tracking protection, impervious to water, tropical conditions and fungi. The insulation shall be non-inflammable and self-extinguishing and in fast colours to indicate phases. The joints shall be insulated in such a way as to provide for accessibility of contact bolts for maintenance. The dielectric strength and properties shall hold good for the temperature range of 0 to 90 degree centigrade. If the insulating sleeve is not colored, bus bars shall be colour coded with colored bands at suitable intervals. Both main horizontal bus bars and vertical bus bars serving modules shall be insulated.

Bus bar joints shall be of the bolted type and shall be insulated. Spring washers shall be provided to ensure good contact at the joints. Bus bars shall be thoroughly cleaned at the joint locations and suitable contact grease shall be applied just before making a joint.

Bus bars shall be located in air-insulated enclosures. Direct access to, or accidental contact with bursars and primary connections shall not be possible. All apertures and slots shall be protected by baffles to prevent accidental shorting of bus bars by the entry of maintenance tools. To provide a tight seal between cubicles, bushings or insulating panels shall be provided for bus bars crossing from one cubicle to another.

Each switchgear cubicle shall be fitted with a label on the front and rear of the cubicle. Each switchgear shall also be fitted with a label indicating the switchgear rating and duty.
Each relay, instrument, switch, fuse and contactor shall be provided with a separate label.
Switchgear shall be complete with inter-panel wiring.
One metal sheet shall be provided between two adjacent vertical sections running to the full height of the switchgear except for the horizontal bus bar compartment. However, each shipping sections shall have metal sheets at both ends.

After isolation of the power and control connections of a circuit, it shall be possible to safely carry out maintenance in a compartment with the bus bars and adjacent circuits alive.
All draw out contacts shall be of silver plated copper.
Clamping arrangement shall be provided for incoming & outgoing cables.

Pre-treatment and Painting:
All metal work of the fabricated panel shall undergo a seven-tank process of degreasing, pickling in acid, cold rinsing, phosphate, passivating etc., in seven-tank treatment plant before painting.
The treated panel shall be painted in 2 coats of high corrosion resistant primer. The primer shall be baked in oven.
The finishing treatment shall be by synthetic enamel or epoxy paint with powder coated finish, as specified. In case of powder coated finish (b) above is not applicable.

Moulded Case Circuit Breakers:

The MCCB shall be 3 pole / 4 pole as the need be. In case of 4 pole MCCB, the 4th pole shall be 100% rated. The MCCB shall be available in fixed version. It shall be possible to convert the MCCB from fixed to plug in/draw out version. The MCCB shall be manually operated. It shall be possible to convert the MCCB from manually operated to motorized MCCB and vice-versa. Moulded case circuit breakers (MCCB) shall
have Thermal magnetic/Microprocessor-based release with overload, short circuit & earth fault protection, as specified. The release shall have communication in future if specified. The MCCB shall be suitable for adapting accessories, such as auxiliary contact block, extended terminal cover & phase barrier etc.

The input and output terminals of the MCCB unit shall be extended and separated so that aluminium cables of given sizes can be easily terminated in the panel.
The MCCB shall be provided with front drive mechanism with door interlock with interlock defeating facility.
The MCCB shall be provided with variable range operating time on short circuit.
The MCCB shall be provided with auxiliary contact block.
The MCCB shall be fully rated for 50oC ambient temperature.

Air Circuit Breakers (ACB)

Scope:
Supplying, erecting, and commissioning of Air Circuit breaker of specified rating, confirming to IS 2516/IES157 manually operated non draw out type/draw out type erected at position in provided panel board in approved manner.

Material:
Air Circuit Breaker:
Draw out type/non draw out type manually quick make quick break type front operated mechanical indication for ON/OFF position with 50 kA short circuit rating. Trip free mechanism with high performance characteristic based on modular construction and should be compact.
The breaker shall have following accessories:
• **Auxiliary Switch:** Auxiliary switch shall consist of 2 NO & 2 NC contacts. The total Auxiliary switch block shall have minimum six auxiliary. In case of draw out breakers two sliding contacts should be provided.
• **Alarm Switch:** For breaker with thermal and magnetic trip units the indication should be direct from trip unit through micro switch with necessary wiring.

• **Shunt Release:** Shunt trips are used for remote control. Shunt trip coil should operate though an auxiliary switch. The operating ranges should be normally 50-110 % of the rated voltage.
• **Under voltage Release:** Under voltage release must be energized before closing breaker. This should be provided for remote control.
• **Over current release:** Over current release shall consist of Current Transformer with slides on each current carrying path of a bi-metal relay common to all transformers. The transformer shall have a fix ratio suited to particular setting range. Overload releases shall be thermal time lagged. Overload relay range shall be 50 % to 100 % of CT ratio. Frame shall facilitate site adjustment from 25-100% of ACB rating to match the load requirement.
• **RA unit -** given for 0-110% operating range of SHT-ensures supply available to shunt trip from same AC source in short circuit condition.
• **RC unit –** for up to 3secs. Time delay with U/V trip. Ideal for protection against transient voltage dips and nuisance tripping continuously adjustable time delay range of 40-500 ms with S/c trip ideal for selective interruption co- ordination of ACB's.
• Contacts made of electrolytic copper of 99.9 % purity, of ACB shall be totally shrouded, for eliminating access to live parts.
• Short Circuit release pick up shall be adjustable for closer protection. Breaker shall be compact in size, for saving space in the cubicle and as far as possible shall be lightweight for easy handling.
• Thermal over load and magnetic short circuit protection shall be provided.

Method of Construction:
The breaker should be erected on provided panel board or cubicle as the case may be, complete with connecting to bus bar by means of provided insulated copper strip of suitable cross section as per the rating, complete.
Mode of Measurement: Executed quantity shall be counted on number basis. (i.e.each)

Switches and Fuses:
415 volts air break switches shall be of the load break, fault make, group operated type. For use on 3 phase systems, the switches shall be of the triple pole type with a link for neutral wire. For use on single-phase system or DC systems, the switches shall be of the two-pole type.
Switches shall be of heavy duty, quick make and quick break type. Switch contacts shall be silver plated and contact spring shall be of stainless steel. Switch handles shall have provision for locking in both fully open and fully closed positions. Mechanical ON/OFF indication shall be provided on the switches.
Switches for controlling motor circuits shall be of the load break, fault make type and shall be capable of breaking locked rotor current of the associated motor.
415V switches and fuses shall be provided with the following interlocks so that:
The fuses are not accessible unless the switch is in fully open condition.
It is not possible to close the switch when the fuse cover is open, but an authorized person may override the interlock and operate the switch. After such an operation, the cover shall be prevented from closing if the switch is left in the 'ON' position.
All fuses shall be of HRC cartridge type, mounted on plug-in type of fuse bases. Fuses shall be provided with visible indicators to show that they have operated.
Earthling and neutral lines in main supply circuits shall be of solid silver plated copper and be of bolted pattern.
Fuses and links functionally associated with the same circuit shall be mounted side by side.

Current Transformers:

(a) Current transformers shall have polarity markings indelibly marked on each transformer and at the lead termination at the associated terminal block.
(b) Current transformers shall be able to withstand the thermal and mechanical s tresses resulting from the maximum short circuit and momentary duties of the sitchgear, as indicated in the Technical Specification.
(c) CT core laminations shall be of high-grade silicon steel.
(d) Identification labels shall be fitted giving type, ratio, rating, output and serial numbers. The label shall be visible after opening the front door without dismantling any component.
(e) Current transformers shall be epoxy resin cast type.
(f) Accuracy Class of Current Transformer for
For Protection → 5P20
For Metering → Class 1
For Restricted → Class PS

Earth Fault:

Internal Wiring:
The internal wiring shall be carried out with 650/1100 V grade, PVC insulated, stranded copper conductor wires. The minimum size of conductor for power circuits shall be 4 sq.mm. Copper. Control circuits shall be wired with copper conductor of at least 1.5 sq.mm. CT secondary circuits shall be wired with 2.5 sq.mm. Stranded Copper conductor.

All wiring shall be run on the sides of panels and shall be nearly bunched and cleaned without affecting access to equipment mounted in the panel.
All wiring shall be taken to terminal blocks without joints or tees in their runs.
All wiring shall be colour coded as follows:

Instrument Transformer	Red, Yellow or Blue determined by the AC circuits phase with which the wire is associated.
AC phase wire	White
AC neutral	Black
DC circuits	Grey
Earth connections	Green

Engraved core identification ferrules, marked to correspond with the wiring diagram shall be fitted to each wire and core of multicore cables terminated on the panels. Ferrules shall fit tightly on wires, without falling off when the wire is removed. Ferrules shall be 'V' type of white or yellow colour with black lettering.
Spare auxiliary contacts of electrical equipment shall be wired to terminal blocks.

Control and Selector Switches:
Control and selector switches shall be of the rotary type, having enclosed contacts, which are accessible by the removal of the cover.

Control and selector switches for instruments shall be flush mounted on the front of the panels and desks. Local / Remote selector switches when located on switchgear cubicles, shall be mounted inside the relay compartment at an accessible location.
All control switches shall be of the spring return to normal type. Circuit breaker control switches on switchgear cubicles shall be lockable in the “trip” position.

Control switches shall have momentary contacts. Circuit breaker control switches shall be provided with a sequencing device to prevent repetitive closing operations without first moving to the trip position.
Selector switches shall be of the stay put, maintained contact type.

Indicating Instrument & Meters:

Electrical indicating instruments shall be either analogue type or digital type as specified. Analogue instrument shall be 144 sq.mm. With 2400 scale or 96 sq.mm. With 2400 scale as specified in specific requirements. Taut band types of instruments are preferred. Taut band moving coil instruments for use on AC systems shall incorporate built-in transducers.
Instrument dials shall be white with black numbers and lettering. Dials shall be parallax free.
Nominal maximum meter reading shall be of the order of 60% normal full-scale deflection.
Ammeters for motor feeders shall have suppressed scale to show current from full load unto six times the full load current.

Instruments shall have an accuracy of Class 1.0.
Digital instruments shall be suitable for panel mounting, true RMS type as per required size.

Indicating Lamps:

Indicating lamps shall be LED cluster type, with low watt consumption. Indicating lamp shall be of the double contact; bayonet cap type rated for operation for either a 240 V AC or specified DC system voltage as applicable. Indicating lamps shall be provided with series resistance. Lamps shall be provided with translucent lamp covers.
Bulbs and lenses shall be interchangeable and easily replaceable from the front.

Space Heaters:

Adequately rated anti-condensation space heaters shall be provided, one for each vertical cubicle of switchgear, for each separate control panel, for each distribution board, for each switchboard.
Space heater shall be of the industrial strip continuous duty type, rated for operation on a 240 V, 1-phase, 50 Hz, AC system.
Each space heater shall be complete with single pole MCB with overload and short circuit release in the phase, link in the neutral, and a control thermostat to cut off the heaters at 450 C.

Safety Arrangements:

All terminals, connections, relays and other components, which may be “live” when front access doors are open shall be adequately screened. It shall not be possible to obtain access to an adjacent cubicle or module when any door is opened.
Components with the cubicles shall be adequately labeled to facilitate testing.

Where provision is made for the padlocking of components under specific condition (e.g. safety shutters, earthling selectors, etc.) one padlock shall be supplied for each cubicle and each shall have a different lock change number with two keys being provided.

Earthing:

Each Switchgear shall be provided with an earth bus bar running along its entire length. The earth bus bar shall be located at the bottom/top of the Switchgear.
Control Panel and Distribution Board as specified.
Earth bus bars shall be of copper. Earth bus bar shall be rated to carry the rated symmetrical short circuit current of the associated board / panel for one second. Earth bus bars shall be supported to withstand stresses induced by the momentary current of value equal to the momentary rating of the associated Switchgear / Switchboard.
Positive connection of all the frames of equipment mounted in the Switchboard to the earth bus bars shall be maintained through insulated conductors of size equal to the ground bus bar or the load current carrying
conductor, whichever is smaller. Earthling of draw out equipment frames shall be achieved through a separate plug-in contact.
All instrument and relay cases shall be connected to earth bus bar by means of 660 V grade, PVC insulated, stranded, tinned copper, 2.5 sq.mm. Conductor looped through the case earth terminals.

Tools & Tackles:

A complete set of tools and tackles required for erection and maintenance shall be supplied with each Switchgear panel.
Inspection & Testing:
Stage-wise Inspection at Manufacturer's Premises.
All major components of each Panel shall be subjected to Routine Tests as per relevant IEC / IS standards and manufacturers Test Certificate shall be presented at the time of inspection.
Capacitors shall be offered for inspection at Manufacturer's premises.
All routine tests and type Tests as per the specific requirement shall be carried out.

Data / Drawing / Documents:

The vendor shall submit the following data / information / drawings / documents at the inquiry / order execution stages as indicated below:

At Inquiry stage:

- List of deviations clause by clause and reasons.
- Descriptive literature of the various equipment offered with catalogues, if any.
- Guaranteed technical particulars of the equipment as per attached annexure.
- Approximate dimensions and weights and preliminary G.A. drawings, as follows: General arrangement showing plan, elevation and typical section views, particularly typical cross sections, to illustrate cable connections.
- Foundation plan showing location of fixing channels, floor openings etc.
- Schematic wiring diagram.

At Order Stage:

- Within 1 weeks of order, vendor shall submit 4 sets of following documents for purchaser's approval.
- Guaranteed technical and performance particulars.
- G.A. Drawings with dimensions and weight, plan and sections and fixing/ foundation details, as follows: Overall outline dimensions and general arrangement including plan, front elevations, and clearances required in front and back, details of bus duct connections, if any.
- Schematic control diagrams to cover controls, protection, interlocks, switch instruments, space heaters for each type of module.
- Itemized bill of material for each module, listing all devices mounted, indicating type, rating, quantity and special notes, if any.
- Detailed internal wiring diagram of each type of module, including terminal block numbers, ferrule numbers and external cable connection designations.
- Inter panel, inter connection-wiring diagram including terminal numbers and ferrule numbers.

At Final Order Execution Stage:

- The following shall be submitted after inspection but before despatch of the equipment:
- 'As-built' drawings (4 sets + 1 soft copy in CD).
- Routine & Type Test Certificate (including all bought-out components– 4 sets)
- Detailed operation & maintenance manuals (4 sets).
- Detailed erection, testing and commissioning manuals (4 sets)

C) TECHNICAL SPECIFICATIONS OF LV POWER & CONTROL CABLES

Scope:

This specification covers the requirements of design, manufacture, inspection, testing, supply and delivery at site of LV power & control cables.

Site conditions:

Climatic conditions :	Normal
Ambient Temp.	50º C
Elevation	BELOW 1000M.

Seismic zone	As per IS 1893, 2002

Electrical system:

Nominal Voltage	415 V ±10%
Frequency	50 Hz.
No. of phases	3 phase, 4 wire
Neutral grounding	Solidly Earthed.

Standards:

The LV cables shall comply with the requirements of the following standard specifications:

IS 7098 (Part 1) : XLPE cables for voltage up to and including 1.1kV.

IS 8130 : Conductors of insulated cables.

IS 3975 : Mild steel wires, strips & tapes of armouring of cables.

IS 1554 (Part 1) : PVC insulated heavy duty cables.

IEC 502 : Power cables with extruded insulation and their accessories for rated voltage from 1kV.

General construction:

All cables shall be suitable for laying in trays, trenches and buried underground installation with uncontrolled backfill, possibility of flooding by water and suitable for high ambient, high humid tropical Indian climatic conditions. The cables shall be designed to withstand the mechanical, electrical and thermal stresses under the foreseen steady state and transient/fault conditions, and shall be suitable for the proposed method of installation. All power and control cables shall have extruded outer sheath.

XLPE insulated cables:

- 415V system power cables shall be of 1.1kV grade, heavy duty, stranded aluminium conductor, XLPE insulated, armoured, FRLS extruded PVC outer sheathed. (Above 16 sq.mm cable)

- 415V system power cables shall be of 1.1kV grade, heavy duty, stranded copper conductor, XLPE insulated, armoured, FRLS extruded PVC outer sheathed. (Up to 16 sq.mm cable)

- The construction of the conductor shall be stranded and compacted circular up to 10 sq.mm armoured XLPE cables and above 10 sq.mm sector shape conductor to be considered.

- The core insulation shall be with cross-linked polyethylene unfilled insulating compound. It shall be free from voids and shall withstand all mechanical and thermal stresses under steady state and transient operating conditions.

- The inner sheath shall be applied over the laid up cores by extrusion and shall conform to the requirements of type ST 2 compound of IS: 5831. The extruded inner sheath shall be of uniform thickness of size as per IS 7098-Part I.

- The outer sheath for the cables shall be applied by extrusion over the armouring and shall be of PVC compound conforming to the requirements of FRLS type ST 2 compound of IS 5831.

- To protect the cable against rodent and termite attack, suitable chemicals shall be added into the PVC compound of outer sheath.

- The dimensions of the insulation armour and outer sheathing materials shall be governed by values given in Tables 2, 3, 4 & 5 of IS 7098 Part-1.

- The cable shall withstand continuous and short circuit temperature of 90º C and 250º C respectively.

- All armoured and multicore unarmoured cables shall have distinct extruded inner sheath

- Material of inner sheath shall be PVC and shall be with black colour

- Material of armour shall be aluminium wire and GS wire / formed wire for single core and multicore cables as per relevant IS and should be as per IS 7098-Part I.

- Outer sheath of all power cable shall have extruded. Flame retardant low smoke type PVC material shall be used; same shall be with black colour. Polyethylene based halogen free material not acceptable.

- Marking of power cable shall contain cable size, voltage grade and word “FRLS” marking and sequential marking at every 1 meter.

PVC insulated cables (For flexible cables and wires):

All flexible cables and wires shall be provided as per IS 694.

Type:

All cables shall be flame retardant (FR) type.

Inspection & testing:

Representative of the purchaser shall have free access to vendor's works to inspect, expedite and witness shop tests. Any materials or works found to be

defective or which does not meet the requirements of the specification will be rejected and shall be replaced at supplier's cost.

All routine tests shall be carried out on the cables as per relevant Indian Standard Specifications and will be witnessed by the Purchaser.

Four sets of routine test certificates as well as four sets of type test certificates for the type tests carried out on identical cables shall be furnished to the purchaser for reference and record.

Data & information:

Vendor shall furnish with the bid full constructional data along with ratings and other parameters of the cables. Deviations, if any, shall be brought out clearly in the bid.

Packing

The cables shall be supplied in standard drum lengths duly wound on non-returnable wooden drums.Vendor shall ensure that the bending radii of cables are not less than 15 times their overall diameters when wound on drums. Both ends of the cables shall be sealed.

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 asincluded 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 theEngineer 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)

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, semi circular 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 andlayout 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 suitablewooden / epoxy resin cast grips, clamped with 25 x 3 mm or50x6 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***	
Sqmm	**PVC**	**XLPE**	**PVC**	**XLPE**	**PVC**	**XLPE**	**PVC**	**XLPE**
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 (^oC)	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***	***Distance in meters for the following cable sizes in Sqmm***												
	Amp	***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

Plate / Pipe type Earthing

Plate type Earthing (With or Without CI Cover, Funnel, etc)(EA-EP)

Scope:

Specification No (EA-EP)

Supplying and erecting galvanised cast iron / copper earth plate type / G.I. pipe type earthingwith / without C.I. cover as per instructions from the site engineer.

Material:

Earth Plate: Galvanised cast iron / Copper earth plate or G.I. pipe as per specifications given in Table No 9.1/1.

CI Cover: As per specifications given in Table No 9.1/1.
EarthingConductor: Copper/G.I strip/Annealed bare copper wire/G.I. earth wire of size as per specifications given in Table No 9.1/1.
GI Pipe: As per specification **(CW-PLB/GP)**mentioned chapter no. 17.5 for watering, and as enclosure for Earth wire, refer specifications given in Table No 9.1/1.
Hardware: Screw / nut bolts with required washer of dimensions, Rawl plug / clip/ 'U' nails and material as per specifications given in Table No 9.1/1.
Filling material: Coal /Charcoal/ salt as per specifications given in Table No 9.1/1. as per specifications given in Table No 9.1/1.
Lugs: As per specification **(CB-LG/AL, CB-LG/CU)**mentioned chapter 7.9 & 7.10 Copper/ Aluminium lugs as per specifications given in Table No 9.1/1.

Method of construction:

Pit is to be dug of required dimensionanddepthfor the earthing at site, and laying of Galvanised cast iron / Copper earth plate or G.I. pipe shall be as per Table No 9.1/1. The earth connection to equipment/ switch gear and earthing electrode shall be connected as shown in the diagram and as per IS 3043 amended up to-date. The connections shall be made either by strip or double run of earth wire with drilling, welding, riveting, brazing and nut bolting to plate or pipe, where ever required in an approved manner. As far as possible continuous strip shall be used, but where ever jointing of strip is unavoidable, the overlap portion must not be less than $\mathbf{2^{1/2}}$ times the width of the strip either welded/ brazed/soldered by all sides or 6 inches overlap with two nut bolts/ riveting of adequate size with required washer and covered by anti-corrosive paint as per approved jointing practice in the industry and as per directives from site engineer in charge.
Pit shall then be filled with screened soil with alternate layer of coal and salt, and if, necessary brick masonry work (Where ever applicable) shall be done as specified in IS: 3043, with laying wires in PVC/ G.I. pipe and watering arrangement as per and covered with C.I. Cover (Where ever applicable).
Where ever requires or as specified by Site Engineer, a Test link shall be provided for facilitating the testing of resistance of earth electrode.

Testing:

The value of each earth electrode shall be measured by earth tester in presence of site Engineer and record to be submitted.

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

Table No 9.1/1
Detailed Specifications of various types of Earthing

Type of earthing ---------->		Galvanised cast iron earth plate type without C.I cover	Copper earth plate type with C.I cover	Galvanised cast iron earth plate type with C.I cover	Pipe type earthing with out C.I cover
S.No.	Particulars				

1)	**Depth from top of plate Up to Ground level**	1.5 m	1.5 m	1.5 m	1.5 m
2)	**Size & type of material for pipe / Plate type earthing.**	Cast iron earth plate size 60x60x0.6 cms	Copper earth plate size 60x60x0.6 cms	cast iron earth plate size 60x60x0.6 cms	'B' grade G.I. pipe 40mm. dia. 2.5 mtr. Long or 20 mm dia. G.I. Rod
3)	**Salt/charcoal**	30 Kg. charcoal and salt each	30 Kg. charcoal and salt each	40 Kg. charcoal and salt each	N A
4)	**Type of Wire**	Double G.I. wire 8 SWG	Double G.I. 8 SWG	Double G.I. 6 SWG	double G.I. 8 SWG
5)	**Wire enclosure**	12mm. dia. G. I. pipe 2 mtr. Long	12mm. dia. G. I. pipe 2 mtr. Long	12mm. dia. G. I. pipe 2.5 mtr. Long	N A
6)	**Nut bolts**	12 mm dia. Cadmium / GI	12 mm dia. Cadmium / GI	12 mm dia. Cadmium / GI	N A
7)	**Washers**	GI	GI	GI	N A
8)	**Watering pipe**	19mm. dia. G.I. pipe	19mm. dia. G.I. pipe	19mm. dia. G.I. pipe	N A
9)	**Lugs**	Yes	Yes	Yes	Yes
10)	**funnel**	No	yes	yes	N A
11)	**Brick Masonry**	No	yes	yes	N A

Low Impedance Earthing (Pipe in pipe technology)(EA-EPP)

Scope:

Specification No (EA-EPP)

Supplying and erecting approved type earthing system with **Pipe in pipe technology**with necessary ancillary materials and complete erection as per instructions from the site engineer.

Material:

GI Pipe: As per specification no. **(CW-PLB/GP)**mentioned chapter 17.5;

1. 50 mm dia x 3 meter long (In place of traditional GI pipe Earthing), for LV / MV applications.

Or

2. 80 mm x 3 meter long (In place of traditional copper plate Earthing), for HV/EHV applications.

Earthing Conductor: G.I strip/GI earth wire of size as per specifications given in Table No9.1/1.

GI Pipe: As per specification no.(CW-PLB/GP)mentioned chapter 17.5 for watering and as enclosure for Earth wire, as per specifications given in Table No 9.1/1.

Hardware: Screw / nut bolts with required washer of dimensions, Rawl plug / clip/ 'U' Nails and material as per specifications given in Table No 9.1/1.

Filling material: Coal /Charcoal/ salt as per specifications given in Table No 9.1/1.as per specifications given in Table No 9.1/1.

Lugs: As per specification no. (CB-LG/AL, CB-LG/CU)mentioned in chapter 7.9 & 7.10 for Copper/ Aluminium lugs and as per specifications given in Table No 9.1/1.

Method of construction:

Earthing Pipe in pipe technology with ancillary materials shall be done by digging an 8" / 10" dia hand bore 10.5' deep sufficient to install the electrode in normal soil conditions. The space between the soil and the electrode is filled up with electrolyte material mixed with the dug out mother soil, along with water and tightly packed up to the base of the terminal. In rocky areas and under hard soil and sandy soil conditions the method of installation will be as specified by manufacturer. Installation shall include drilling, welding, reverting, brazing and nut bolting pipe when ever required in an approved manner with required material such as nut bolts and washer etc. and with necessary brick masonry work as per the specification. (As per IS 3043 amended up to-date). As far as possible continuous GI strip shall be used but when ever jointing of strip is un avoidable, the jointing over lap portion must not be less than $\mathbf{2^{1/2}}$ times the width of the strip either welded/ brazed/soldered by all sides or overlap of 6 inch with two nut bolts/ riveting of adequate size with required washer and covered by anti corrosive paint as per approved jointing practice in the industry and as per directives from site engineer in-charge.

Testing:

The value of each earth electrode shall be measured by earth tester and record to be submitted.

Mode of Measurement: Executed quantity will be measured on number basis i.e. each

SP/SPN/DP/TP/FP MCB'S

Scope:

Supplying MCB of specified poles, current rating, and either of B or C series with required wiring connections & lugs etc. and erecting in provided enclosure / distribution board

General Specifications for MCB's

- 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.
- All the active, live parts of MCB's should be out of human reach, ensuring safety & confirms to IP: 54 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.

Material:

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 mechanism15 arc plates,10 KA capacity with nominal rating of 240/415V.

Method of Construction:

MCB shall be erected in provided enclosure / distribution board and terminating the provided wires by copper lugs (crimping type) and connecting the same.

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

Moulded Case Circuit Breaker (MCCB)

(MCCB)

Scope:

Providing & erecting 3 Pole/4 Pole MCCB of specified rating and with specified short circuit rupturing capacity in KA, complete erecting in provided enclosure & connected with provided leads on incoming and outgoing side, complete.

General Specifications for MCCB's

- 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 house 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.

Material:

3 pole or 4 Pole MCCB Moulded case circuit breaker. Fixed version– front Terminals with current rating & breaking capacity as specified in SLD:

Method of Construction:

3 pole /4 pole MCCB shall be erected in provided enclosure & connected with provided leads/strip on incoming & out going site complete

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

D) TECHNICAL SPECIFICATION FOR ISOLATION TRANSFORMER

ISOLATION TRANSFORMER

1. **Scope :-** Supplying, installing, testing & commissioning 250KVA, Three Phase, 415/190 V, 50 Hz, AC Air-Cooled Varnish Impregnated, Step Down Isolation Transformer, suitable for indoor Distribution Transformer.
2. **Site Details :-**

   Reference ambient Temp:- 45 deg C

   Altitude :- 62 M

   Relative Humidity :- 70 %
3. **Recommended standards:** The Transformer shall comply to latest edition of following & relevant other standards.

IS 2026 / IS 11171	Power Transformer
IS 2099	High Voltage porcelain bushings
IS 3639	Power Transformer fittings & accessories
IS 10028 Part II 1985	Code of practice for selection installation and maintenance of transformers

4. **Technical specifications :**

Description	Unit	Item
MAXIMUM CONTINUOUS RATING	KVA	250
PHASES		3
FREQUENCY		50 Hz
APPLICATION		LT Distribution Continuous Duty
VOLTAGE RATIO	V	415 V AC +/- 10% (Delta – Star)
VECTOR GROUP		Dy 11
TAPPING (RANGE / STEP) OLTC+ RTCC+AVR	%	% +5% to -15% in steps of 1.25%
APPLICATION OF THE TRANSFORMER		Distribution Duty
TYPE OF COOLING		Air - Cooled
AMBIENT TEMP. / TEMP RISE OF WDG.	DEG.C	0-45 DEG CENT, 90% R.H
TYPE OF WINDING HV & LV		Copper Double wound Oil immersed, core type
INSULATION LEVEL HV Winding (KV Uniform)		12 KV or 24 KV

INSULATION LEVEL LV Winding (KV Uniform)		*
NO LOAD LOSS (Sub to IS Tol) @ 75°C	KW	*
LOAD LOSS (Sub to IS Tol) @ 75°C	KW	*
IMPEDANCE (Sub to IS Tol) @ 75°C.	%	*
NO LOAD CURRENT		*
REGULATION at Full Load @ 75°C u.p.f.		*
Max. EFFICIENCY %		*
ENCLOSURE PROTECTION		Indoor
SHADE (powder coating shall be provided)	IS:5	PU 631
TERMINAL ARRANGEMENT		
HV TERMINATION		Bushing Cable Box
LV TERMINATION		Cable Box
LV NEUTRAL		To be brought out for connecting earthing conductor in addition to neutral terminal in cable box

5. Standard Fittings & Accessories

Particulars	Qty
Rating & terminal marking plate	One
Earthing terminals	Two
Lifting Lugs	Four
OLTC	One
Conservator with drain plug	One
Oil filling hole with cap	One
Oil level indicator	One
M.S. Roller	Four
Air release device	One
Thermometer Pocket	One
Pressure relief valve with contacts	One

Drain valve with blanking plate	One
Explosion vent with Diaphragm	One
Radiators (Detachable)	Four
Unidirectional flat rollers	Four
Separate Neural Bushing	One
OTI, WTI & CT Assy with Marshaling Box	One
RTCC panel with buzzer to indicate changing operation	One

Constructional Details :- Natural air cooled transformer ar esuplied in steel ventilated case, with screwed top cover, input and output terminals are provided on the top of the transformer, inside the casing. The Isolation Transformer shall invariably be in one air cooled section. The enclosures are constructed from M.S. angles and CRCA M.S. sheets of best quality The professional painting process comprises of (i) 7-tank pre-treatment (ii) Primer Coating and (iii)Two coats of final finish paint or powder coating of specified shade.

Ip Enclosure Protection For Isolation Transfoemer:
Isolation Transformer conforms to IP-30 protection as per IS:2147.

Details Of Earthing For Isolation Transformer
It is recommended that every Isolation Transformer should have its own grounded earth, complete in itself.

Testing:-

During inspection at manufacturer's works, following tests are to be carried out jointly in presence of concern contractor in presence of client / client's representative. Tests to be carried out on AC generator.

1) Routine Test as per IS 2026
2) Type test (Heat Run test).
3) Specific Resistance Test
4) Insulation Resistance of HV, LV, in between HV and LV, Winding and Body.
5) Dielectric Strength.
6) Losses as per Is 1180-Part-1
7) Separate Source Voltage Withstand Test

Test Voltages

a. Impulse (1.2 / 50 micro second wave) withstand voltage
   H.V. Winding – 415 V (Peak)
b. One Minute power frequency withstand voltage

H.V. Winding – 28 KV

L.V. Winding – 3 KV

- The test results of joint inspection shall be recorded on the test report of Transformer with its Sr. No. prior to delivery of the Transformer to site.
- Necessary work of transformer foundation and substation work to be completed before dispatch of the transformer. Earthing arrangement should be completed. The Transformer should be installed on foundation by arranging chains pulley block, crane etc as per IS Norms.
- After Installation of Transformer the stopper/lock should be provided to rollers of the Transformer.
- The connection of H.T/L.T. side should be completed by provided Copper wire/ cable with necessary lugs to avoid loose connection. The earthing (2 Nos for Neutral & 2 Nos for Body) should be connected from distinct electrodes. The earthing should be connected by lugs/proper size of strip. Neutral earthing strip to be insulated & should not come in contact with body earthing.
- The Engineer in charge or his representative should check all-connections on H.T. side, L.T. side and earths and insulation and earth resistance test should be carried out and results obtained shall be recorded.
- After above formalities the Transformer, should be charged/commissioned in presence of Engineer in charge or his representative along with load trials and shall be handed over to the department for beneficial use.
- After charging the Transformer, line, phase voltages, and line current shall be measured, and the same shall be submitted. Correct phase sequence to be set.

Following test certificates shall be submitted:

1. Manufacturer's original certificate of Transformer as stipulated in IS.
2. Test certificate for dielectric strength *of oil* as per IS.
3. Test results of *IR* values.
4. Test results of all earth electrodes.
5. Readings of Voltages & currents at the time of commissioning.