

# **Request for Proposal**

## **For**

# **REFURBISHMENT OF GANDHI MANDAP**

## **Design, Build and Operate Basis**

### **Volume II A: SCOPE OF WORK & SPECIFICATIONS FOR CIVIL WORK**

**Client:**



**GSCL,  
Guwahati, Assam**

**DOCUMENT NO: TCE.10477A-AC-1007-1300**

## **GANDHI MANDAP**

### **BIDDING DOCUMENT FOR REFURBISHMENT OF GANDHI MANDAP**

Design and Development of Landscaping works consisting of Softscaping, Hardscaping and related Civil works along with Maintenance of Entire Garden for period of One years at Gandhi Mandap , sarania Hill.

#### **VOLUME II A**

#### **TECHNICAL BID - EMPLOYERS REQUIREMENT AND SPECIFICATION OF CIVIL WORK**

**Employer**

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## **1 BRIEF SCOPE OF CIVIL WORK**

Scope of Work includes, Planning, Designing, Fabrication, Supply, Erection, Testing, Estimating, Supervising construction, Managing construction for structures like Retailing wall, Hardscape work, railing, work in Brick and rubble masonry for steps, walls etc.

Contractor has to Submit Complete detailed design calculations of foundations and superstructure together with general arrangement drawings and explanatory sketches shall be submitted by the Contractor to the Engineer. Separate design calculations for foundations or superstructures submitted independent of each other shall be deemed to be incomplete and will not be accepted by the Engineer.

Submissions of detailed design calculations and Good for Construction drawings shall include the following as a minimum:

### **1.1 Detailed Design Calculations**

- One (1) Copy of a Compact Disc (CD) containing electronic files relevant to the structure's modelling, analysis and design calculations (Microsoft Excel, Staad Pro, etc.). Files submitted shall be in editable format.
- Print copy (6 Copies) of the contents as submitted in the Compact Disc.

### **1.2 Good for Construction Drawings**

- One (1) Copy of a Compact Disc (CD) containing AutoCAD files (Civil General Arrangement, Structural Dimensions and Reinforcement Details) pertaining to the structure. Files submitted shall be in editable format.
- Print copy (6 Copies) of the contents as submitted in the Compact Disc. Prints to be submitted on A1 Size Sheet as a minimum or A0 Size Sheet when required by the employer.
- Detailed drawing showing the location, number and depth of inserts shall be included for any structural steel inserts/Metal inserts in the structure such as rungs, bolted connections for ladders/railings, etc.
- Location of Construction Joints and pour sequence shall be included on the drawing for base slabs, walls and top slabs.
- Revised drawings shall be submitted by clouding at the location with the latest revision number and also show the history of revisions in a table format just above the title block.

The design considerations described hereunder establish the minimum basic requirements of plain and reinforced concrete structures, masonry structures and structural steel works. However, any particular structure shall be designed for the satisfactory performance of the functions for which the same is being constructed. The Contractor shall also take care to check the stability of partly completed structures.

## 2 EXCAVATION

### 2.1 Scope

This specification covers the general requirements of earthwork in excavation in different materials, site grading, filling in areas as shown in drawing, filling back around foundations and retaining wall, conveyance and disposal of surplus soils or stacking them properly as shown on the drawings and as directed by the ENGINEER and all operations covered within the intent and purpose of this specification.

### 2.2 Applicable Codes

The following Indian Standard Codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to.

IS: 1200	Method of measurement of building and civil engineering works.
(Part 1)	Part 1 Earthwork.
(Part 27)	Part 27 Earthwork done by mechanical appliances.
IS: 3764	Excavation work-code of safety.
IS: 2720	Methods of test for soils:
(Part 1)	Preparation of dry soil samples for various tests.
(Part 2)	Determination of water content.
(Part 4)	Grain size analysis.
(Part 5)	Determination of liquid and plastic limit.
(Part 7)	Determination of water content-dry density relation using light compaction.
Part (9)	Determination of dry density - moisture content relation by constant weight of soil method.
(Part 14)	Determination of density index (relative density) of cohesionless soils.
(Part 28)	Determination of dry density of soils in place, by the sand replacement method.
(Part 33)	Determination of the density in place by the ring and water replacement method.
(Part 34)	Determination of density of soil in place by rubber balloon method.
(Part 38)	Compaction control test (HILF Method).

**2.3 General**

The CONTRACTOR shall furnish all tools, plants, instruments, qualified supervisory personnel, labour, materials any temporary works, consumables, any and everything necessary, whether or not such items are specifically stated herein for completion of the job in accordance with the specification requirements.

The excavation shall be done to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night for ensuring safety.

The rates quoted shall also include for dumping of excavated materials in regular heaps, bunds, riprap with regular slopes and levelling the same so as to provide natural drainage, with all leads and lifts as directed by the ENGINEER,. Rock/ soil excavated

**2.4 Topographic Survey & Geotechnical Investigation**

The CONTRACTOR shall carry out the topographical and geotechnical survey of site before excavation and set properly all lines and establish levels for various works such as earthwork in excavation for grading, basement, foundations, plinth filling, roads, drains, cable trenches, pipelines, etc. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to established reference/ grid lines at 8 m. intervals or nearer as determined by the ENGINEER based on ground profile. These shall be checked by the ENGINEER and thereafter properly recorded.

**2.5 Clearing**

The area to be excavated filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation, rubbish, slush, etc. and other objectionable matter. If any roots or stumps of trees are met during excavation, they shall also be removed. The material so removed shall be burnt or disposed off as directed by the ENGINEER. Where earth fill is intended, the area shall be stripped of all loose/ soft patches, top soil containing objectionable matter/ materials before fill commences.

**2.6 Precious Objects, Relics, Objects of Antiquity, Etc.**

All gold, silver, oil, minerals, archaeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall



be the property of the OWNER and the CONTRACTOR shall duly preserve the same to the satisfaction of the OWNER and from time to time deliver the same to such person or persons as the OWNER may from time to time authorise or appoint to receive the same.

## **2.7 Classification**

All materials to be excavated shall be classified by the ENGINEER, as per relevant codes and standards shall be paid for at the rate tendered for that particular class of material. No distinction shall be made whether the material is dry, moist or wet. The decision of the ENGINEER regarding the classification of the material shall be final and binding on the CONTRACTOR and not be a subject matter of any appeal or arbitration.

## **2.8 Excavation**

All excavation work shall be carried out by mechanical equipment unless, in the opinion of the ENGINEER, the work involved and time schedule permit manual work. Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the ENGINEER. Rough excavation shall be carried out to a depth 150 mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed even below the final level and extra excavation filled up as directed by the ENGINEER. The final excavation if so instructed by the ENGINEER should be carried out just prior to laying the mud-mat. The CONTRACTOR may, for facility of work or similar other reasons excavate, and also backfill later, if so approved by the ENGINEER, at his own cost outside the lines shown on the drawings or directed by the ENGINEER. Should any excavation be taken below the specified elevations, the CONTRACTOR shall fill it up, with concrete of the same class as in the foundation resting thereon, upto the required elevation. No extra shall be claimed by the CONTRACTOR on this account.

All excavation shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the ENGINEER shall be obtained by the CONTRACTOR in each individual case, for the method he proposes to adopt for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval, however, shall not in any way relieve the CONTRACTOR of his responsibility for any consequent loss or damage. The excavation must be carried

out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips. Should slips occur, the slipped material shall be removed and the slope dressed to a modified stable slope. Removal of the slipped earth will not be paid for and CONTRACTOR shall take adequate precautions to avoid slips in view of the restricted plot and presence of buildings/ structures in nearby vicinity.

Excavation shall be carried out with such tools, tackles and equipment as described herein before. Blasting or other methods may be resorted to in the case of hard rock; however not without the specific permission of the ENGINEER.

## **2.9 Stripping Loose Rock**

All loose boulders, semi-detached rocks (along with earthy stuff which might move therewith) not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of the ENGINEER, to fall or otherwise endanger the workmen, equipment, or the work, etc., shall be stripped off and removed away from the area of the excavation. The method used shall be such as not to shatter or render unstable or unsafe the portion, which was originally sound and safe.

Any material not requiring removal as contemplated in the work, but which, in the opinion of the ENGINEER, is likely to become loose or unstable later, shall also be promptly and satisfactorily removed as directed by the ENGINEER. The cost of such stripping will be paid for at the unit rates accepted for the class of materials in question.

### **3 FILL, BACK FILLING AND SITE GRADING:**

#### **3.1 General**

All fill material will be subject to the ENGINEER's approval. If any material is rejected by the ENGINEER, the CONTRACTOR shall remove the same forthwith from the site at no extra cost to the OWNER. Surplus fill material shall be deposited/ disposed off as directed by the ENGINEER after the fill work is completed.

No earth fill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by the ENGINEER

#### **3.2 Material**

To the extent available, selected surplus soils from excavated materials shall be used as backfill. Fill material shall be free from clods, salts, sulphates, organic or other foreign material. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murum or earth to fill up the voids and the mixture used for filling.

If any selected fill material is required to be borrowed, the CONTRACTOR shall make arrangements for bringing such material from outside borrow pits. The material and source shall be subject to prior approval of the ENGINEER. The approved borrow pit area shall be cleared of all bushes, roots of trees, plants, rubbish, etc. top soil containing salts/ sulphate and other foreign material shall be removed. The materials so removed shall be burnt or disposed off as directed by the ENGINEER. The CONTRACTOR shall make necessary access roads to borrow areas and maintain the same, if such access road does not exist, at his cost.

Filling with excavated earth shall be done in regular horizontal layers each not exceeding 20 cm in depth. All lumps and clods exceeding 8 cm in any direction shall be broken. Each layer shall be watered and consolidated with steel rammer or half (½) tonne roller. Where specified, every third and top most layer shall also be consolidated with power roller of minimum 8 tonnes. Wherever depth of filling exceeds 1.5 metres, vibratory power roller shall be used to consolidate the filling unless otherwise directed by ENGINEER. The CONTRACTOR shall make good all subsidence and shrinkage in earth fillings, embankments, traverses, etc. during execution and till the completion of work unless otherwise specified.

### **3.3 Filling In Pits and Trenches around Foundations of Structures, Walls**

As soon as the work in foundations has been accepted and measured, the spaces around the foundations, structures, pits, trenches, etc. shall be cleared of all debris, and filled with earth in layers not exceeding 15 cm., each layer being watered, rammed and properly consolidated, before the succeeding one is laid. Each layer shall be consolidated to the satisfaction of the ENGINEER. Earth shall be rammed with approved mechanical compaction machines. Usually no manual compaction shall be allowed unless the ENGINEER is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and levelled to proper profile as directed by the ENGINEER or indicated on the drawings.

### **3.4 Filling in Trenches**

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. The backfilling material shall be properly consolidated by watering and ramming, taking due care that no damage is caused to the pipes.

Where the trenches are excavated in soil, the filling from the bottom of the trench to the level of the centre line of the pipe shall be done by hand compaction with selected approved earth in layers not exceeding 8 cm, backfilling above the level of the centre line of the pipe shall be done with selected earth by hand compaction or other approved means in layers not exceeding 15 cm.

In case of excavation of trenches in rock, the filling upto a level 30 cm above the top of the pipe shall be done with fine materials, such as earth, murrum etc. The filling up of the level of the centre line of the pipe shall be done by hand compaction in layers not exceeding 8 cm whereas the filling above the centre line of the pipe shall be done by hand compaction or approved means in layers not exceeding 15 cm. The filling from a level 30 cm above the top of the pipe to the top of the trench shall be done by hand or other approved mechanical methods with broken rock filling of size not exceeding 15 cm mixed with fine material as available to fill up the voids.

Filling of the trenches shall be carried simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

**GENERAL SITE GRADING** Site grading shall be carried out as indicated in the drawings and as directed by the ENGINEER. Excavation shall be carried out as

specified in the specification. Filling and compaction shall be carried out as specified under Clause 10.0 and elsewhere unless otherwise indicated below.

If no compaction is called for, the fill may be deposited to the full height in one operation and levelled. If the fill has to be compacted, it shall be placed in layers not exceeding 225 mm and levelled uniformly and compacted as indicated in Clause 10.0 before the next layer is deposited.

To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out by the CONTRACTOR at his cost. Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed. This shall hold good for embankments as well. The CONTRACTOR shall protect the earth fill from being washed away by rain damaged in any other way. Should any slip occur, the CONTRACTOR shall remove the affected material and make good the slip at his cost. The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the desired compaction has not been obtained. If specifically permitted by the ENGINEER, compaction can be obtained by allowing loaded trucks conveying fill or other material to ply over the fill area. Even if such a method is permitted, it will be for the CONTRACTOR to demonstrate that the desired/ specified compaction has been obtained. In order that the fill may be reasonably uniform throughout, the material should be dumped in place in approximately uniform layers. Traffic over the fill shall then be so routed to compact the area uniformly throughout.

If so specified, the rock as obtained from excavation may be used for filling and levelling to indicated grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 tonne roller. No less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.

### **3.5 Fill Density**

The compaction, only where so called for, in the schedule of quantities/ items shall comply with the specified (Standard Proctor/ Modified Proctor) density at moisture

content differing not more than 4 percent from the optimum moisture content. The CONTRACTOR shall demonstrate adequately at his cost, by field and laboratory tests that the specified density has been obtained.

### **3.6 Measurement and Payment**

All excavation shall be measured net. Dimensions for purpose of payment shall be reckoned on the horizontal area of the excavation at the base for foundations of the walls, columns, footings, tanks, rafts or other foundations/ structures to be built, multiplied by the mean depth from the surface of the ground in accordance with the drawings. Excavation in side slopes will not be paid for. The CONTRACTOR may make such allowance in his rates to provide for excavation in side slopes keeping in mind the nature of the soil and safety of excavation.

Backfilling as per specification the sides of foundations of columns, footings, structures, walls, tanks, rafts, trenches, etc. with excavated material will not be paid for separately. It shall be clearly understood that the rate quoted for excavation including backfilling shall include stacking of excavated material as directed, excavation/ packing of selected stacked material, conveying it to the place of final backfill, compaction etc. as specified. Payment for fill inside trenches, plinth or similar filling with selected excavated material will be made for only compaction as specified/ directed. Cost of all other operations shall be deemed to have been covered in the rate quoted for excavation. The plinth ground levels shall be surveyed before hand for this purpose. If no compaction is specified/ desired, such filling will not be separately paid for. In such an event the fill shall be levelled/ finished to the profile as directed at no extra cost.

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

## 4 REINFORCED CONCRETE & ALLIED WORKS

### 4.1 Scope

This Specification covers the general requirements for ready mixed concrete and for concrete using on-site production facilities including requirements in regard to the quality, handling, storage of ingredients, proportioning, batching, mixing, transporting, placing, curing, protecting, repairing, finishing and testing of concrete; formwork; requirements in regard to the quality, storage, bending and fixing of reinforcement; grouting as well as mode of measurement and payment for completed works.

It shall be very clearly understood that the specifications given herein are brief and do not cover minute details. However, all works shall have to be carried out in accordance with the relevant standards and codes of practices or in their absence in accordance with the best accepted current ENGINEERING practices or as directed by ENGINEER from time to time. The decision of ENGINEER as regards the specification to be adopted and their interpretation and the mode of execution of work shall be final and binding on CONTRACTOR and no claim whatsoever will be entertained on this account.

### 4.2 Applicable Codes and Specifications

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

IS Code No.	Subject
<b>GENERAL</b>	
IS 4082	Stacking & storage of construction materials and components at site – Recommendations
IS 1200	Method of measurement of building and civil engineering work.(All Parts)
<b>EARTH WORK</b>	
IS 3674	Safety code for excavation work
IS 1498	Classification and identification of soils for general engineering

	purposes.
IS 1200 (Pt-1)	Method of measurement of earth work
IS 1200 (Pt-27)	Method of measurement of earth work (by Mechanical Appliances)
IS 4081	Safety code for Blasting and related drilling operation
IS 4988 (Part-IV)	Excavators
IS 12138	Earth moving equipments
<b>MORTARS</b>	
IS 269	Specification for 33 grade ordinary Portland cement
IS 455	Specification for Portland slag cement
IS 650	Specification for standard sand for testing of cement
IS 1269	Specification for 53 grade ordinary Portland cement
IS 1542	Specification for sand for plaster
IS 2116	Specification for sand for masonry mortar
IS 2250	Code of practice for preparation and use of masonry Mortar
IS 3025	Method of sampling and test for water
IS 3406	Specification for masonry cement
IS 3812 (Part-I)	Specification for fly ash for use as pozzolana in cement mortar and concrete
IS 3812 (Part-II)	Specification for flyash for use as admixture in cement mortar and concrete
IS 8041	Rapid hardening Portland cement
IS 8042	Specification for white cement
IS 8112	Specification for 43 grade ordinary Portland cement
IS 1298	Methods of test for determination of free lime in portland cement
IS 6452	High alumina cement for structural use
IS 1489	Portland Pazzolana Cement
<b>CONCRETE WORK</b>	
IS 383	Specification for coarse and fine aggregate from natural source for concrete
IS 303	Coarse and fine aggregates from natural sources for concrete
IS 1830	Methods for sampling of aggregates for concrete
IS 2386	Method of test for aggregates for concrete
(a) Part-I : Particle size and shape	



(b) Part-II : Estimation of deleterious materials and organic impurities	
(c) Part-III : Specific gravity, density, voids absorption and bulking	
(d) Part-IV : Mechanical properties	
(e) Part-V : Soundness	
IS 2505	General requirements for concrete vibrators – immersion type
IS 2506	General requirements for concrete vibrators – screed board concrete vibrators
IS 2645	Specification for integral water proofing compounds for cement mortar and concrete
IS 9103	Specification for concrete admixtures
IS 460	Test sieves
IS 1607	Methods for dry sieving
IS 1834	Hot applied sealing compounds for jointing concrete
<b>REINFORCED CEMENT CONCRETE WORK</b>	
IS 1904	Structural safety of buildings, shallow foundation
IS 1893	Criteria for earthquake resistant design of structures
IS 432 (Part-I)	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement part-I mild steel and medium tensile steel bars
IS 432 (part-II)	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement part-II hard drawn steel wire
IS 456	Code of practice for plain and reinforced concrete
IS 516	Method of test for strength of concrete
IS 1199	Method of sampling and analysis of concrete
IS 1200 (Part-II)	Method of measurement of building and civil engineering work – concrete work
IS 1200 (Part-V)	Method of measurement of building and civil engineering work – concrete work (Part 5 – Form work)
IS 1566	Specification for hard drawn steel wire fabric for concrete requirement
IS 1599	Method of bend test
IS 1786	Specification for high strength deformed steel and wires for concrete reinforcement
IS 1791	Specification for batch type concrete mixes
IS 2502	Code of practice for bending and fixing of bars for concrete

	reinforcement
IS 2751	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction
IS 4925	Batch plants specification for concrete batching and mixing plant
IS 4926	Ready – Mixed Concrete
IS 10262	Recommended guidelines for concrete mix design
IS 13311 (Part-I)	Indian standard for non-destructive testing of concrete. Method of test for ultrasonic pulse velocity
IS 13311 (Part-II)	Indian standard for non-destructive testing of concrete. Method of testing by rebound hammer.
IS 3370	Concrete structures for storage of liquids
IS 1568	Wire gauge for general purposes
IS 1139	Hot rolled mild steel and medium tensile steel deformed bars for concrete reinforcements
IS 2502	Code of practice for bending and fixing of bars for concrete reinforcement
IS 2751	Code of practice for welding of mild steel bars used for reinforced concrete work
<b>STEEL WORK</b>	
IS 226	Structural steel
IS 2062	Steel for general structural purpose
IS 800	Code of practice for use of structural steel in general in steel construction
IS 806	Code of practice for use of steel Tubes in general building construction
IS 816	Code of practice for use of metal arc welding for general construction in mild steel
IS 818	Code of practice for safety and healthy requirements in electric and gas welding and cutting operations
IS 822	Code of procedure for inspection of welds
IS 1038	Steel doors, windows and ventilators
IS 1081	Code of practice for fixing and glazing of metal (Steel and aluminium) doors, windows and ventilators
IS 1161	Steel tubes for structural purposes
IS 1200 (Pt. VIII)	Method of measurements of steel work and iron works

IS 1367	Technical supply conditions for threaded steel fasteners
IS 1821	Dimensions for clearances holes for bolts and screws
IS 2074	Ready mixed paint, air drying redoxide zinc chrome priming
IS 4736	Hot – dip zinc coating on mild steel tubes
IS 4923	Hollow steel sections for structural use – specification
IS 6188	Metal rolling shutters and rolling grills
<b>BRICK WORK</b>	
IS 712	Specification for building limes
IS 1077	Common burnt clay building bricks
IS 1200 (Part 3)	Method of measurements of brick works
IS 2212	Code of practice for brick work (1 <sup>st</sup> Revision)
IS 3495	Method of test for burnt clay building bricks
IS 5454	Methods of sampling of clay building bricks
IS 13757	Specification of burnt clay fly ash bricks
IS 2691	Burnt clay facing bricks
<b>MARBLE WORK</b>	
IS 1122	Method of test for determination of true specific gravity of natural building stones
IS 1118	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones
IS 1130	Marble (blocks, slabs and tiles)
IS 4101 (Part-I)	Code of practice for external facing and veneers: Stone facing
IS 14223 (Part-I)	Polished Building Stones ( Part-I) Granite
<b>FLOORING</b>	
IS 1200 (Part-XI)	Method of measurement of Building and Civil Engineering work (Part 11) paving, floor finishes, dado and skirting
IS 1237-Edition 2.3	Specification for cement concrete flooring tiles
IS 1443	Code of practice for laying and finishing of cement concrete flooring tiles
IS 2114	Code of practice for laying in-situ terrazzo floor finish
IS 3622	Specification for sand stone (Slab & Tiles)
IS 4457	Acid and / or alkali Resistant tiles
IS 5318	Code of practice for laying of hard wood parquet and wood block floors
IS 5766	Code of practice for laying of burnt clay brick floor

IS 13630 (Part-1 to 15)	Methods of Testing for ceramic tiles
IS 13712	Specification for ceramic tiles, definition, classification characteristic and marking
IS 15622	Specification for pressed ceramic tile.
<b>ROOFING</b>	
IS 277	Galvanised steel sheets (Plain and corrugated)
IS 651	Glazed stoneware pipes and fittings
IS 1200 (Pt IX)	Method of measurements of building and civil engineering work : Part-9 Roof covering (including cladding)
IS 1200 (Pt X)	Method of measurements of building and civil engineering work : Part-10 ceiling and lining
IS 2095 (Pt-1)	Gypsum plaster boards (Pt. 1) plain Gypsum plaster boards
IS 2935	Specification for flat transparent sheet glass
IS 459	Corrugated and semi corrugated asbestos cement sheet
<b>FINISHING WORKS</b>	
IS 1542	Sand for plaster
IS 1661	Code of practice for cement and cement-lime plaster finishes on walls and Ceilings
IS 2250	Code of practice for preparation and use of masonry mortars
IS 712	Building limes
IS 1635	Code of practice for field slacking of lime and preparation of putty.
IS 427	Distemper, dry colour as required
IS 428	Distemper, oil emulsion, colour as required
IS 6278	Code of practice for white washing and colour washing
IS 106	Ready mixed paint, brushing, priming for enamels for use on wood.
IS 102	Ready mixed paint, brushing, red lead, non- setting, priming
IS 123	Ready mixed paint, brushing, finishing, semi-gloss, for general purposes
IS 1477	Code of practice for painting of ferrous metals in buildings
IS 2074	Ready mixed paint, red oxide-zinc chrome priming
IS 2339	Aluminium paint for general purposes in dual container
IS 2932	Enamel, synthetic, exterior, type 1

	(a) under coating,
	(b) finishing, colour as required
IS 137	Specification for ready mixed paint, brushing, matt or eggshell flat finishing interior to Indian Standard colour as required
IS 1131	Specification for enamel, interior
	(a) under coating
	(b) finishing.
(Part I) general purposes	
IS 2933	Enamel, Exterior
(a) Under Coating	
(b) Finishing	
IS 5410	Cement Paint
IS 5411	Plastic emulsion, Paint Part- I for interior use
IS 419	Specifications for putty for use in window frames
<b>ROAD WORK</b>	
IS 164	Ready mixed paint for road marking
IS 278	Specification for galvanized steel barbed wire for fencing
IS 1838 (Pt.1)	Specification for performed filters for expansion joint in concrete pavements and structures (non extruding and resilient type / bitumen impregnated fibre)
IS 73-1992	Specification for paving bitumen
IS 1203	Method of testing tar and bituminous material Determination of penetration
<b>WATER SUPPLY, SANITORY INSTALLATIONS &amp; DRAINAGE</b>	
IS 771 (Pt.1)	Specification for glazed fire clay sanitary appliances : part 1: General requirements
IS 1703	Water fittings – copper alloy float valves (horizontal plunger type) – Specification
IS 4127	Code of practice for laying of glazed stoneware pipes
<b>ALUMINIUM WORK</b>	
IS 733	Wrought Aluminium Alloys, Bars, Rods and Sections (For General Engineering Purposes) – Specification
IS 737	Wrought Aluminium and aluminium alloy sheet
IS 1285	Wrought Aluminium and Aluminum Alloy, Extruded Round Tube and Hollow sections (for General Engineering Purposes) –

	Specification
IS 1868	Anodic coating on Aluminium and its alloy – Specification
IS 1948	Specification for Aluminium Doors, Windows and Ventilators
IS 5523	Method of testing anodic coating on aluminum and its alloys
IS 6012	Measurement of coating thickness by Eddy Current Method
IS 6315	Floor springs (Hydraulic regulated) for heavy doors – Specifications
IS 6477	Dimensions of extruded hollow section and tolerances
IS 14900	Transparent Float Glass – Specifications
<b>WATR PROOFING TREATMENT</b>	
IS 3370 (Part 1)	Code of practice for concrete structures for the storage of liquid : Part-1 General Requirements

### Materials

IS: 269	Specification for 33 grade Ordinary Portland Cement.
IS: 455	Specification for Portland Slag Cement.
IS: 1489	Specification for Portland Pozzolana Cement (Parts 1 & 2)
IS: 8112	Specification for 43 grade Ordinary Portland Cement.
IS: 12330	Specification for Sulphate resisting Portland Cement.
IS: 383	Specification for coarse and fine aggregates from natural sources for concrete.
IS: 432	Specification for mild steel and medium tensile (Parts steel bars and hard drawn steel wires for 1 & 2) concrete reinforcement.
IS: 1786	Specification for high strength deformed steel bars and wires for concrete reinforcement.
IS: 1566	Specification for hard drawn steel wire fabric for (Parts II) concrete reinforcement.
IS: 9103	Specification for admixtures for concrete.
IS: 2645	Specification for integral cement waterproofing compounds.
IS: 4900	Specification for plywood for concrete shuttering work.
IS: 4926	Ready Mixed Concrete.
IS: 12269	Specification for 53 grade Ordinary Portland Cement.
IS: 8041	Specification for rapid hardening cement.
IS: 12600	Specification for low heat cement.
IS: 6909	Specification for Supersulphated Cement.

IS: 12089	Specification for Granulated Ground Blast Furnace Slag.
BS: 6699	Specification for Granulated Ground Blast Furnace Slag.
BS: 6073	Specifications for precast concrete masonry units (Part 1)
	Methods for specifying precast concrete masonry (Part 2)
<b><u>Material Testing</u></b>	
IS: 4031	Methods of physical tests for hydraulic cement. (Parts 1 to 15)
IS: 4032	Method of chemical analysis of hydraulic cement.
IS: 650	Specification for standard sand for testing of cement.
IS: 2430	Methods for sampling of aggregates for concrete.
IS: 2386	Methods of test for aggregates for concrete (Parts 1 to 8)
IS: 3025	Methods of sampling and test (physical and chemical) water used in industry.(Part 1 to 51)
IS: 6925	Methods of test for determination of water soluble chlorides in concrete admixtures.
<b><u>Concrete Mix Design</u></b>	
IS: 10262	Recommended guidelines for Concrete Mix Design.
SP: 23	Handbook on Concrete Mixes.

<b><u>Concrete Testing</u></b>	
IS: 1199	Method of sampling and analysis of concrete.
IS: 516	Method of test for strength of concrete.
IS: 9013	Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.
IS: 8142	Method of test for determining setting time of concrete by penetration resistance.
IS: 9284	Method of test for abrasion resistance of concrete.
IS: 2770	Methods of testing bond in reinforced concrete.
<b><u>Equipment</u></b>	
IS: 1791	Specification for batch type concrete mixers.
IS: 2438	Specification for roller pan mixer.
IS: 4925	Specification for concrete batching and mixing plant.
IS: 5892	Specification for concrete transit mixer and agitator.

IS: 7242	Specification for concrete spreaders.
IS: 2505	General Requirements for concrete vibrators: Immersion type.
IS: 2506	General Requirements for screed board concrete vibrators.
IS: 2514	Specification for concrete vibrating tables.
IS: 3366	Specification for pan vibrators.
IS: 4656	Specification for form vibrators for concrete.
IS: 2722	Specifications for portable swing weigh batchers for concrete (single and double bucket type).
IS: 2750	Specifications for steel scaffoldings.
<b><u>Construction</u></b>	
<b><u>Safety</u></b>	
IS: 3696	Safety code for scaffolds and ladders.(Parts 1 & 2)
IS: 7969	Safety code for handling and storage of building materials.
IS: 8989	Safety code for erection of concrete framed structures.
<b><u>Measurement</u></b>	
IS: 1200	Method of measurement of building and ENGINEERING works
(Part 1 to 12)	(Part 2 and 5).

### 4.3 General

ENGINEER shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and ENGINEER's approval obtained, prior to starting of concrete work. This shall, however, not relieve CONTRACTOR of any of his responsibilities. All materials, which do not conform to this specification, shall be rejected. Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due regards to the functional requirements and the environmental conditions to which the structure will be subjected. Materials complying with codes/standards shall only be used. Other materials may be used after approval of the ENGINEER and after establishing their performance suitability based on previous data, experience or tests.

### 4.4 Materials

- **Cement**



Unless otherwise specified or called for by ENGINEER/ OWNER, cement shall be Ordinary Portland Cement conforming to IS: 269, IS: 8112 or IS: 12269. The Portland Pozzolana Cement shall conform to IS: 1489 and it shall be used as directed by ENGINEER. Where Portland Pozzolana or slag cements are used, it shall be ensured that consistency of quality is maintained and there will be no adverse interactions between the materials and the finish specified is not marred. Only one type of cement shall be used in any one mix unless specifically approved by ENGINEER. The source of supply, type or brand of cement within the same structure or portion thereof shall not be changed without prior approval from ENGINEER.

Cement, which is not used within 90 days from its date of manufacture, shall be tested at a laboratory approved by ENGINEER and until the results of such tests are found satisfactory, it shall not be used in any work.

Fly Ash Blended Cements conforming to IS: 1489 (Part I) may be used in RCC structures as per the guidelines given below:

### **General**

IS: 456-2000 Code of Practice for Plain and Reinforced Concrete (as amended up to date) shall be followed in regard to Concrete Mix Proportion and its production as under:

- i. The concrete mix design shall be done as "Design Mix Concrete" as prescribed in clause 9 of IS: 456 mentioned above.
- ii. Concrete shall be manufactured in accordance with clause 10 of above mentioned IS: 456 covering quality assurance measures both technical and organisational, which shall also necessarily require a qualified Concrete Technologist to be available during manufacture of concrete for certification of quality of concrete.

Minimum M25 grade of concrete shall be used in all structural elements made with RCC both in load bearing and framed structure.

The mechanical properties such as modulus of elasticity, tensile strength, creep and shrinkage of fly ash mixed concrete or concrete using fly ash blended cements (PPCs) are not likely to be significantly different and their values are to be taken same as those used for concrete made with OPC.

To control higher rate of carbonation in early ages of concrete both in fly ash admixed as well as PPC based concrete, water/ binder ratio shall be kept as low as possible, which shall be closely monitored during concrete manufacture.

If necessitated due to low water/binder ratio, required workability shall be achieved by use of chloride free chemical admixtures conforming to IS 9103. The compatibility of chemical admixtures and super plasticizers with each set OPC, fly ash and/ or PPC received from different sources shall be ensured by trials.

In environment subjected to aggressive chloride or sulphate attack in particular, use of fly ash admixed or PPC based concrete is recommended. In cases, where structural concrete is exposed to excessive magnesium sulphate, flyash substitution/ content shall be limited to 18% by weight. Special type of cement with low C3A content may also be alternatively used. Durability criteria like minimum binder content and maximum water /binder ratio also need to be given due consideration in such environment.

Wet curing period shall be enhanced to a minimum of 10 days or its equivalent. In hot and arid regions, the minimum curing period shall be 14 days or its equivalent.

#### **Use of Fly Ash Admixed Cement Concrete (FACC) in RCC Structures**

There shall be no bar on use of FACC in RCC structures subject to following additional conditions.

Fly ash shall have its chemical characteristics and physical requirements, etc. conforming to IS: 3812 (Parts I and II) and shall be duly certified.

- (a) To ensure uniform blending of fly ash with cement in conformity with IS: 456, a specific facility needs to be created at site with complete computerised automated process control to achieve design quality or with similar facility from Ready Mix Concrete (RMC) plants.
- (b) As per IS: 1489 (Part-I) maximum 35% of OPC by mass is permitted to be substituted with fly ash conforming to IS: 3812 (Part-I) and same is reiterated.
- (c) Separate storage for dry fly ash shall be provided. Storage bins or silos shall be weather proof and permit a free flow and efficient discharge of fly ash. The filter or dust control system provided in the bins or silos shall be of sufficient size to allow delivery of fly ash maintained at specified pressure to prevent undue emission of fly ash dust, which may interfere weighing accuracy.

#### **Use of Fly Ash Blended Cements in Cement Concrete (PPCC) in RCC Structures**

- (a) Subject to General Guidelines detailed out as above, PPC manufactured conforming to IS: 1489 (Part-I) shall be treated at par with OPC for manufacture of Design Mix concrete for structural use in RCC.

- (b) Till the time, BIS makes it mandatory to print the percentage of fly ash on each bag of cement, the certificate from the PPC manufacture indicating the same shall be insisted upon before allowing use of such cements in works.
- (c) While using PPC for structural concrete work, no further admixing of fly ash shall be permitted.

#### **4.5 Aggregates**

Aggregates shall consist of naturally occurring stones and gravel (crushed or uncrushed) and sand. They shall be chemically inert, strong, hard, clean, durable against weathering, of limited porosity, free from dust/silt/organic impurities/deleterious materials and conform to IS: 383. Aggregates such as slag, crushed over burnt bricks, bloated clay ash, sintered fly ash and tiles shall not be used. Aggregates shall be washed and screened before use where necessary or if directed by the ENGINEER. Aggregates containing reactive materials shall be used only after tests conclusively prove that there will be no adverse affect on strength, durability and finish, including long term effects, on the concrete. The fineness modulus of sand shall neither be less than 2.2 nor more than 3.2. If use of sand having fineness modulus more than 3.2 is unavoidable then it shall be suitable blended with crusher stone dust.

The maximum size of coarse aggregate shall be as stated on the drawings, but in no case greater than 1/4 of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of the form. For most work 20 mm aggregate is suitable. Where there is no restriction to the flow of concrete into sections, 40 mm or larger size is permitted.

In concrete elements with thin sections, closely spaced reinforcements or small cover, consideration should be given to the use of 10mm nominal maximum size.

Plums 160 mm and above of a reasonable size may be used where directed. Plums shall not constitute more than 20% by volume of concrete unless specified by ENGINEER.

#### **4.6 Water**

Water used for both mixing and curing shall conform to IS: 456.

Potable water is generally satisfactory.

The pH value of water shall not be less than 6.

Seawater shall not be used for concrete mixing and curing.

**4.7 Reinforcement**

Reinforcement bars shall conform to IS: 432 and/ or IS: 1786 and welded wire fabric to IS: 1566 as shown on the drawing. Grade of Reinforcement shall be Fe500 TMT/CRS as approved by Engineer In Charge.

All reinforcement shall be clean, free from pitting, oil, grease, paint, loose mill scales, rust, dirt, dust or any other substance that will destroy or reduce bond.

The work includes supplying, cutting, bending, binding, welding and erecting in position high yield strength deformed (H.Y.S.D.) steel bars and mild steel (M.S.) bars as reinforcement for concrete of various components.

**INDIAN STANDARDS FOR REFERENCE**

1	IS : 226-1975	Structural steel (Standard Quality).
2	IS : 280-1978	Mild steel wire for general Engineering purposes.
3	IS : 432-1966	Mild steel and medium tensile bars and drawn steel wire for concrete reinforcement
4	IS : 432-1966(part-I)	Mild Steel and medium tensile steel bars.
5	IS : 432-1996 (part-V) Hard drawn steel wire.	
6	IS : 814-1974	Covered electrodes for metal or welding of structural steel.
7	IS : 814-1974(part-I)	For welding products other than sheets.
8	IS : 814-1974(part-II)	For welding sheets
9	IS : 1139-1966	Hot rolled mild steel medium tensile steel and high yield strength steel deformed bars for concrete
10	IS : 1278-1972	Filler rods and wires for gas welding.
11	IS : 1481-1970	Metric steel scales for Engineers.
12	IS : 1521-1972	Method for tensile testing of steel wires.
13	IS : 1566-1967	Hard drawn steel wire fabrics for concrete reinforcement.
14	IS : 1608-1972	Method for tensile testing of steel products.
15	US : 1786-1979	Cold twisted steel bars for concrete reinforcement.
16	IS : 2502-1963	Code of practice for bending and fixing of bars for concrete reinforcement
17	IS : 2751-1979	Code of practice for welding of mild steel bars used for reinforced concrete construction.
18	IS : 5525-1969	Recommendations for detailing of reinforcement in reinforced concrete works.

19	IS : 9417-1979	Recommendations for welding cold worked steel bars for reinforced concrete construction
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## 4.8 Steel reinforcing bars

### a. General

(a) Steel reinforcing bars shall be placed in concrete where shown on the drawings or as directed by the Engineer-in-charge. The drawings issued with these specifications show only in part the requirement of reinforcement and further drawings shall be issued by the Engineer-in-charge during the course of the contract.

(b) As far as possible, high yield strength deformed bars conforming to IS : 1786-1979 shall be used as reinforcement. However, in case of Non-availability of such bars other steel bars conforming to IS : 432-1966 and / or IS : 1139-1966 shall be used as per the directions of the Engineer-in-charge.

### b. Cutting, Bending and Binding

(a) The contractor shall be responsible for the accuracy of the cutting, bending and placing of the reinforcement as shown in the drawing. Reinforcement shall be inspected for compliance with the requirement of grade, size, shape, length splicing and locations after it has been placed. No concreting shall be started unless the reinforcement as placed in the work is finally checked, recorded and certified by the Engineer-in-charge.

(b) Before the reinforcement is placed, the surface of the bars and the surfaces of any metal bar supports shall be cleaned of the rust, loose mill scale, dirt, grease and other objectionable foreign substances. After being placed, the reinforcing bars shall be maintained in a clean condition until they are completely embedded in the concrete.

(c) Wire for binding reinforcement shall be of soft and annealed mild steel and shall conform to IS : 280-1978. The binding wire shall have tensile strength of not less than 56kg/sqmm. The wire shall have minimum diameter of 1 mm. Chairs, hangers, spacers and other supports for reinforcement, may be of concrete, metal or other approved material. Where portions of such supports will be exposed on concrete surfaces designated to receive F2 or F3 finish, the exposed portion of support shall be galvanized or coated with other corrosion resistant material without which the concreting will not be permitted. Such supports shall not be exposed on surfaces of F4 finish unless otherwise shown on the drawings. The minimum allowable clearance

between parallel round bars shall not be less than 1.50 times the diameter of the larger bars and for square bars shall not be less than twice the side dimensions of the larger bars. In no case the minimum clearance between the bars shall be less than 1.50 times the maximum size of aggregate irrespective of the shape of the reinforcing bar. Bars crossing each other where required shall be secured by binding wire in such a manner that they do not slip over each other at the time of fixing and concreting. Wire used for binding reinforcement shall not be measured for payment.

**c. Splicing**

(a) Where it is necessary to splice reinforcement the splices shall be made by lapping, by welding or by mechanical means.

(b) Joints or splices in reinforcing bar shall generally be made at the locations where neither shear nor bending moment is maximum, but the contractor would be permitted to take joints or splices at other position provided that such positions are approved by the Engineer-in-charge and joints and splices in adjacent bars are staggered as directed by the Engineer-in-charge. Approval of such additional splices will generally be restricted to splices not closer than 9 mtrs. in horizontal bars and 4 mtrs. in vertical bars measured between midpoint of laps.

(c) If the contractor proposes to use welded splices in reinforcing bars the equipment, the material and all welding testing procedures shall be subject to the approval of the Engineer-in-charge. The contractor shall also carry out test welds as required by the Engineer-in-charge.

(d) For welded splices for reinforcing bars conforming to IS : 1786-1979, welding shall be done in accordance with IS : 9419-1979. For reinforcing bars conforming to IS: 432 (part-I) 1966 and IS : 1139-1966 welding shall be done in accordance with IS : 2751-1966. Electrodes for manual metal arc welding shall conform to IS : 814 (part-I) 1974 and IS : 814 (part-II) 1974, mild steel filler rods for oxyacetylene welding shall conform to IS : 1278-1972 provided they are capable of giving a minimum butt weld tensile strength of 41 kg / sq mm.

(e) Reinforcing bars 28mm in diameter and larger may be connected by butt welding, provided that lapped splices will be permitted if found to be more practicable than butt welding and if lapping does not encroach on cover limitation or hinder concrete or reinforcement placing.

(f) Reinforcing bars 25mm diameter and less may be either lapped or butt welded, whichever is most practicable.

(g) Butt welding of reinforcing bars shall be performed under cover from weather and may be performed either by the gas pressure or flash pressure welding process,

or by the electric arc methods. The following requirements shall apply to all welding of reinforcing bars including butt welding and the preparation of welded reinforcement mats.

(h) Welded pieces of reinforcement shall be tested at the rate of 5% of total number of joints welded. Specimen shall be taken from the actual site of work. Strength of the weld provided shall be at least 25% higher than the strength of bar.

(i) If the contractor proposes to use mechanical couplings for reinforcing bars he shall submit samples of the proposed coupling to the Engineer-in-charge for approval not less than 60 days prior to their proposed use.

#### **Lapped Splices**

6mm	Structural Plain	30 cm
10mm	Structural Plain	46 cm
12 mm	Structural deformed	38 cm
16 mm	Structural deformed	48 cm
20 mm	Structural deformed	58 cm
22 mm	Structural deformed	66 cm
25 mm	Structural deformed	86 cm
30 mm	Structural deformed	97 cm
35 mm	Structural deformed	107 cm

#### **d. Reinforcement Fabrication and Placement**

Reinforcing bars supplied in the form of bent coils shall be straightened cold without damage at no extra cost. No bending shall be done when ambient temperature is below 5 Deg C. Suitable preheating may be permitted if steel bar bending is to be done at or above 0 Deg C. Bars supplied in bent coils shall be straightened only by machine. All bars shall be accurately bent gradually and according to the sizes and shapes shown on the drawings/ schedules or as directed by ENGINEER. Bar bending machines shall be used to achieve desired accuracy. Re-bending or straightening incorrectly bent bars shall not be done without approval of ENGINEER. Reinforcement shall be accurately fixed and maintained firmly in the correct position by the use of blocks, spacers, chairs, binding wire, etc. to prevent displacement during placing and compaction of concrete. The tied in place reinforcement shall be approved by ENGINEER prior to concrete placement. Spacers (PVC or Concrete) shall be of such material and design as will be durable, not lead to corrosion of the reinforcement and not cause spalling of the concrete cover. Binding wire shall be 16

gauge soft annealed wires. Ends of the binding wire shall be bent away from the concrete surface and in no case encroach into the concrete cover.

Substitution of reinforcement, laps/splices not shown on drawing shall be proposed by CONTRACTOR and approved by ENGINEER.

If permitted by ENGINEER, welding of reinforcement shall be done in accordance with IS: 2751, IS: 9417 and SP: 34 as applicable.

Tolerance on placement of reinforcement shall be as per Cl. 12.3 of IS: 456.

#### **E. Care of Placed Reinforcement and Concrete**

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

### **4.9 CONCRETE**

- **General**

Concrete grade shall be as designated on drawings. Concrete in the works shall be "DESIGN MIX CONCRETE" OR "NOMINAL MIX CONCRETE". All concrete works of up to grade M15 shall be NOMINAL MIX CONCRETE whereas all other grades, M20 and above, shall be DESIGN MIX CONCRETE.

- **Design Mix Concrete Design**

Mix Concrete are classified in three categories, viz. "Normal Concrete (M)", "Heavy Concrete (H)", "Super Heavy Concrete (SH)". Each class of concrete shall be identified by a prefix and two numbers. Prefix "M" would denote Normal Concrete, prefix "H" would denote heavy concrete and prefix "SH" would denote super heavy concrete. The two numbers e.g. 25 - 40 would denote the crushing strength of cube at 28 days in N/sqmm and maximum size of the coarse aggregates in millimetres respectively.

Normal concrete shall have a net dry unit weight of not less than 25 kN/cum, for the finished structure after curing, Heavy concrete shall have a net dry unit weight of not less than 36.30 kN/cum, for the finished structure after curing and special heavy concrete shall have a net dry unit weight of not less than 41 kN/cum for the finished structure after curing.

#### **4.10 Mix Design and Testing**

For Design Mix Concrete, the mix shall be designed as per any of four methods given in SP: 23 to provide the grade of concrete having the required workability and



characteristic strength not less than appropriate values given in IS: 456. The design mix shall in addition be such that it is cohesive and does not segregate during placement and should result in a dense and durable concrete capable of giving the specified finish. For liquid retaining structures, the mix shall also result in watertight concrete. The CONTRACTOR shall exercise great care while designing the concrete mix and executing the works to achieve the desired result.

The minimum grade of concrete shall be as per Table 5 of IS: 456 for various exposure conditions of concrete. For various environmental conditions, refer Table 3 of IS: 456.

The minimum cement content for Design Mix Concrete shall be as per Table 5 of IS: 456 or as given below, whichever is higher.

Grade of Concrete, (M)	Minimum Cement Content in kg/cum of Concrete
20	300
25	320
30	340
35	360
40	360
45	400

The minimum cement content stipulated above shall be adopted irrespective of whether the CONTRACTOR achieves the desired strength with less quantity of cement. The CONTRACTOR's quoted rates for concrete shall provide for the above eventuality and nothing extra shall become payable to the CONTRACTOR on this account. Even in the case where the quantity of cement required is higher than that specified above to achieve desired strength based on an approved mix design, nothing extra shall become payable to the CONTRACTOR.

It shall be CONTRACTOR's sole responsibility to carry out the mix designs at his own cost. He shall furnish to ENGINEER for approval at least 30 days before concreting operations, a statement of proportions proposed to be used for the various concrete mixes and the strength results obtained. The strength requirements of the concrete mixes ascertained on 150 mm cubes as per IS: 516 shall comply with the requirements of IS: 456.

Grade of Concrete	Minimum Compressive Strength N/mm <sup>2</sup> at 7 days	Specified Characteristic compressive strength N/mm <sup>2</sup> at 28 days
M15	10.0	15.0
M20	13.5	20.0
M25	17.0	25.0
M30	20.0	30.0
M35	23.5	35.0
M40	27.0	40.0
M45	30.0	45.0

A range of slumps recommended for various types of construction, unless otherwise instructed by the ENGINEER, shall be as given below:

Structure/ Member	Slump in millimetres	
	Maximum	Minimum
Reinforced foundation walls and footings	75	25
Plain footings, caissons and substructure walls	75	25
TG and massive compressor foundations	50	25
Slabs, Beams and reinforced walls	50	25
Pumps and miscellaneous Equipment Foundations	75	25
Building columns	50	25
Pavements	50	25
Heavy mass construction	50	25
Liquid retaining/ conveying structures	50	25

(NOTE: These values are not meant for pumped concrete placed using slip formed technique.)

Where single size graded coarse aggregate are not available, aggregates of different sizes shall be properly combined. The CONTRACTORS mix design shall show that combined grading of coarse aggregate meets the requirements of Table 2 of IS: 383 for graded aggregates.

**4.11 Batching and Mixing of Concrete**

Proportions of aggregates and cement, as per approved concrete mix design, shall be by weight. These proportions shall be maintained during subsequent concrete batching by means of weigh batchers capable of controlling the weights within  $\pm 2\%$  for cement and  $\pm 3\%$  for aggregate. The batching equipment shall be calibrated at the frequency decided by ENGINEER. Amount of water added shall be such as to produce dense concrete of required consistency, specified strength and satisfactory workability and shall be so adjusted to account for moisture content in the aggregates. Water- cement ratio specified for use by ENGINEER shall be maintained. Each time the work stops, the mixer shall be cleaned out, and while recommencing, the first batch shall have 10% additional sand and cement to allow for sticking in the drum. Arrangement should be made by CONTRACTOR to have the cubes tested at his own expense in an approved laboratory or in field with prior consent of ENGINEER. Sampling and testing of strength and workability of concrete shall be as per IS: 1199, IS: 516 and IS: 456. It is preferable to cast additional cubes (minimum 3 specimen) for testing at 7 days and 14 days.

**4.12 Nominal Mix Concrete****a) Mix Design and Testing**

Mix Design and preliminary tests are not necessary for Nominal Mix Concrete. However works tests shall be carried out as per IS: 456. Proportions for Nominal Mix Concrete and water-cement ratio may be adopted as per Table 9 of IS: 456. However, it will be CONTRACTOR's sole responsibility to adopt appropriate nominal mix proportions to achieve the specified characteristic strength.

**b) Batching and Mixing of Concrete**

Based on the adopted nominal mixes, aggregates shall be measured by volume. However cement shall be by weight only. Appropriate correction shall be made for bulking of sand after testing.

**4.13 Ready Mixed Concrete**

All specification as per IS: 4926 – "Specification for Ready Mixed Concrete" shall be used.

The CONTRACTOR shall identify at least two sources of ready mix concrete supplier and get it approved by ENGINEER prior to start of the Works. Any change in the source of the RMC, shall be got approved by the ENGINEER.

The design mix prepared by the RMC supplier shall be the responsibility of the CONTRACTOR. The testing of concrete as per Codal provisions and the

specifications shall be done by the CONTRACTOR same as the normal concreting works.

#### Transporting, **Placing and Compacting Concrete**

Concrete shall be transported from the mixing plant to the formwork with minimum time lapse by methods that shall maintain the required workability and will prevent segregation, loss of any ingredients or ingress of foreign matter or water.

In all cases concrete shall be deposited as nearly as practicable directly in its final position manually or concrete by pumping methods. To avoid segregation, concrete shall not be rehandled or caused to flow. For locations where direct placement is not possible and in narrow forms, CONTRACTOR shall provide suitable drops and “Elephant Trunks”. Concrete shall not be dropped from a height of more than 1.5 m as stipulated in clause 9.13.

Concrete shall not be placed in flowing water. Under water concrete shall be placed in position by tremie or by pipeline from the mixer and shall never be allowed to fall freely through the water.

While placing concrete the CONTRACTOR shall proceed as specified below and also ensure the following:

- (a) Continuously between construction joints and predetermined abutments.
- (b) Without disturbance to forms or reinforcement.
- (c) Without disturbance to pipes, ducts, fixings and the like to be cast in; ensure that such items are securely fixed. Ensure that concrete cannot enter open ends of pipes and conduits, etc.
- (d) Without dropping in a manner that could cause segregation or shock.
- (e) In deep pours only when the concrete and formwork is designed for this purpose and by using suitable chutes or pipes.
- (f) Do not place if the workability is such that full compaction cannot be achieved.
- (g) Without disturbing the unsupported sides of excavations; prevent contamination of concrete with earth. Provide sheeting if necessary. In supported excavations, withdraw the linings progressively as concrete is placed.
- (h) If placed directly onto hardcore or any other porous material, dampen the surface to reduce loss of water from the concrete.

- (i) Ensure that there is no damage or displacement to sheet membranes.
- (j) Record the time and location of placing structural concrete.

Concrete shall normally be compacted in its final position within thirty minutes (Initial setting time) of leaving the mixer. Concrete shall be compacted during placing with approved vibrating equipment without causing segregation until it forms a solid mass free from voids, thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn slowly till air bubbles cease to come to the surface, leaving no voids. When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration, blending and melding of the concrete between successive layers. Vibrators shall not be allowed to come in contact with reinforcement, formwork and finished surfaces after start of initial set. Over-vibration leads to segregation and shall be avoided.

Concrete may be conveyed and placed by mechanically operated equipment after getting the complete procedure approved by ENGINEER. The slump shall be held to the minimum necessary for conveying concrete by this method. When concrete is to be pumped, the concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

CONTRACTOR shall submit a method statement to ENGINEER for approval, furnishing details of pour sequence, thickness of each layer, mixing and conveying equipments proposed etc. preferably with a sketch.

Except when placing with slip forms, each placement of concrete in multiple lift work shall be allowed to set for at least 24 hours after the final set of concrete before the start of subsequent placement. Placing shall stop when concrete reaches the top of the opening in walls or bottom surface of slab, in slab and beam construction, and it shall be resumed before concrete takes initial set but not until it has had time to settle as determined by ENGINEER. Concrete shall be protected against damage until final acceptance.

#### **4.14 Water and Slump**

Water requirements and slump control for pumpable normal weight concrete are interrelated and extremely important considerations. The mixing water requirements for a particular mix shall be determined by the ENGINEER and modified to suit the fineness of sands, quality of admixtures, additives, cement replacements or other special materials being used in the concrete.

The CONTRACTOR shall establish the optimum slump jointly with the ENGINEER for a pumpable mix at the discharge hose end and shall maintain control of that particular slump throughout the course of a job.

#### **Cement Content**

The determination of the cement content for a normal weight pump mix shall follow the same basic principles used for conventionally placed concrete. The water cement ratio shall be established by the ENGINEER on the basis of exposure conditions, strength requirements or minimum cement consumption. While establishing the cement content for normal weight trial mixes, it will be necessary to take into account the capabilities of the particular pump and its operator for over strength proportioning in the laboratory to provide for field variations.

In case of pumping difficulties, it is desirable and economical to correct any deficiencies in the aggregates, especially in the sand instead of using extra quantities of sand.

#### **Admixtures**

The use of poor aggregate grading or aggregate with continuous change in overall grading of the 'combinations' during concreting operation will make special admixtures quite useful in overcoming the main difficulty like blockage in pumping. These admixtures shall be incorporated in concrete to make it workable.

For improvement of pumpability the following admixtures are generally recommended. Such admixtures used shall be conforming to ASTM C-494/ IS: 9103:

- (a) Water Reducing Admixtures/ Super Plasticisers
- (b) Air Entraining Admixtures
- (c) Finely Divided Mineral Admixtures.

#### **4.15 Quality Control**

CONTRACTOR shall ensure that workmanship and plant shall be maintained at peak efficiency. Degree of control on all the concrete operation from selection of the ingredients to the final testing of specimen shall be in line with the assumptions made in mix design with respect to the standard deviation and co-efficient of variation.

The CONTRACTOR shall ensure that any compromise in quality is not done for the pumped concrete. To be pumpable, a high level of quality control for the assurance of uniformity must be maintained. Sampling at both the truck discharges and point of final placement shall be done by the CONTRACTOR and the ENGINEER jointly, as frequently as the ENGINEER desires to determine, if any change in the slump air

content, and other significant mix characteristics occur take necessary corrective actions.

The CONTRACTOR shall engage experienced supervision at all levels. The placing crew shall be experienced and qualified and each operation shall be well planned and properly scheduled.

All the crew engaged in each of the concrete activities shall demonstrate in the presence of the ENGINEER, their skills and capabilities to produce the final product as specified.

#### **4.16 Mass Concrete Works**

Sequence of pouring for mass concrete works shall be as approved by ENGINEER. CONTRACTOR shall exercise great care to prevent shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

##### **Placing Temperature of Concrete**

Placing temperature of concrete should be maintained as specified in Bill of Quantities or as directed by ENGINEER, to avoid shrinkage cracking.

##### **Curing**

Curing and protection shall start immediately after the compaction of the concrete to protect it from:

- (a) Premature drying out, particularly by solar radiation and wind;
- (b) leaching out by rain and flowing water;
- (c) rapid cooling during the first few days after placing;
- (d) high internal thermal gradients;
- (e) low temperature or frost;
- (f) Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

All concrete, unless directed otherwise by ENGINEER, shall be cured by use of continuous sprays or ponded water or continuously saturated coverings of sacking, canvas, hessian or other absorbent material for the period of complete hydration with a minimum of 7 days. The quality of curing water shall be the same as that used for mixing.

Extra precautions shall be exercised in curing concrete during cold and hot weather as per Clause no. 8.3 of IS: 7861 (Part II) and Clause no. 8.2 of IS: 7861 (Part I) respectively.

Curing arrangement shall be subjected to ENGINEER's approval.

**4.17 Construction Joints and Keys**

Construction joints (location and type) shall be as shown on the drawing or as approved by ENGINEER. Concrete shall be placed without interruption until completion of work between construction joints. If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made with the approval of ENGINEER.

Dowels for concrete work, not likely to be taken up in the near future, shall be coated with cement slurry and encased in lean concrete as indicated on the drawings or as directed by ENGINEER.

Before resuming concreting on a surface which has hardened all laitance and loose aggregates shall be thoroughly removed by wire brushing and/ or hacking, the surface washed with high pressure water jet and treated with thin layer of cement slurry for vertical joints and a 15 mm thick layer of cement sand mortar for horizontal joints, the ratio of cement and sand being the same as in the concrete mix.

When concreting is to be resumed on a surface, which has not fully hardened, all laitance shall be removed by wire brushing, the surface wetted, free water removed and a coat of cement slurry applied. On this a layer of concrete not exceeding 150 mm thickness shall be placed and well rammed against the old work. Thereafter work shall proceed in the normal way.

Approved epoxy Bonding agent, for bond between old (say 28 days or more) and new concrete may also be used as per manufacturer's specifications.

**4.18 Foundation Bedding**

All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft or spongy area shall be cleaned out and back filled with either soil-cement mixture, lean concrete or clean sand compacted as directed by ENGINEER. The surfaces of absorptive soils shall be moistened.

Concrete shall not be deposited on large sloping rock surfaces. The rock shall be cut to form rough steps or benches by picking, barring or wedging. The rock surface shall be kept wet for 2 to 4 hours before concreting.

**4.19 Base Concrete**

The thickness and grade of concrete and reinforcement shall be as specified in the item of work.

Before placing the blinding concrete of 1:4:8 mix, 50/75mm thick as per the item of work, the sub-base of rubble packing shall be properly wetted and rammed. Concrete



for the base shall then be deposited between the forms, thoroughly tamped and the surface finished level with the top edges of the forms. Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surface of the base concrete shall be left rough to provide adequate bond for the floor finish to be provided later.

#### **4.20 Hot Weather Requirement**

- a. Concreting during hot weather shall be carried out as per IS: 7861 (Part I).
- b. Adequate provisions shall be made to lower concrete temperatures which shall not exceed 40° C at the time of placement of fresh concrete.
- c. Where directed by ENGINEER, CONTRACTOR shall spray non-wax based curing compound on unformed concrete surface at no extra costs.

#### **4.21 Cold Weather Requirements**

- a. Concreting during cold weather shall be carried out as per IS: 7861 (PART 2).
- b. The ambient temperature during placement and upto final set shall not fall below 5° C.
- c. Approved anti-freeze/ accelerating additive shall be used where directed.

For major and large scale concreting works the temperature of concrete at times of mixing and placing, the thermal conductivity of the formwork and its insulation and stripping period shall be closely monitored.

#### **4.22 Mode of Measurement and Payment**

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

Payments for concrete will be made on the basis of unit rates quoted for the respective items in the Schedule of Quantities. No deduction in the concrete quantity will be made for reinforcements, inserts etc. and opening less than 0.100 sq.m, in areas where concrete is measured in sqm and 0.010 cum where concrete is measured in cubic metres. Where no such deduction for concrete is made, payment

for shuttering work provided for such holes, pockets, etc. will not be made. Similarly, the unit rates for concrete work shall be inclusive or exclusive of shuttering as provided for in the Schedule of Quantities.

Payment for beams will be made for the quantity based on the depth being reckoned from the underside of the slabs and length measured as the clear distance between supports. Payment for columns shall be made for the quantity based on height reckoned upto the underside of slabs.

The unit rate for precast concrete members shall include formwork, mouldings, finishing, hoisting and setting in position including setting mortar, provision of lifting arrangement etc. complete. Reinforcement and inserts shall be measured and paid for separately under respective item rates.

Only the actual quantity of steel embedded in concrete including laps as shown on drawings or as approved by ENGINEER shall be measured and paid for, irrespective of the level or height at which the work is done. The unit rate for reinforcement shall include all wastage, binding wires, chairs, spacer bars etc. for which no separate payment shall be made.

Where the formwork is paid for separately, it shall be very clearly understood that payment for formwork is inclusive of formwork, shuttering, shoring, propping, scaffolding, deshuttering, etc. complete. Only the net area of concrete formed (shuttered) shall be measured for payment.

#### **4.23 Repair and Replacement of Unsatisfactory Concrete**

Immediately after the shuttering is removed, all the defective areas such as honeycombed surfaces, rough patches, etc. shall be brought to the notice of ENGINEER who may permit patching of the defective areas or reject the concrete work. ENGINEER's decision on rejection of concrete work shall be final.

All through holes for shuttering shall be filled with cement mortar for full depth and neatly plugged flush with surface.

Rejected concrete shall be removed and replaced by CONTRACTOR at no additional cost to OWNER.

For patching of defective areas all loose materials shall be removed and the surface shall be prepared as directed by the ENGINEER.

Bonding between hardened and fresh concrete shall be done either by placing cement mortar or by applying epoxy. The decision of the ENGINEER as to be the method of repairs to be adopted shall be final and binding on the CONTRACTOR and no extra claim shall be entertained on this account. The surface shall be saturated with water for 24 hours before patching is done with 1:5 cement sand

mortar. The use of epoxy for bonding fresh concrete shall be carried out as directed by ENGINEER.

CONTRACTOR shall submit a method statement for such repairs to ENGINEER for approval.

#### **4.24 Optional Tests**

If ENGINEER feels that the materials i.e. cement, sand, coarse aggregates, reinforcement and water are not in accordance with the specifications or if specified concrete strengths are not obtained, he may order tests to be carried out on these materials in laboratory, to be approved by the ENGINEER, as per relevant IS Codes. OWNER shall pay only for the testing of material supplied by the OWNER, otherwise CONTRACTOR shall have to pay for the tests. Transporting of all material to the laboratory shall however be done by the CONTRACTOR at no extra cost to OWNER. In the event of any work being suspected of faulty material or workmanship requiring its removal or if the works cubes do not give the stipulated strength, ENGINEER reserves the right to order the CONTRACTOR to take out cores and conduct tests on them or do ultrasonic testing or load testing of structure, as per relevant IS specifications. All these tests shall be carried out by CONTRACTOR at no extra cost to the OWNER. Alternately ENGINEER also reserves the right to ask the CONTRACTOR to dismantle and re-do such unacceptable work at the cost of CONTRACTOR.

If the structure is certified by ENGINEER as having failed, the cost of the test and subsequent dismantling/reconstruction shall be borne by CONTRACTOR.

The quoted unit rates/prices of concrete shall deemed to provide for all tests mentioned above.

#### **4.25 Quality Control**

CONTRACTOR shall note that it is required to adopt quality control formats. A copy of formats shall be furnished to CONTRACTOR by ENGINEER/ OWNER after the contract is awarded.

Alternatively, if CONTRACTOR has his own QC formats he may adopt them subjected to such modifications considered necessary by ENGINEER.

In either case CONTRACTOR shall submit his detailed Quality Assurance Plan along with the bid. This would be reviewed, appropriately modified and approved by CONSULTANT/ ENGINEER after the award of contract.

#### **4.26 Inspection**

All materials, workmanship and finished construction shall be subject to continuous inspection and approval of ENGINEER. Materials rejected by ENGINEER shall be

expressly removed from site within 3 working days and shall be replaced by CONTRACTOR immediately at no extra cost to OWNER.

#### **4.27 Clean-Up**

Upon the completion of concrete work, all forms, equipment, construction tools, protective coverings and any debris, scraps of wood, etc. resulting from the work shall be removed and the premises left clean.

#### **4.28 Acceptance Criteria**

Any concrete work shall satisfy the requirements given below individually and collectively for it to be acceptable.

- (a) properties of constituent materials;
- (b) characteristic compressive strength;
- (c) specified mix proportions;
- (d) minimum cement content;
- (e) maximum free-water/cement ratio;
- (f) workability;
- (g) temperature of fresh concrete;
- (h) density of fully compacted concrete;
- (i) cover to embedded steel;
- (j) curing;
- (k) tolerances in dimensions;
- (l) tolerances in levels;
- (m) durability;
- (n) surface finishes;
- (o) special requirements such as :
  - i. Water tightness
  - ii. resistance to aggressive chemicals
  - iii. resistance to freezing and thawing
  - iv. very high strength
  - v. improved fire resistance
  - vi. wear resistance
  - vii. resistance to early thermal cracking

ENGINEER's decision as to the acceptability or otherwise of any concrete work shall be final and binding on the CONTRACTOR.

For work not accepted, ENGINEER may review and decide whether remedial measures are feasible so as to render the work acceptable. ENGINEER shall in that case direct the CONTRACTOR to undertake the remedial measures. These shall be

expeditiously and effectively implemented by CONTRACTOR. Nothing extra shall become payable to CONTRACTOR by OWNER for executing remedial measures.

#### 4.29 Concrete Pour Card

- (a) CLIENT: \_\_\_\_\_ DATE: \_\_\_\_\_ POUR NO. \_\_\_\_\_
- (b) PROJECT: \_\_\_\_\_  
STRUCTURE: \_\_\_\_\_
- (c) CONTRACTOR: \_\_\_\_\_
- (d) MAX AGGREGATE SIZE \_\_\_\_\_ mm SLUMP: \_\_\_\_\_ mm
- (e) DRG. NO. \_\_\_\_\_
- (f) START/ COMPLETION TIME: \_\_\_\_\_
- (g) CONCRETE GRADE QUANTITY: M / M<sup>3</sup> MIXING TIME: \_\_\_\_\_

SR. NO	ITEM	CONTRACTOR's REP. SIGNATURE	ENGINEER's SIGNATURE	REMARKS
1.	CENTERLINES CHECKED			
2.	FORMWORK AND STAGING CHECKED			
3.	REINFORCEMENT CHECKED			
4.	COVER TO REINFORCEMENT CHECKED			
5.	VERIFIED TEST CERTIFICATE FOR CEMENT/ STEEL	YES/ NO	YES/ NO	
6.	ADEQUACY OF MATERIALS EQUIPMENT FOR POUR	YES/ NO	YES/ NO	
7.	EMBEDED PARTS CHECKED (LOCATION AND PLUMB)	CIVIL		
		MECHANICAL		
		ELECTRICAL		
POUR AUTHORISED SITE ENGINEER				

8.	SOFFIT(S) AND POUR TOP (T) LEVELS CHECKED BEFORE (B) AND AFTER (A) FROM REMOVAL (ONLY OF BEAMS OF OVER 10 M SPAN AND IMPORTANT STRUCTURES LIKE TG, ETC.)	S(B) S(A)	T(B) T(A)	
9.	CONSTRUCTION JOINT LOCATION AND TIME (IF NOT AS PER DRAWING)			
10.	CEMENT CONSUMPTION IN Kg			
11.	NUMBER OF CUBES AND IDENTIFICATION MARK			
12.	TEST CUBE RESULTS (7 DAYS/ 28 DAYS)	/	/	/
13.	CONCRETE CONDITION ON FORM REMOVAL	VERY GOOD/ GOOD/ FAIR/ POOR		
SITE-IN-CHARGE				

**NOTES:**

- (a) EACH ITEM TO BE CHECKED AND SIGNED BY THE RESPECTIVE ENGINEERS.
- (b) ITEMS 8 TO 13 (BOTH INCLUSIVE) TO BE FILLED BY ONLY TCE ENGINEER.
- (c) EACH POUR TO HAVE SEPARATE CARDS, IN TRIPLICATE ONE EACH FOR CLIENT, TCE AND SITE OFFICE. FORM 279
- (d) UNDER REMARKS INDICATE DEVIATIONS FROM DRAWINGS AND SPECIFICATIONS, CONGESTION IN REINFORCEMENT, IF ANY, UNUSUAL OCCURENCES, SUCH AS FAILURE OF EQUIPMENT, SINKING OF SUPPORTS/ PROPS, HEAVY RAINS AFFECTING CONCRETEING, POOR COMPACTION, IMPROPER CURING, OTHER DEFICIENCIES, OBSERVATIONS, ETC.

## 5 FORM WORK

### 5.1 Scope

This specification covers the general requirements for formwork as well as mode of measurement and payment for completed works.

This specification shall be read in conjunction with Specification Reinforced concrete and allied works. It shall be very clearly understood that the specifications given herein are brief and do not cover minute details. however, all works shall have to be carried out in accordance with the relevant standards and codes of practices or in their absence in accordance with the best accepted current engineering practices or as directed by Engineer from time to time. The decision of engineer as regards the specification to be adopted and their interpretation and the mode of execution of work shall be final and binding on contractor and no claim whatsoever will be entertained on this account.

### 5.2 Applicable Codes and Specifications

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

#### Codes of Practice

a)	IS: 303	Specification for plywood for general purpose.
b)	IS: 456	Code of practice for plain and reinforced concrete.
c)	IS:1200 (Part 1 to 12)	Method of measurement of building and engineering works (Parts 2 and 5).
d)	IS: 2750	Specifications for steel scaffoldings.
e)	IS:3370	Code of practice for concrete structures for storage of liquids (Parts 1 to 4).
f)	IS: 3696	Safety code for scaffolds and ladders (Parts 1 & 2).
g)	IS: 4014	Code of practice for steel tubular scaffolding. (Parts 1 & 2).
h)	IS: 4082	Recommendations on stacking and storing of construction materials at site.
i)	IS: 4900	Specification for plywood for concrete shuttering work.
j)	IS: 7969	Safety code for handling and storage of building materials.
k)	IS: 4990	Specifications for plywood formwork for concrete.

### 5.3 General

Engineer shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials and the quality control system. Such an inspection shall be arranged and Engineer's approval obtained, prior to starting of concrete work. This shall, however, not relieve the Contractor of any of his responsibilities. All materials, which do not conform to this specification, shall be rejected.

Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due regards to the functional requirements and the environmental conditions to which the structure will be subjected. Materials complying with codes/ standards shall only be used. Other materials may be used after approval of the Engineer and after establishing their performance suitability based on previous data, experience or tests.

### 5.4 Materials

#### **Storing of Materials**

All material shall be stored in a manner so as to prevent its deterioration and contamination, which would preclude its use in the works. Requirements of IS: 4082 shall be complied with.

Contractor will have to make his own arrangements for the storage of adequate quantity of formwork/ shuttering material

### 5.5 Formwork

Formwork shall be all inclusive and shall consist of but not limited to shores, bracings, sides of footings, walls, beams and columns, bottom of slabs, etc. including ties, anchors, hangers, inserts, falsework, wedges, etc.

The design and engineering of the formwork as well as its construction shall be the responsibility of Contractor. However, if so directed by Engineer, the drawings and calculations for the design of the formwork shall be submitted to Engineer for approval.

Formwork shall be designed to fulfil the following requirements:

- (a) Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and appropriate to the methods of placing and compacting.



- (b) Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.
- (c) Capable of withstanding without deflection the worst combination of self weight, reinforcement and concrete weight, all loads and dynamic effects arising from construction and compacting activities, wind and weather forces.
- (d) Capable of easily striking without shock, disturbance or damage to the concrete.
- (e) Soffit forms capable of imparting a camber, if required.
- (f) Soffit forms and supports capable of being left in position, if required.
- (g) Capable of being cleaned and/ or coated, if necessary, immediately prior to casting the concrete; design temporary openings where necessary for these purposes and to facilitate the preparation of construction joints.

The formwork may be of lined timber, waterproof/ plastic coated plywood, steel, plastic depending upon the type of finish specified. Sliding forms and slip form may be used with the approval of ENGINEER. Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps and other surface defects. Joints between formwork and formwork and between formwork and structure shall be sufficiently tight to prevent loss of slurry from concrete using foam and rubber seals.

The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before fixing reinforcement. All rubbish, particularly chippings, shavings, sawdust, wire pieces, dust, etc. shall be removed from the interior of the forms before the concrete is placed. Where directed, cleaning of forms shall be done by blasting with a jet of compressed air at no extra cost.

Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced to the satisfaction of Engineer. Contractor shall equip himself with enough quantity of shuttering to allow for wastage so as to complete the job in time.

Permanent formwork shall be checked for its durability and compatibility with adjoining concrete before it is used in the structure. It shall be properly anchored to the concrete.

Wire ties passing through beams, columns and walls shall not be allowed. In their place bolts passing through sleeves may be used. Formwork spacers left in situ shall

not impair the desired appearance or durability of the structure by causing spalling, rust staining or allowing the passage of moisture.

For liquid retaining structures sleeves shall not be provided for through bolts nor shall through bolts be removed, if provided. The bolts, in the latter case, shall be cut at 25 mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.

Where specified or shown on drawings all corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm x 20 mm size.

Forms for substructure may be omitted when, in the opinion of Engineer, the open excavation is firm enough (in hard non-porous soils) to act as a form. Such excavation shall be slightly larger, as directed by Engineer, than that required as per drawing to compensate for irregularities in excavation.

Contractor shall provide adequate props of adjustable steel pipes carried down to a firm bearing without overloading any of the structures.

The shuttering for beams and slabs shall be so erected that the side shuttering of beams can be removed without disturbing the bottom shuttering. If the shuttering for a column is erected for the full height of the column, one side shall be built up in sections as placing of concrete proceeds or windows left for placing concrete from the side to limit the drop of concrete to 1.5 m or as directed by Engineer. Contractor shall temporarily and securely fix items to be cast (embedment/ inserts) in a manner that will not hinder the striking of forms or permit loss of grout.

Formwork showing excessive distortion, during any stage of construction, shall be removed. Placed concrete affected by faulty formwork, shall be entirely removed and formwork corrected prior to placement of new concrete at Contractor's cost.

The striking time for formwork shall be determined based on the following requirements:

- (a) Development of adequate concrete strength,
- (b) Permissible deflection at time of striking form work,
- (c) Curing procedure employed - its efficiency and effectiveness,
- (d) Subsequent surface treatment to be done,
- (e) Prevention of thermal cracking at re-entrant angles,
- (f) Ambient temperatures; and Aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete).

Before removing formwork of soffit of slabs/ beams compressive strength at 7/ 14/ 21 days shall be checked.

Under normal circumstances (generally where temperatures are above 20 Deg C) forms may be struck after expiry of the period given in IS: 456 unless directed otherwise by Engineer. For Portland Pozzolana / Slag Cement the stripping time shall be suitably modified as directed by the Engineer. It is the Contractor's responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not undergo excessive deformation and resists surface damage and any stresses arising during the construction period.

### **5.6 Formwork-Finishes**

The formwork for concrete works shall be such as to give the finish as specified in relevant Indian code for formwork. . The Contractor shall make good any unavoidable defects as approved consistent with the type of concrete and finish specified; defects due to bad workmanship (e.g. damaged or misaligned forms, defective or poorly compacted concrete) will not be accepted. The Contractor shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

### **5.7 Re-use of forms, etc.**

Forms required to be used more than once shall be maintained in serviceable condition 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. Steel forms shall be cleaned by buffing before reuse.

### **5.8 Execution and Removal of Forms**

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

The form releasing agent shall cover the forms fully and evenly without excess over drip. Care shall be taken to prevent form releasing agents from getting on the surface of the construction joints and on reinforcement bars. Special care shall be taken to

thoroughly cover 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.

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.

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.

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

Removal of forms shall never be started until the concrete is thoroughly set and adequately hardened such that it can 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, with reference to weather conditions, shape and position of the structure or 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:

1.	Beam sides, walls, unloaded columns	-	after 24 hours
2.	Slabs and arches (props left under)	-	after 4 days
3.	Props to slabs and arches	-	after 10 days
4.	Beam soffit (props left under)	-	after 8 days
5.	Props to beams	-	after 21 days
6.	Lean concrete (sides)	-	after 2 days

**Note:** Time shall be measured from last batch concreted 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 causing any jerks to the structure.

Re-propping shall be done to the below during construction of upper floor and props left under till the period of removal of props supported to or any other load due to construction load on the upper floor. Re-propping shall be part of shuttering/formwork for concrete without any claim for extra cost.

### 5.9 Settlement of Formwork and Camber

Due to various reasons such as closure of form joints, shrinkage of timber, dead load deflections, elastic shortening of form members or formwork, deflections, settlement may occur. The Contractor shall take precautions, including using adequately rigid formwork, in order to prevent excessive settlement/ deflection; 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 pre-stressed concrete beams shall be laid to a camber, the amount of which at mid span shall not be less than  $1/500$  of the span of the structure. The profile of soffit shall be parabolic.

### 5.10 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:

- (a) Zones around penetrations and openings.
- (b) Behind anchorage of pre-stressed members.
- (c) Dome and shell in general requiring single and double forms.
- (d) 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. 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.

Pockets, duct, cut-outs or any kind of holes in/ at ends/ edges of slabs/ beams kept for pre-stressed post tensioning operations shall be finished to the mark of formwork finish by the Contractor with the same grade of concrete without any claim for extra costs.

### 5.11 Mode of Measurement and Payment

Where the formwork is paid for separately, it shall be very clearly understood that payment for formwork is inclusive of formwork, shuttering, shoring, propping, scaffolding, deshuttering, etc. complete. Only the net area of concrete formed (shuttered) shall be measured for payment.

## 5.12 Tolerance

Tolerance is a specified permissible variation from lines, grade or dimensions given in drawings. No tolerance specified for horizontal or vertical building lines or footings shall be construed to permit encroachment beyond the legal boundaries. Tolerance for formed and concrete dimensions shall be as per IS: 456 unless specified otherwise.

- Tolerances for RC Buildings

- (a) Variation from the Plumb

- i. In the lines and surfaces of columns, piers, walls and in arises  
5 mm per 2.5 m or 25 mm, whichever is less.
    - ii. For exposed corner columns and other conspicuous lines  
In any bay or 5 m maximum - 5 mm  
In 10 m or more - 10 mm

- (b) Variation from the level or from the grades indicated on the drawings

- i. In slab soffits, ceilings, beam soffits and in arises  
In 2.5 m - 5 mm  
In any bay or 5 m maximum - 10 mm  
In 10 m or more - 15 mm
    - ii. For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines  
In any bay or 5 m maximum - 5 mm  
In 10 m or more - 15 mm

- (c) Variation of the linear building lines from established position in plan and related position of columns, wall and partitions

- In any bay or 5 m maximum - 10 mm
    - In 10 m or more - 20 mm

- (d) Variation in the sizes and locations of sleeves, openings in walls and floors - 5 mm except in the case of and for anchor bolts.

- (e) Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls

- Minus - 5 mm
    - Plus - 10 mm

- (f)

## (g) Footings

## i. Variation in dimension in plan

Minus	-	5 mm
Plus	-	50 mm

## ii. Misplacement or eccentricity

2% of footing width in the direction of misplacement but not more than 50 mm

## iii. Reduction in thickness

Minus	-	5% of specified thickness subject to a maximum of 50 mm
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## (h) Variation in steps

## i. In a flight of stairs

Rise	-	3 mm
Tread	-	5 mm

## ii. In consecutive steps

Rise	-	1.5 mm
Tread	-	2 mm

- Tolerances In other Structures**

## (a) All structures

## i. Variation of the construction linear outline from established position in plan

In 5 m	-	10 mm
In 10 m or more	-	15 mm

## ii. Variation of dimensions to individual structure features from established positions

In 20 m or more	-	25 mm
In buried construction	-	50 mm

## iii. Variations from plumb, from specified batter or from curved surfaces of all structures

In 2.5 m	-	10 mm
In 5 m	-	15 mm
In 10 m or more	-	25 mm

- |  |                        |   |                        |
|--|------------------------|---|------------------------|
|  | In buried construction | - | Twice the above values |
|--|------------------------|---|------------------------|
- iv. Variations from level or grade indicated on drawings in slabs, beams, soffits, horizontal grooves and visible arrises
- |  |                  |   |       |
|--|------------------|---|-------|
|  | In 2.5 m         | - | 5 mm  |
|  | In 7.5 m or more | - | 10 mm |
- |  |                        |   |                        |
|--|------------------------|---|------------------------|
|  | In buried construction | - | Twice the above values |
|--|------------------------|---|------------------------|
- v. Variation in cross-sectional dimensions of columns, beams, buttresses, piers and similar members
- |  |       |   |       |
|--|-------|---|-------|
|  | Minus | - | 5 mm  |
|  | Plus  | - | 10 mm |
- vi. Variation in the thickness of slabs, walls, arch sections and similar members.
- |  |       |   |       |
|--|-------|---|-------|
|  | Minus | - | 5 mm  |
|  | Plus  | - | 50 mm |
- (b) Footing for Columns, Piers, Walls, Buttresses and Similar Members
- i. Variation of dimension in plan
- |  |       |   |       |
|--|-------|---|-------|
|  | Minus | - | 10 mm |
|  | Plus  | - | 50 mm |
- ii. Misplacement or eccentricity
- 2% footing width in the direction of misplacement but not more than 50 mm
- iii. Reduction in thickness
- 5% of specified thickness subject to a maximum of 50 mm
- (c) Tolerance in fixing Anchor Bolts shall be as follows:
- |     |   |   |                        |
|-----|---|---|------------------------|
| i.  | Anchor bolts without sleeves              | : | 1.5 mm in plan         |
| ii. | Anchor bolts with sleeves                 | : | 5.0 mm in elevation    |
|     | - for bolts upto and including 28 mm dia. | : | 5 mm in all directions |
|     | - for bolts upto 32 mm dia.               | : | 3 mm in all directions |



iii. Embedded parts : 5 mm in all directions

(d) Tolerances in Formwork

The formwork shall be designed and constructed to the shapes, lines and dimensions shown on the drawings within the tolerances given below:

1. Deviation from specified dimensions of cross section of columns and beams -6 mm

2. Deviations from dimensions of footings (tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel or dowels) +12 mm

- (a) Dimension in plan -12 mm  
+50 mm

- (b) Eccentricity 0.02 times the width of the footing in the direction of deviation but not more than 50 mm

- (c) Thickness  $\pm 0.05$  times the specified thickness

## **6 STRUCTURAL DESIGN**

### **6.1 Design of Buildings Elements**

- a. To the requirements of the National Building Code of India and the standards quoted therein.
- b. For the specified climatic and loading conditions.
- c. To adequately suit the requirements of the equipment and apparatus contained in the buildings and in all respects to be compatible with the intended use and occupancy.
- d. With a functional and economical space arrangement.
- e. For a life expectancy of structure, systems and components not less than that of the equipment which is contained in the building, provided regular maintenance is carried out.
- f. To be aesthetically pleasing. Different buildings shall show a uniformity and consistency in architectural design.
- g. To allow for easy access to equipment and maintenance of the equipment.
- h. With, wherever required, fire retarding materials for walls, ceilings and doors, which would prevent supporting or spreading of fire. With materials preventing dust accumulation.
- i. All members of structure shall be designed for the worst combination of forces such as bending moment, axial force, shear force, torsion etc.
- j.

### **6.2 Design of RCC Earth Retaining Wall**

- a. Foundations shall be in reinforced cement concrete. The design and construction of RCC structures shall be carried out as per IS-456 & IS-3370, minimum grade of concrete shall be M-30. Higher grade of concrete than specified above may be used at the discretion of Bidder, which has to be stated at the time of bidding.
- b. Limit state method of design shall be adopted unless specified otherwise in the specification.
- c. For design and construction of steel concrete composite beam IS:1 1384 shall be followed.
- d. For detailing of reinforcement IS:2502 and SP:34 shall be followed. Cold twisted deformed bars ( $F_y=500 \text{ N/mm}^2$ ) conforming to IS:1786 shall be used as reinforcement. However in specific areas. Mild steel Grade D conforming to IS:432 can also be used Two layers of reinforcement (inner and outer

face) shall be provided for wall & slab sections basing thickness of 150 mm and above. Clear cover to reinforcement towards each face shall be 40mm in case of side walls of cable ducts and for sewer foundations & equipment foundation clear cover shall be 50mm.

- e. The procedure used for the design of the foundations shall be the most critical loading combination of the steel structure and or equipment and /or super structure and other conditions which produce the maximum stresses in the foundation or the foundation component and as per the relevant IS Codes of foundation design. Detailed design calculations shall be submitted by the bidder showing complete details of piles/pile groups proposed to be used.
- f. All foundations shall rest below virgin ground level and the minimum depth of foundation below the virgin ground level shall be at least 500mm for equipment foundations and 1000mm for towers, transformers and reactors
- g. Design shall consider any sub-soil water pressure that may be encountered following relevant standard strictly.
- h. Necessary protection to the foundation work if required shall be provided to take care of any special requirements for aggressive alkaline soil, black cotton soil or any other type of soil which is detrimental/harmful to the concrete foundations.
- i. All sub-structures shall be checked for sliding and overturning stability during both construction and operating conditions for various combinations of load. Factors of safety for these cases shall be taken as mentioned in relevant IS codes or as stipulated elsewhere in the Specifications. For checking against overturning, weight of soil vertically above footing shall be taken and inverted frustum of pyramid of earth on the foundation should not be considered.
- j. Earth pressure for all underground structures shall be calculated using coefficient of earth pressure at rest coefficient of active or passive earth pressure (whichever is applicable). However, for the design of substructures of any underground enclosures. earth pressure at rest shall be considered.
- k. In addition to earth pressure and ground water pressure etc. a surcharge load of  $2T/Sq.m$  shall also be considered for the design of all underground structures including channels sumps Tanks, trenches substructure of any underground hollow enclosure etc. for the vehicular traffic in the vicinity of the structure.

- l. The foundations shall be proportioned so that the estimated total and differential movements of the foundations are not greater than the movements that the structure or equipment is designed to accommodate.
- m. Suitable expansion joints shall be provided in the longitudinal direction wherever, necessary with provision of twin columns.
- n. Permissible stresses for different load combinations shall be taken as per relevant IS codes.

### 6.3 Design Loads

Building structures shall be designed for the most critical combinations of dead loads, super-imposed loads, equipment loads, crane load, wind loads, seismic loads and temperature loads. In additions, loads and forces developed due to differential settlement shall also be considered.

Dead loads shall include the weight of structures complete with finishes, fixtures and partitions and should be taken as per IS:1911 ( latest revision). Super-imposed loads in different areas shall include live loads, minor equipment loads, cable trays, small pipe racks/hangers and erection, operation and maintenance loads. Equipments loads shall constitute if applicable all load of equipments to be supported on the building frame.

Wind and seismic forces shall not be considered to act simultaneously.

Floors / slabs shall be designed to carry loads imposed by equipment , cables piping travel of maintenance trucks and equipment and other loads associated with building. In general, floors shall be designed for live loads as per relevant IS and cable and piping loads not less than 5 kN/sqm. Hanging from the underside.

In addition, beams shall be designed for incidental point loads of 20 kN to be applied at any point along the beams. The floor loads shall be subject to KNNL approval.

For consideration of the loads on structure, IS:875 “code of practice for structural safety of building” shall be followed. The following minimum superimposed live loads shall however, be considered for the design.

- |               |                       |   |
|---------------|-----------------------|---|
| a. Roof       | 150kg/m <sup>2</sup>  | for accessible roofs                                  |
|               | 75 kg/m <sup>2</sup>  | for non-accessible roofs                              |
| b. RCC floors | 500 kg/m <sup>2</sup> | for offices and minimum 1000 kg/m <sup>2</sup> for    |
|               |                       | Equipment floors or actual requirement , if           |
|               |                       | Higher than 1000 kg/m <sup>2</sup> based on equipment |
|               |                       | Component weight and layout plans.                    |

- |                          |                       |
|--------------------------|-----------------------|
| c. Stair and balconies   | 500kg/m <sup>2</sup>  |
| d. Toilet rooms          | 200 kg/m <sup>2</sup> |
| e. Chequered plate floor | 400kg/m <sup>2</sup>  |

#### **6.4 Submission**

The following information shall be submitted for review and approval to the Department.

1. Design criteria shall comprise the codes and standards used, applicable climatic data including wind loads, earthquake factors maximum and minimum temperatures applicable to the building locations, assumptions of dead and live loads, including equipment loads impact factors, safety factors and other relevant information.

2. Structural design calculations and drawing (including construction/ fabrication) for all reinforces concrete and structural steel structures.

3. Fully, dimensioned floor plans, cross sections, longitudinal section and elevations of each building. These drawings shall be drawn at a scale not smaller than 1:50 and shall identify the major building components.

4. Fully dimensioned drawing showing details and sections drawn to scales of sufficient size to clearly show sizes and configuration of the building components and the relationship between them.

5. Product information of building components and materials, including walls, partitions, flooring, ceiling, roofing, door and windows and building finishes.

6. A detailed schedule of building finishes including colour schemes.

7. A door and window schedule showing door type and locations, door locks sets and latch sets and other door hardware. Approval of the above information shall be obtained before ordering materials or starting fabrication or construction as applicable.

### **7 MISCELLANEOUS GENERAL REQUIREMENTS**

Dense concrete with controlled water cement ratio preferable 0.45 shall be used for all underground concrete structures such as pump house. Tanks water retaining structure, cable and pipe trenches etc. For achieving water tightness.

All joints including construction and expansion joints for the water retaining structures shall be made watertight by using PVC ribbed water stops with general bulb. However kicker type (externally placed) PVC water stops shall be used for the base slab and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stops shall be 5mm and minimum width shall be 230mm.

All steel sections and fabricated structures which are required to be transported on sea shall be provided with anti-corrosive paint to take care of sea worthiness.

All mild steel parts used in the water retaining structures shall be hot-dip galvanized, the minimum coating of the zinc shall be hot-dip galvanize. The minimum coating of the zinc shall be 750 gm/sq. for galvanized structures and shall comply with IS: 2629 and IS:2633 . Galvanizing shall be checked and tested in accordance with IS:2629. The galvanizing shall be followed by the application of an etching primer and dipping in black bitumen in accordance with BS:3416.

A screed concrete layer not less than 100mm thick and of grade not weaker than M10 conforming to IS:456-1978 shall be provided below all water retaining structures. A sliding layer of bitumen paper or craft paper shall be provided over the screed layer to destroy the bond between the screed and the base slab concrete of the water retaining structures.

Bricks having minimum 75 kg/cm<sup>2</sup> compressive strength can only be used for masonry work. Bidder shall ascertain himself at site regarding the availability of bricks of minimum 75 kg/cm<sup>2</sup> compressive strength before submitting his offer.

Doors and windows on external walls of the buildings (other than areas provided with insulated metal claddings) shall be provided with RCC sun-shade over the openings with 300mm projection on either side of the openings. Projection of sunshade from the wall shall be minimum 450mm over window openings and 750mm over door openings.

Stairs shall have maximum riser height of 150mm and minimum tread width of 300mm . Minimum width of the stairs shall be 1500mm.

Angles 50x50x6 mm (minimum) with lugs shall be provided for edge protection all around cut outs/openings in floor slab. Edges of drains supporting grating covers. Edges of RCC cable/ pipe trenches supporting covers, edges of manholes supporting covers, supporting edges of precise cover and any other place where breakage of corners of concrete is expected.

Anti termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc, as per IS :6313 and other relevant Indian standard.

Hand-railing minimum 900mm high shall be provided around all floor/roof openings projections/balconies, walk-ways, platforms, steel stairs etc. All handrails and ladder pipes shall be 32mm nominal bore MS pipes (medium class) and shall be galvanized (medium class as per IS:277). All rungs for ladder shall also be galvanized as per IS:277 medium class.

For RCC stairs: Hard railing with 20mm square MS bars. Balustrades with suitable MS flats and aluminium handrails shall be provided.

### **7.1 Interfacing:**

The proper coordination and execution of all interfacing civil works activities like fixing of conduit's in roofs/walls./floors. Fixing of foundation bolts. Fixing of lighting fixtures. Fixing of supports / embedment, provisions of cutouts etc shall be the sole responsibility of the contractor. He shall plan all such activities in advance and execute in such a manner that interfacing activities do not become bottlenecks and dismantling, breakage etc, is reduced to minimum.

### **7.2 Water Supply**

The contractor shall be overall responsible for supply of water within switchyard for firefighting drinking purpose and other miscellaneous purposes water shall be made available at single point by the contractor by providing at least 1 bore points To scope is also inclusive of supply and erection of all tanks pipes. Fittings etc required for water supply to be taken from the terminal point to the respective buildings A scheme still be prepared by the contractor indicating the layout and details of water supply when shall be got approved by the owner before actual start of work. Any extra boreholes if required shall be within the scope of contractor.

### **7.3 STATUTORY RULES:**

- 1 Contractor shall comply with all the applicable statutory rules pertaining to enquire act (as applicable for the state). Fire safety rules of Tariff Advisory committee's water act for pollution control etc.
- 2 Preventions for fireproof doors of staircases fire separately we plastering on structural members (in fire prone at case) etc., shall be made according to the recommendations of Tariff Advisory Committee.
- 3 Statutory clearance and norms of state pollution control board shall be showed as per Water Act for effluent quality from plant.
- 4 Requirement of sulfate resistant cement (SRC) for sub-structural works should decided in accordance with the Indian Standards based on the findings of the detailed investigation to be carried out by the Bidder
- 5 Foundation system adopted by Bidder shall ensure that relating settlement shall be as per provision in IS: 1904 and other Indian Standards
- 6 All water retaining structures designed as un-cracked section shall also be tested for water tightness at full water level in accordance with clause no 10 of 3370 (part-I).
- 7 Construction joints at the following locations shall be provided.
  - a) At the meeting points of the columns and the raft.

- b) At the point of contra flexure in the columns.

Additional reinforcements and shear keys shall be provided at the construction joints. All underground concrete structures like basements pumps. Retaining structures etc. shall have plasticizer cum water proofing cement addition conforming to IS: 9103. In addition. Limit an permeability as given is IS: 2615 shall also be met with. The concrete surface of these structures in contact with earth shall also be provided with two coat of bituminous painting for water/damp proofing In case of water leakage in the above structures. Injection method shall be applied for repairing the leakage.

#### 1. Samples and Tests

All materials used for the works shall be tested before use. The frequency of such confirmatory tests shall be decided by ENGINEER. Manufacturer's test certificate shall be furnished for each batch of cement/steel and when directed by ENGINEER samples shall also be got tested by the CONTRACTOR in a laboratory approved by ENGINEER at no extra cost to OWNER. However, where material is supplied by OWNER, all testing charges shall be borne by OWNER, but transportation and preparation of material samples for the laboratory shall be done by CONTRACTOR at no extra cost.

Sampling and testing of aggregates shall be as per IS: 2386 under the supervision of ENGINEER. The cost of all tests, sampling, etc. shall be borne by CONTRACTOR. For coarse aggregate crushing value shall be tested.

Water to be used shall be tested to comply with clause 5.4 of IS: 456.

CONTRACTOR shall furnish manufacturer's test certificates and technical literature for the admixture proposed to be used. If directed, the admixture shall be got tested at an approved laboratory at no extra cost.

### 7.4 Storing of Materials

All material shall be stored in a manner so as to prevent its deterioration and contamination, which would preclude its use in the works. Requirements of IS: 4082 shall be complied with. CONTRACTOR will have to make his own arrangements for the storage of adequate quantity of cement even if cement is supplied by OWNER. If such cement is not stored properly and has deteriorated, the material shall be rejected. Cost of such rejected cement, where cement is supplied by OWNER, shall be recovered at issue rate or open market rate whichever is higher. Cement bags shall be stored in dry weatherproof shed with a raised floor, well away from the outer walls and insulated from the floor to avoid moisture from ground. Not more than 15



bags shall be stacked in any tier. Storage arrangement shall be approved by ENGINEER. Storage under tarpaulins shall not be permitted. Each consignment of cement shall be stored separately and consumed in its order of receipt. CONTRACTOR shall maintain record of receipt and consumption of cement. Each size of coarse and fine aggregates shall be stacked separately and shall be protected from dropping leaves and contamination with foreign material. The stacks shall be on hard, clean, free draining bases, draining away from the concrete mixing area.

CONTRACTOR shall make his own arrangements for storing water at site in tanks of approved capacity. The tanks shall be cleaned at least once a week to prevent contamination.

The reinforcement shall be stacked on top of timber sleepers to avoid contact with ground/ water. Each type and size shall be stacked separately.

## 8 MASONARY WORKS

### 8.1 Scope

This specification covers the general requirements for brick and stone masonry work, flooring, doors, water- proofing, plastering, painting and such other related works forming a part of this job, which may be required to be carried out though not specifically mentioned above. The works under this specification shall consist of furnishing of all tools, plants, labour, materials, and everything necessary for carrying out the works.

### 8.2 Applicable Codes and Specifications

The following codes, standards and specifications are made a part of this specification. All standards, specifications, codes of practice referred to herein shall be the latest version on the date of offer made by the Bidder.

In case of discrepancy between this specification and those referred to herein, this specification shall govern.

IS: 110	-	Ready mixed paint, brushing, grey filler, for enamels for use over primers.
IS: 280	-	Specification for mild steel wire for general engineering purposes.
IS: 412	-	Expanded metal steel sheets for general purposes.
IS: 426	-	Paste filler for Colour coats.
IS: 428	-	Distemper, oil emulsion, Colour as required.
IS: 1077	-	Specification for common burnt clay building bricks.
IS: 1081	-	Code of practice for fixing and glazing of metal (steel & aluminium) doors, windows and ventilators.
IS: 1124	-	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.
IS: 1200	-	Method of measurement of building and civil engineering works.
IS: 1237	-	Specification for cement concrete flooring tiles.
IS: 1346	-	Code of practice for water-proofing of roofs with bitumen felts.
IS: 1443	-	Code of practice for laying and finishing of cement concrete flooring tiles.
IS: 1542	-	Specification for sand for plaster.
IS: 1597	-	Code of practice for construction of stone masonry: Part 1 Rubble stone masonry.

IS: 1661	-	Code of practice for application of cement and cement-lime plaster finishes.
IS: 1834	-	Specification for hot applied sealing compound for joint in concrete.
IS: 1838	-	Specification for preformed fillers for expansion joint in concrete pavements and structures (non extruding and resilient type) : Part 1 Bitumen impregnated fibre.
IS: 2116	-	Specification for sand for masonry mortars.
IS: 2185	-	Specification for concrete masonry units (Parts 1, 2 & 3).
IS: 2212	-	Code of practice for brickwork.
IS: 2250	-	Code of practice for preparation and use of masonry mortars.
IS: 2339	-	Aluminium paint for general purposes, in dual container.
IS: 2395	-	Code of practice for painting Concrete, masonry and plaster surfaces (Part 1 & Part 2).
IS: 2571	-	Code of practice for laying in-situ cement concrete flooring.
IS: 2690	-	Specification for burnt clay flat terracing tiles: Part 1 Machine made.
IS: 2691	-	Specification for burnt clay facing bricks.
IS: 2750	-	Specification for steel scaffoldings.
IS: 3036	-	Code of practice for laying lime concrete for a water-proofed roof finish.
IS: 3067	-	Code of practice of general design details and preparatory work for damp-proofing and water-proofing of buildings.
IS: 3068	-	Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete.
IS: 3384	-	Specification for bitumen primer for use in water-proofing and damp-proofing.
IS: 3495	-	Method of test for burnt clay building bricks : Part 1 to 4.
IS: 3696	-	Safety code of scaffolds and ladders (Part 1).
IS: 3696	-	-DO- (Part 2).
IS: 5410	-	Cement paint, colour as required.
IS: 6248	-	Specification for metal rolling shutters and rolling grilles.
IS: 8042	-	Specification for white Portland cement.
IS: 8112	-	Specification for 43 grade ordinary Portland cement.

IS: 8543	-	Methods of Testing Plastics (Part 4 / Section 1 )
IS: 15058	-	PVC water stops at transverse contraction joints – specification.

### 8.3 Brickwork

#### 1. Materials

Bricks used in the works shall conform to the requirements laid down in IS: 1077. The class of the bricks shall be as specifically indicated in the respective items of work.

Standard modular size of common bricks shall be 190mm x 90mm x 90mm as per IS: 1077. The nominal thickness of one brick and half brick walls using modular bricks shall be considered as 200 mm and 100 mm respectively. In the event of use of non-modular bricks, standard size shall be 230mm x 110mm x 70mm. The nominal thickness of one brick and half brick walls using non-modular bricks shall be considered as 230 mm and 115 mm respectively. The dimensional tolerances of modular and non-modular sized bricks over the standard sizes shall be as per IS 1077.

Bricks shall be sound, hard, homogenous in texture, well burnt in kiln without being vitrified, hand/machine moulded, deep red, cherry or copper coloured, of regular shape and size & shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaws and nodules of free lime. Hand moulded bricks shall be moulded with a frog and those made by extrusion process may not be provided with a frog. Bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 5N/sq.mm unless otherwise specified in the item.

The average water absorption shall not be more than 20 percent by weight upto class 12.5 and 15 percent by weight for higher classes. Bricks which do not conform to this requirement shall be rejected. Over or under burnt bricks are not acceptable for use in the works.

Sample bricks shall be submitted to the ENGINEER for approval and bricks supplied shall conform to approved samples. If demanded by ENGINEER, brick samples shall be got tested as per IS: 3495 by CONTRACTOR at no extra cost to OWNER. Bricks rejected by ENGINEER shall be removed from the site of works within 24 hours.

Mortar for brick masonry shall consist of cement and sand and shall be prepared as per IS: 2250. Mix shall be in the proportion of 1:5 for all brickworks, unless otherwise specified in the respective items of work. Sand for masonry mortar shall conform to

IS: 2116. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by ENGINEER. If so directed by the ENGINEER, sand shall be screened and washed till it satisfies the limits of deleterious materials.

For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Mixing shall be done thoroughly in a mechanical mixer, unless hand mixing is specifically permitted by ENGINEER. The mortar thus mixed shall be used as soon as possible, preferably within 30 minutes from the time water is added to cement. In case, the mortar has stiffened due to evaporation of water, this may be re-tempered by adding water as required to restore consistency, but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and shall be removed forthwith from the site. Droppings of mortar shall not be re-used under any circumstances.

The CONTRACTOR shall arrange for test on mortar samples if so directed by ENGINEER.

## **2. Workmanship**

Workmanship of brick work shall conform to IS: 2212. All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of work. Brick work 200mm/230mm thick and over shall be laid in English Bond unless otherwise specified. 100mm/115mm thick brickwork shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be slightly pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Only full size bricks shall be used for the works and cut bricks utilised only to make up required wall length or for bonding. Bricks shall be laid with frogs uppermost.

All brickwork shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. In case of one brick thick or half brick thick wall, at least one face should be kept smooth and plane, even if the other is slightly rough due to variation in size of bricks. For walls of thickness greater than one brick both faces shall be kept smooth and plane. All interconnected brickwork shall be carried out at nearly one level so that there is uniform distribution of pressure on the supporting structure and no portion of the work shall be left more than one course lower than the adjacent work. Where this

is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45°. But in no case the level difference between adjoining walls shall exceed one metre. Brick-work shall not be raised more than one metre per day.

Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 10mm/15mm by raking tools during the progress of work when the mortar is still green, so as to provide a proper key for the plastering/pointing respectively to be done later. When plastering or pointing is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top.

During inclement weather conditions, newly built brick masonry works shall be protected by tarpaulin or other suitable covering to prevent mortar being washed away by rain.

Brickwork shall be kept constantly moist on all the faces for at least seven days. The arrangement for curing shall be got approved from the ENGINEER.

Double scaffolding having two sets of vertical supports shall be provided to facilitate execution of the masonry works. The scaffolding shall be designed adequately considering all the dead, live and possible impact loads to ensure safety of the workmen, in accordance with the requirements stipulated in IS: 2750 and IS: 3696 (Part 1). Scaffolding shall be properly maintained during the entire period of construction. Single scaffolding shall not be used on important works and will be permitted only in certain cases as decided by the ENGINEER. Where single scaffolding is adopted, only minimum number of holes, by omitting a header shall be left in the masonry for supporting horizontal scaffolding poles. All holes in the masonry shall be carefully made good before plastering/painting.

In the event of usage of traditional bricks of size 230 mm x 115 mm x 75 mm, the courses at the top of the plinth and sills as well as at the top of the wall just below the roof/floor or slabs and at the top of the parapet shall be laid with bricks on edge.

All brickwork shall be built tightly against columns, floor slabs or other structural members.

To overcome the possibility of development of cracks in the brick masonry following measures shall be adopted.

- (a) For resting RCC slabs, the bearing surface of masonry wall shall be finished on top with 12 mm thick cement mortar 1:3 and provided with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50 micron thick polyethylene sheets.

RCC/steel beams resting on masonry wall shall be provided with plain or reinforced concrete bed blocks of dimensions as indicated in the drawings duly finished on top with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50 micron thick polyethylene sheets.

- (b) Steel wire fabric shall be provided at the junction of brick masonry and concrete as specified elsewhere before taking up plastering work.

The above items shall be measured and paid for separately under the respective items of work.

Bricks for partition walls shall be stacked adjacent to the structural member to pre-deflect the structural member before the wall is taken up for execution. Further, the top most course of half or full brick walls abutting against either a de-shuttered slab or beam shall be built only after any proposed masonry wall above the structural member is executed to cater for the deflection of the structural element.

Reinforced cement concrete transoms and mullions of dimensions as indicated in the construction drawings are generally required to be provided in half brick partition walls. Reinforced concrete for transoms and mullions shall be measured and paid for separately under the respective items of work.

Where drawings indicate that structural steel sections are to be encased in brickwork, the brick masonry shall be built closely against the steel section, ensuring a minimum of 20mm thick cement-sand 1:4 over all the steel surfaces. Steel sections partly embedded in brickwork shall be provided with bituminous protective coating to the surfaces at the point of entry into the brick masonry.

CONTRACTOR shall note that the unit rates quoted for the masonry work shall be deemed to include for the installation of miscellaneous inserts such as pipe sleeves, bolts, steel sections with anchors etc. and providing pockets, leaving openings, cutting chases etc. in accordance with the construction drawings. Miscellaneous inserts shall be either supplied FREE by the OWNER or to be furnished by the CONTRACTOR. Any of the miscellaneous inserts which are required to be fabricated and supplied by the CONTRACTOR and cement concrete to be provided in the pockets for the hold fasts of door/window frames etc. shall however, be measured and paid separately under the respective items of work.

Facing bricks of the type specified conforming to IS: 2691 shall be laid in the positions indicated on the drawings and all facing brickwork shall be well bonded to

the backing bricks/RCC surfaces. The level of execution of the facing brickwork shall at any time be lower by at least 600 mm below the level of the backing brickwork.

Facing bricks shall be laid over 10 mm thick backing of cement mortar. The mortar mix, thickness of joint and the type of painting to be carried out shall be as specified in the item of work. The pattern of laying the bricks shall be as specifically indicated in the drawings.

For facing brickwork, double scaffolding shall be used.

Faced works shall be kept clean and free from damage, discoloration etc., at all times. Cutting of chases in 230 thick wall and above for routing GI pipes, CI pipes or for any other services shall preferably be in the vertical direction. Horizontal chases shall be avoided, as far as possible. The depth of vertical chases and horizontal chases, if any, shall not exceed one third and one sixth of the thickness of masonry respectively. Vertical chases shall not be closer than 2m in any stretch. Not more than 2 horizontal chases shall be permitted in a stretch of wall and these should be located in upper or lower one-third of height of wall. No continuous horizontal chase should exceed 1m length. No horizontal chases will be permitted in half brick wall.

No lintel need be provided for circular openings upto 400mm diameter in 230 mm thick wall and above. Similarly, no lintel need be provided for rectangular holes of 300 mm wide and below. No openings shall be provided in 115 mm thick brick wall.

### **3. Measurement**

Measurement shall be in cu. m correct to two places of decimal for brickwork of thickness one brick i.e. 200 mm/230 mm and above. Measurement shall be in sq. m correct to two places decimal for facing brickwork and brickwork of thickness half brick i.e. 100mm/115mm and below. Measurement shall be for the quantities as actually executed duly deducting for openings, lintels, transoms/mullions etc. subject to clauses b & c given below.

No deductions shall be made for openings less than 0.1sq.m area or for embedments upto 0.1 sq. m in section.

Brick works curved in plan to a mean radius upto 6m shall be measured and paid as curved wall as a separate item of works. Brick works curved in plan to a mean radius more than 6m shall be measured and paid like a straight wall

All concrete works shall be measured and paid for separately under the respective items of work.



## 8.4 Un-coursed Random Rubble Masonry

### Un-coursed Random Rubble Masonry Foundation, Plinth and Superstructure

#### 1. Materials

Stones for the works shall be of the specified varieties which are hard, durable, fine grained and uniform in colour (for superstructure work) free from veins, flaws and other defects. Quality and work shall conform to the requirements specified in IS: 1597 (Part-1). The percentage of water absorption shall not exceed 0.5 percent as per test conducted in accordance with IS: 1124. The CONTRACTOR shall supply sample stones to the ENGINEER for approval. Stones shall be laid with its grains horizontal so that the load transmitted is always perpendicular to the natural bed.

Cement-sand mortar for stone masonry works shall be in the proportion of 1:6 unless otherwise specified in the respective items of work. Materials and preparation of mortar shall be as specified in clause 3.1.

#### 2. Workmanship

For all works below ground level the masonry shall be random rubble un-coursed with ordinary quarry dressed stones for the hearting and selected quarry dressed stones for the facing.

For all works above ground level and in superstructure the masonry shall be random rubble un-coursed, well bonded, faced with hammer dressed stones with squared quoins at corners. The bushings on the face shall not be more than 40 mm on an exposed face and on the face to be plastered it shall not project by more than 12 mm nor shall it have depressions more than 10 mm from the average wall surface.

Face stones shall extend back sufficiently and bond well with the masonry. The depth of stone from the face of the wall inwards shall not be less than the height or breadth at the face. The length of the stone shall not exceed three times the height and the breadth on base shall not be greater than three-fourths the thickness of wall nor less than 150 mm. The height of stone may be up to a maximum of 300 mm. Face stones or hearting stones shall not be less than 150 mm in any direction.

Chips and spalls shall be used wherever necessary to avoid thick mortar joints and to ensure that no hollow spaces are left in the masonry. The use of chips and spalls in the hearting shall not exceed 20 percent of the quantity of stone masonry. Spalls & chips shall not be used on the face of the wall and below hearting stones to bring them to the level of face stones.

The maximum thickness of joints shall not exceed 20 mm. All joints shall be completely filled with mortar. When plastering or pointing is not required to be done,

the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool during the progress of the work while the mortar is still green.

Through or bond stones shall be provided in walls up to 600 mm thick and in case of walls above 600 mm thickness, a set of two or more bond stones overlapping each other by at least 150 mm shall be provided in a line from face to back. In case of highly absorbent types of stones (porous lime stone and sand stone, etc.) the bond stone shall extend about two-thirds into the wall and a set of two or more bond stones overlapping each other by at least 150 mm shall be provided. Each bond stone or a set of bond stones shall be provided for every 0.5 sq.m of wall surface.

All stones shall be sufficiently wetted before laying to prevent absorption of water from the mortar. All connected walls in a structure shall be normally raised uniformly and regularly. However if any part of the masonry is required to be left behind, the wall shall be raked back (and not saw toothed) at an angle not exceeding 45°. Masonry work shall not be raised by more than one metre per day.

Green work shall be protected from rain by suitable covering. Masonry work shall be kept constantly moist on all the faces for a minimum period of seven days for proper curing of the joints.

Type of scaffolding to be used shall be as specified in clause 3.2.

Installation of miscellaneous inserts in the masonry shall be as specified in clause 3.2.

### **3. Measurement**

Measurement shall be in cu. m correct to two places of decimal. The quantities measured and paid for, shall be those as actually executed after making deductions for openings, lintels etc.

No deductions shall be made for openings less than 0.1sq.m area or for embedments upto 0.1 sq. m in section.

Brick works curved in plan to a mean radius upto 6m shall be measured and paid as curved wall as a separate item of works. Brick works curved in plan to a mean radius more than 6m shall be measured and paid like a straight wall.

## **8.5 Coursed Rubble Masonry (First Sort) For Superstructure**

### **1. Materials**

The material specification for the work shall be as per clause 4.1.

## 2. Workmanship

All courses shall be laid truly horizontal and shall be of the same height in any course. The height of course shall not be less than 150 mm and not more than 300 mm. The width of stone shall not be less than its height.

Face stones shall tail into the work for not less than their height and at least 1/3rd the number of stones, shall tail into the work for a length not less than twice their height but not more than three-fourths the thickness of the wall whichever is smaller. These should be laid as headers and stretchers alternately to break joints by at least 75 mm. The face stones shall be squared on all joints and beds; the bed joints being hammer or chisel dressed true and square for at least 80 mm back from the face and the side joints for at least 40 mm. The face of the stone shall be hammer dressed so that the bushing shall not be more than 40 mm on an exposed face and 10 mm on a face to be plastered. No portion of the dressed surface shall show a depth of gap more than 6 mm from a straight edge placed on it. The remaining unexposed portion of the stone shall not project beyond the surface of bed and side joints.

No spalls or pinnings shall be allowed on the face. All bed joints shall be horizontal and side joints shall be vertical and no joints shall be more than 10 mm in thickness. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool, during the progress of the work while the mortar is still green.

Hearting shall consist of flat bedded stones carefully laid on their proper beds and solidly bedded in mortar. The use of chips shall be restricted to the filling of interstices between the adjacent stones, in hearting and these shall not exceed 10 percent of the quantity of the stone masonry. Care shall be taken so that no hollow spaces are left anywhere in the masonry.

The requirement regarding through or bond stones shall be as specified in clause 4.2.6 with the further stipulation that these shall be provided at 1.5 m to 1.8 m apart clear in every course but staggered at alternate courses.

The quoins which shall be of the same height as the course in which they occur, shall not be less than 450 mm in any direction. Quoin stones shall be laid as stretchers and headers alternately. They shall be laid square on their beds, which shall be rough chisel dressed to a depth of at least 100 mm from the face. These stones shall have a minimum uniform chisel draft of 25mm width at four edges, all the edges being in the same plane.

Type of scaffolding to be used shall be as per Clause 3.2.

Requirements of execution of the work and curing shall be as stipulated in clause 4.2 and clause 4.2.

Installation of miscellaneous inserts in the masonry shall be as specified in clause 3.2.

### **3. Measurement**

Measurement shall be in cu. m correct to two places of decimal. The quantities measured and paid for, shall be those as actually executed after making necessary deductions for openings, lintels etc.

## **8.6 Concrete Block Masonry**

### **1. Materials**

Masonry units of hollow and solid concrete blocks shall conform to the requirements of IS: 2185 (Part 1).

Masonry units of hollow and solid light-weight concrete blocks shall conform to the requirements of IS: 2185 (Part 2).

Masonry units of autoclaved cellular concrete blocks shall conform to the requirements of IS: 2185 (Part 3).

The height of the concrete masonry units shall not exceed either its length or six times its width.

The nominal dimensions of concrete block shall be as under.

- (a) Length 400,500 or 600 mm.
- (b) Height 100 or 200 mm.
- (c) Width 100 to 300 mm in 50 mm increments
- (d) Half blocks shall be in lengths of 200, 250 or 300 mm to correspond to the full length blocks. Actual dimensions shall be 10 mm short of the nominal dimensions.

The maximum variation in the length of the units shall not be more than  $\pm 5$ mm and maximum variation in height or width of the units shall not be more than  $\pm 3$ mm.

Concrete blocks shall be either hollow blocks with open or closed cavities or solid blocks.

Concrete blocks shall be sound, free of cracks, chipping or other defects which impair the strength or performance of the construction. Surface texture shall be as specified. The faces of the units shall be flat and rectangular, opposite faces shall be parallel and all arises shall be square. The bedding surfaces shall be at right angles to the faces of the block.

The concrete mix for the hollow and solid concrete blocks/light weight concrete blocks shall not be richer than one part of cement to six parts of combined aggregates by volume i.e. (1:6).

Concrete blocks shall be of approved manufacture, which satisfy the limitations in the values of water absorption, drying shrinkage and moisture movement, as specified for the type of block as per relevant IS code. CONTRACTOR shall furnish the test certificates and also supply the samples, for the approval of ENGINEER.

## **2. Workmanship**

The type of the concrete block, thickness and grade based on the compressive strength for use in load bearing and/or non-load bearing walls shall be as specified in the respective items of work. The minimum nominal thickness of non-load bearing internal walls shall be 100 mm. The minimum nominal thickness of external panel walls in framed construction shall be 200 mm.

The workmanship shall generally conform to the requirements of IS: 2572 for concrete block masonry, IS: 6042 for light weight concrete block masonry and IS: 6041 for autoclaved cellular concrete block masonry works.

From considerations of durability, generally concrete block masonry shall be used in superstructure works above the damp-proof course level.

Concrete blocks shall be embedded with a mortar which is relatively weaker than the mix of the blocks in order to avoid the formation of cracks. Cement mortar of proportion 1:6 shall be used for the works unless otherwise specified in the respective items of work. Preparation of mortar shall be as specified in clause 3.1 to 3.1.

The thickness of both horizontal and vertical joints shall be 10 mm. The first course shall be laid with greater care, ensuring that it is properly aligned, levelled and plumb since this will facilitate in laying succeeding courses to obtain a straight and truly vertical wall. For the horizontal (bedding) joint, mortar shall be spread over the entire top surface of the block including front and rear shells as well as the webs to a uniform layer of 10 mm. For vertical joints, the mortar shall be applied on the vertical edges of the front and rear shells of the blocks. The mortar may be applied either to the unit already placed on the wall or on the edges of the succeeding unit when it is standing vertically and then placing it horizontally, well pressed against the previously laid unit to produce a compacted vertical joint. In case of two cell blocks with slight depression on the vertical sides these shall also be filled up with mortar to secure greater lateral rigidity. To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of the block as the mortar will stiffen and lose its plasticity.

Mortar while hardening shrinks slightly and thus pulls away from the edges of the block. The mortar shall be pressed against the units with a jointing tool after it has stiffened to effect intimate contact between the mortar and the unit to obtain a weather tight joint. The mortar shall be raked to a depth of 10 mm as each course is laid to ensure good bond for the plaster.

Dimensional stability of hollow concrete blocks greatly affected by variations of moisture content in the units. Only well dried blocks should be used for the construction. Blocks with moisture content more than 25% of maximum water absorption permissible shall not be used. The blocks should not be wetted before or during laying in the walls. Blocks should be laid dry except slightly moistening their surface on which mortar is to be applied to obviate absorption of water from the mortar.

As per the design requirements and to effectively control cracks in the masonry, RCC bond beam/studs, joint reinforcement shall be provided at locations as per details indicated in the construction drawings. Joint reinforcement shall be fabricated either from mild steel wires conforming to IS: 280 or welded wire fabric/high strength deformed bar as per the drawings.

For jambs of doors, windows and openings, solid concrete blocks shall be provided. If hollow units are used, the hollows shall be filled with concrete of mix 1:3:6. Hold fasts of doors/windows should be arranged so that they occur at block course level.

At intersection of walls, the courses shall be laid up at the same time with a true masonry bond between at least 50% of the concrete blocks. The sequence for construction of partition walls and treatment at the top of load bearing walls for the RCC slab shall be as detailed under clause 3 for the brick work.

Curing of the mortar joints shall be carried out for at least 7 days. The walls should only be lightly moistened and shall not be allowed to become excessively wet.

Double scaffolding as per clause 3.2 shall be adopted for execution of block masonry work.

Cutting of the units shall be restricted to a minimum. All horizontal and vertical dimensions shall be in multiples of half length and full height of units respectively, adapting modular co-ordination for walls, opening locations for doors, windows etc.

Concrete blocks shall be stored at site suitably to avoid any contact with moisture from the ground and covered to protect against wetting.

### **3. Measurement**

Measurement shall be in cu. m. correct up to two places of decimal for walls of thickness 200 mm and above. Measurement shall be in sq. m correct up to two

places of decimal for walls of 100mm/150mm in thickness. Measurement shall be for the quantities as actually executed duly deducting for openings, and concrete works. Concrete and reinforcement will be measured and paid separately. The rate quoted shall be for the type of masonry blocks specified in the respective items of work which shall include for the specific sequential operations as stipulated in the construction drawings.

## **8.7 Damp - Proof Course**

### **1. Materials and Workmanship**

Where specified, all the walls in a building shall be provided with damp-proof course to prevent water from rising up the wall. The damp-proof course shall run without a break throughout the length of the wall, even under the door or other openings. Damp-proof course shall consist of 50 mm thick cement concrete of 1:2:4 nominal mix with approved water-proofing compound admixture conforming to IS: 2645 in proportion as directed by the manufacturer. Concrete shall be with 10 mm downgraded coarse aggregates.

The surface of brick/stone masonry work shall be levelled and prepared before laying the cement concrete. Side shuttering shall be properly fixed to ensure that slurry does not leak through and is also not disturbed during compaction. The upper and side surface shall be made rough to afford key to the masonry above and to the plaster.

Damp-proof course shall be cured properly for atleast seven days after which it shall be allowed to dry for taking up further work.

### **2. Measurement**

Measurement of damp-proof course shall be in Sq.m correct to two places of decimal as actually executed. No separate payment will be made for formwork.

## **8.8 Rubble Sub-Base**

### **1. Materials**

Stones used for rubble packing under floors on grade, foundations etc., shall be clean, hard, durable rock free from veins, flaws, laminations, weathering and other defects. Stones shall generally conform to the requirements stipulated in IS: 1597 (Part-I).

Stones shall be as regular as can be obtained from quarries. Stones shall be of height equal to the thickness of the packing proposed with a tolerance of  $\pm 10$ mm. Stones shall not have a base area less than 250 sq.cm nor more than 500 sq.cm,

and the smallest dimension of any stone shall not be less than half the largest dimension. The quality and size of stones shall be subject to the approval of ENGINEER.

## **2. Workmanship**

Stones shall be hand packed carefully and laid with their largest base downwards resting flat on the prepared sub-grade and with their height equal to the thickness of the packing. Stones shall be laid breaking joints and in close contact with each other. All interstices between the stones shall be wedged-in by small stones of suitable size, well driven in by crow bars and hammers to ensure tight packing and complete filling-in of the interstices. The wedging shall be tarried out simultaneously with the placing in position of rubble packing and shall not lag behind. After this, any interstices between the smaller wedged stones shall be in-filled with clean hard sand by brooming so as to fill the joints completely.

The laid rubble packing shall be sprinkled with water and compacted by using suitable rammers.

## **3. Measurement**

Measurement shall be in sq. m correct to two places of decimal for the specified compacted thickness of rubble sub-base.

## **8.9 Miscellaneous Inserts, Bolts Etc.**

All the miscellaneous inserts such as bolts, pipes, plate embedments etc. to be furnished by the CONTRACTOR shall be accurately installed in the building works at the correct locations and levels, all as detailed in the construction drawings. CONTRACTOR shall prepare and use templates for this purpose, if so directed by ENGINEER. In the event, any of the inserts are improperly installed, CONTRACTOR shall make necessary arrangements to remove and re-install at the correct locations/levels, all as directed by ENGINEER without any extra cost to the OWNER.

### **a. Measurement**

Miscellaneous inserts, supplied by the CONTRACTOR shall be measured and paid for as per the respective items of work.



## 9 HARDSCAPE

CONTRACTOR shall do all Tiles, stone slab work etc. as per Standard specification, landscape or architectural drawing or as directed by engineer in charge.

### 9.1 Granite

#### a. General

Granite should be sourced, however, if not compliant with the requirements indicated below and LA's approval then an alternative material should be submitted for approval.

#### b. Granite paving shall be:

Crushing strength: 55.0 MN/sq.m

- (i) mass density: 2220 kg/cu.m
- (ii) water absorption: 9.6%
- (iii) acid immersion test: pass
- (iv) saturation coefficient: 0.64%
- (v) All stone to be free from vents, cracks, fissures, discoloration or other defects, which may adversely affect strength, durability or appearance. Granite to be consistently colored. Thoroughly seasoned, dressed and worked before delivery to site in accordance with shop drawings prepared by the contractor.

All granite shall be sourced from an approved supplier:

- Granite to be bedded on 25 mm full mortar bed, mortar mix to manufacturers recommendations, colour to consultants approval. Refer to drawings.
- All stone' to be sealed with a premium quality, durable, water based clear stone sealer. Such sealant shall be Aqua mix grout sealer applied to all faces and edges after cutting and prior to installation. A further coat of sealant shall be applied after installation. Sealant to be applied in strict accordance with manufacturer's instructions.  
Aqua mix grout sealer of an approved Quality to be used.
- Contractor to allow for providing different samples of stone and for the construction of 2.0m x 2.0m panels of selected sample pieces for Consultants approval.

## 10 CEMENT PLASTERING & POINTING WORK

### 10.1 Plastering work

#### a. Materials

The proportions of the cement mortar for plastering shall be 1:4 (one part of cement to four parts of sand) unless otherwise specified under the respective item of work. Cement and sand shall be mixed thoroughly in dry condition and then water added to obtain a workable consistency. The quality of water and cement shall be as per relevant IS. The quality and grading of sand for plastering shall conform to IS: 1542. The mixing shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by ENGINEER. If so desired by the ENGINEER sand shall be screened and washed to meet the specification requirements. The mortar thus mixed shall be used as soon as possible preferably within 30 minutes from the time water is added to cement. In case the mortar has stiffened due to evaporation of water this may be re-tempered by adding water as required to restore consistency but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and removed forthwith from the site. Droppings of plaster shall not be re-used under any circumstances

#### b. Workmanship

Preparation of surfaces and application of plaster finishes shall generally confirm to the requirements specified in IS: 1661 and IS: 2402.

Plastering operations shall not be commenced until installation of all fittings and fixtures such as door/ window panels, pipes, conduits etc. are completed.

All joints in masonry shall be raked as the work proceeds to a depth of 10mm/20mm for brick/ stone masonry respectively with a tool made for the purpose when the mortar is still green. The masonry surface to be rendered shall be washed with clean-water to remove all dirt, loose materials, etc., Concrete surfaces to be rendered shall be roughened suitably by hacking or bush hammering for proper adhesion of plaster and the surface shall be evenly wetted to provide the correct suction. The masonry surfaces should not be too wet but only damp at the time of plastering. The dampness shall be uniform to get uniform bond between the plaster and the masonry surface.

Interior Plain Faced Plaster - This plaster shall be laid in a single coat of 13mm thickness. The mortar shall be dashed against the prepared surface with a trowel. The dashing of the coat shall be done using a strong whipping motion at right angles to the face of the wall or it may be applied with a plaster machine. The coat shall be

trowelled hard and tight forcing it to surface depressions to obtain a permanent bond and finished to smooth surface. Interior plaster shall be carried out on jambs, lintel and sill faces, etc. as shown in the drawing and as directed by ENGINEER. Rate quoted for plaster work shall be deemed to include for plastering of all these surfaces.

Plain Faced Ceiling plaster - This plaster shall be applied in a single coat of 6mm thickness. Application of mortar shall be as stipulated in clause 30.2.

Exterior plain faced plaster - This plaster shall be applied in 2 coats. The first coat or the rendering coat shall be approximately 14mm thick. The rendering coat shall be applied as stipulated in clause 30.2 except finishing it to a true and even surface and then lightly roughened by cross scratch lines to provide bond for the finishing coat. The rendering coat shall be cured for atleast two days and then allowed to dry. The second coat or finishing coat shall be 6 mm thick. Before application of the second coat, the rendering coat shall be evenly damped. The second coat shall be applied from top to bottom in one operation without joints and shall be finished leaving an even and uniform surface. The mortar proportions for the coats shall be as specified in the respective item of work. The finished plastering work shall be cured for atleast 7 days.

Interior plain faced plaster 20mm thick if specified for uneven faces of brick walls or for random/coursed rubble masonry walls shall be executed in 2 coats similar to the procedure stipulated in clause 30.2.

Exterior Sand Faced Plaster - This plaster shall be applied in 2 coats. The first coat shall be 14mm thick and the second coat shall be 6mm thick. These coats shall be applied as stipulated in clause 30.2. However, only approved quality white sand shall be used for the second coat and for the finishing work. Sand for the finishing work shall be coarse and of even size and shall be dashed against the surface and sponged. The mortar proportions for the first and second coats shall be as specified in the respective items of work.

Wherever more than 20mm thick plaster has been specified, which is intended for purposes of providing beading, bands, etc. this work shall be carried out in two or three coats as directed by ENGINEER duly satisfying the requirements of curing each coat (rendering/floating) for a minimum period of 2 days and curing the finished work for atleast 7 days.

In the case of pebble faced finish plaster, pebbles of approved size and quality shall be dashed against the final coat while it is still green to obtain as far as possible a uniform pattern all as directed by ENGINEER.

Where specified in the drawings, rectangular grooves of the dimensions indicated shall be provided in external plaster by means of timber battens when the plaster is still in green condition. Battens shall be carefully removed after the initial set of plaster and the broken edges and corners made good. All grooves shall be uniform in width and depth and shall be true to the lines and levels as per the drawings.

Curing of plaster shall be started as soon as the applied plaster has hardened sufficiently so as not to be damaged when watered. Curing shall be done by continuously applying water in a fine spray and shall be carried out for atleast 7 days. When the specification items of work calls for waterproofing plaster the CONTRACTOR shall provide the waterproofing compound as specified while preparing the cement mortar. Payment for water-proofing compound will be made separately if it is not included as a combined item of work.

Where lath plastering is specified, it shall be paid for at the same rate as for plaster work except that separate payment for metal lath will be made.

For external plaster, the plastering operations shall be commenced from the top floor and carried downwards. For internal plaster, the plastering operations for the walls shall commence at the top and carried downwards. Plastering shall be carried out to the full length of the wall or to natural breaking points like doors/ windows etc. Ceiling plaster shall be completed first before commencing wall plastering.

Double scaffolding to be used shall be as specified in clause 3.2.6.

The finished plaster surface shall not show any deviation more than 4mm when checked with a straight edge of 2m length placed against the surface.

To overcome the possibility of development of cracks in the plastering work following measures shall be adapted.

- (a) Plastering work shall be deferred as much as possible so that fairly complete drying shrinkage in concrete and masonry works takes place.
- (b) Steel wire fabric shall be provided at the junction of brick masonry and concrete to overcome reasonably the differential drying shrinkage/thermal movement. This steel item shall be measured and paid for separately.
- (c) Ceiling plaster shall be done, with a trowel cut at its junction with wall plaster. Similarly trowel cut shall be adopted between adjacent surfaces where discontinuity of the background exists.

### **c. Measurement**

Measurement for plastering work shall be in sq.m correct to two places of decimal. Unless a separate item is provided for grooves, mouldings, etc., these works are

deemed to be included in the unit rates quoted for plastering work. The quantity of work to be paid for under these items shall be calculated by taking the projected surface of the areas plastered after making necessary deductions for openings for doors, windows, fan openings etc. The actual plaster work carried out on jambs/sills of windows, openings, etc. shall be measured for payment.

## **1. CEMENT POINTING**

### **a. Materials**

The cement mortar for pointing shall be in the proportion of 1:3 (one part of cement to three parts of fine sand) unless otherwise specified in the respective items of work. Sand shall conform to IS: 1542 and shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by ENGINEER and if so directed it shall be washed/screened to meet specification requirements.

### **b. Workmanship**

Where pointing of joints in masonry work is specified on drawings/respective items of work, the joints shall be raked at least 15mm/ 20mm deep in brick/stone masonry respectively as the work proceeds when the mortar is still green.

Any dust/dirt in the raked joints shall be brushed out clean and the joints shall be washed with water. The joints shall be damp at the time of pointing. Mortar shall be filled into joints and well pressed with special steel trowels. The joints shall not be disturbed after it has once begun to set. The joints of the pointed work shall be neat. The lines shall be regular and uniform in breadth and the joints shall be raised, flat, sunk or 'V' as may be specified in the respective items of work. No false joints shall be allowed.

The work shall be kept moist for at least 7 days after the pointing is completed. Whenever coloured pointing is to be done, the colouring pigment of the colour required shall be added to cement in such proportions as recommended by the manufacturer and as approved by ENGINEER.

### **c. Measurement**

The quantity of work to be paid for under this Item shall be measured in sq.m correct to two places of decimal by taking the projected surface of the area pointed after making necessary deductions for openings, etc.

## **2. WATER-PROOFING ADMIXTURE**

Water-proofing admixture shall conform to the requirements of IS: 2645 and shall be of approved manufacture. The admixture shall not contain calcium chloride. The

quantity of the admixture to be used for the works and method of mixing etc., shall be as per manufacturer's instructions and as directed by ENGINEER. Payment shall be made for the actual quantity of such admixture used unless it is already covered in the rate for the relevant item of work.

## **11 PAINTING - CONCRETE MASONRY & PLASTERED SURFACES**

### **11.1 Materials**

Oil bound distemper shall conform to IS: 428. The primer shall be alkali resistant primer of the same manufacture as that of the distemper.

Cement paint shall conform to IS: 5410. The primer shall be a thinned coat of cement paint.

Acrylic emulsion paint shall be of an approved manufacture.

Plastic emulsion paint shall conform to IS: 5411.

Lead free acid, alkali and chlorine resisting paint shall conform to IS: 9862.

White wash shall be made from good quality fat lime conforming to IS: 712. It shall be slaked at site and mixed with water in the proportion of 5 litres of water to 1 kg of un-slaked lime stirred well to make a thin cream. This shall be allowed to stand for a minimum period of one day and strained through a clean coarse cloth. Four kg of gum dissolved in hot water shall be added to each cu.m of cream. 1.30 kg of sodium chloride dissolved in hot water shall then be added per 10 kg of lime used for the white wash to be ready for application.

Colour wash shall be made by addition of a suitable quantity of mineral pigment, not affected by lime, to the prepared white wash to obtain the shade/tint as approved by ENGINEER.

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

### **11.2 Workmanship**

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

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

The surfaces to be treated shall be prepared by thoroughly brushing them free from dirt, mortar droppings and any loose foreign materials. Surfaces shall be free from oil,

grease and efflorescence. Efflorescence shall be removed only by dry brushing of the growth. Cracks shall be filled with Gypsum. Workmanship of painting shall generally conform to IS: 2395.

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

### **11.3 White Wash & Colour Wash**

The prepared surfaces shall be wetted and the finish applied by brushing. The operation for each coat shall consist of a stroke of the brush first given horizontally from the right and the other from the left and similarly, the subsequent stroke from bottom upwards and the other from top downwards, before the first coat dries. Each coat shall be allowed to dry before the next coat is applied. Minimum of 2 coats shall be applied unless otherwise specified in the item of work. The dry surface shall present a uniform finish without any brush marks.

### **11.4 Measurement**

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

## **12 DISMANTLING**

### **12.1 Scope**

Contractor has to dismantle existing railing, kerbs, Gurd Rail RC Post, Brick work in steps, Tiles, Rubble masonry Retaining wall as shown in drawings or as directed by the Engineer. The work shall be executed in accordance with Indian standards and Specifications. Dismantled material shall be stacked or shall be neatly piled at points designated by the Engineer.

#### **1. Applicable Codes**

IS 1200	(Pt – XVIII) Method of Measurements of Building and Civil Engineering Works (Part –XVIII) Demolition and Dismantling
IS 4130	Demolition of Buildings–Code of Safety

## 12.2 General

Precautions - All materials obtained from dismantling or demolition shall be the property of the Government unless otherwise specified and shall be kept in safe custody until they are handed over to the Engineer-in-Charge/ authorized representative. The demolition shall always be well planned before hand and shall generally be done in reverse order of the one in which the structure was constructed. The operations shall be got approved from the Engineer-in-Charge before starting the work. Due care shall be taken to maintain the safety measures prescribed in IS 4130. Necessary propping, shoring and or under pinning shall be provided to ensure the safety of the adjoining work or property before dismantling and demolishing is taken up and the work shall be carried out in such a way that no damage is caused to the adjoining work or property. Wherever specified, temporary enclosures or partitions and necessary scaffolding with suitable double scaffolding and proper cloth covering shall also be provided, as directed by the Engineer-in-Charge. Necessary precautions shall be taken to keep noise and dust nuisance to the minimum. All work needs to be done under the direction of Engineer-in-Charge. Helmets, goggle, safety belts etc. should be used whenever required and as directed by the Engineer-in-Charge. The demolition work shall be proceeded with in such a way that it causes the least damage and nuisance to the adjoining building and the public. Dismantling shall be done in a systematic manner. All materials which are likely to be damaged by dropping from a height or by demolishing roofs, masonry etc. shall be carefully removed first. Chisels and cutters may be used carefully as directed. The dismantled articles shall be removed manually or otherwise, lowered to the ground (and not thrown) and then properly stacked as directed by the Engineer-in-Charge. Where existing fixing is done by nails, screws, bolts, rivets, etc., dismantling shall be done by taking out the fixing with proper tools and not by tearing or ripping off. Any serviceable material, obtained during dismantling or demolition, shall be separated out and stacked properly as directed by the Engineer-in-Charge within. All unserviceable materials, rubbish etc. shall be disposed off as directed by the Engineer-in-Charge. The contractor shall maintain/disconnect existing services, whether temporary or permanent, where required by the Engineer-in-Charge. No demolition work should be carried out at night. Screens shall be placed where necessary to prevent injuries due to falling pieces. Water may be used to reduce dust while tearing down plaster from brick work. Safety belts shall be used by labourers while



working at higher level to prevent falling from the structure. First-aid equipment shall be got available at all demolition works of any magnitude.

### **12.3 Demolition of Certain Special Elements of Structures** **Recommendations for Demolition of Roof Trusses**

If a building has a pitched roof, the roof structure should be removed to wall plate level by hand method. Sufficient purlins and bracing should be retained to ensure stability of the remaining roof trusses while each individual truss is removed progressively. Temporary bracing should be added, where necessary, to maintain stability. The end frame opposite to the end where dismantling is commenced, or a convenient intermediate frame should be independently and securely guyed in both directions before work starts. On no account should the bottom tie of roof trusses be cut until the principal rafters are prevented from making outward movement.

## **13 PEDESTRIAN STEEL BRIDGE WORK**

### **13.1 Scope**

This specification covers the requirement for materials, surface preparation and application of all painting, materials, fabrication, welding, bolting and erection of steel structures.

### **13.2 Codes and Standards**

<b>STEEL WORK</b>	
IS 226	Structural steel
IS 2062	Steel for general structural purpose
IS 800	Code of practice for use of structural steel in general in steel construction
IS 806	Code of practice for use of steel Tubes in general building construction
IS 816	Code of practice for use of metal arc welding for general construction in mild steel
IS 818	Code of practice for safety and healthy requirements in electric and gas welding and cutting operations
IS 822	Code of procedure for inspection of welds
IS 1081	Code of practice for fixing and glazing of metal (Steel and aluminium) doors, windows and ventilators
IS 1161	Steel tubes for structural purposes
IS 1200 (Pt. VIII)	Method of measurements of steel work and iron works
IS 1367	Technical supply conditions for threaded steel fasteners

IS 1821	Dimensions for clearances holes for bolts and screws
IS 2074	Ready mixed paint, air drying redoxide zinc chrome priming
IS 4736	Hot – dip zinc coating on mild steel tubes
IS 4923	Hollow steel sections for structural use – specification

### 13.3 General

CONTRACTOR shall submit details of welding procedures for review and approval to Technical consultant. CONTRACTOR shall supply two sets of detailed fabrication and assembly drawings. Technical consultant shall return one set of marked up and signed shop drawings to the CONTRACTOR. Shop fabrication may commence prior to return of the signed shop drawings to the CONTRACTOR. However, CONTRACTOR is responsible for correcting any work resulting from shop drawings errors detected by Technical consultant. Approval of drawings by Technical consultant will imply that the shop drawings have been examined and appear to be in accordance with the approved for construction drawings for the accurate dimensions of components and provision of sufficient fixings for attachment of sheeting, fixtures and fittings attached to frames or trusses. CONTRACTOR shall supply one reproducible of each final shop drawing. All drawings shall be produced on A2 size sheets.

### 13.4 Materials

#### a. General

All paints solvents and related materials shall be of approved manufacture to the quality of the appropriate Indian Standard.

The CONTRACTOR shall furnish all equipment necessary for the proper application of the paint. The equipment shall be compatible with the paint type.

#### b. Paint Material

The CONTRACTOR shall use provide and apply a good quality paint or approved by Engineer in charge.

#### c. Structural Steel

All structural steel shall comply with the requirements of, except hollow sections, which shall be Grade 43C. Hot rolled steel sections shall comply with IS 226-E250.

All structural bolts and nuts, welding etc. unless stated otherwise, shall comply with the relevant Indian standards..

Anchor bolts shall be Grade 4.6. All anchor bolts, nuts and washers shall be hot dip galvanized. Drilled-in-concrete anchors shall be Hilt HAS stud anchor or approved Equivalent.

Hot-dip galvanizing shall be in accordance with IS 2629. Minimum coating weight shall not be less than 610 g/m<sup>2</sup>.

Bolts should be of such length as to project not less than 3mm or more than 12mm beyond the nut when tightened up.

### **13.5 Execution**

#### **1. General**

The CONTRACTOR shall examine the substrates, adjoining construction and the conditions under which the work is to be installed and shall not proceed with the work until unsatisfactory conditions detrimental to the proper and timely completion of the work have been corrected. Surface shall be sound and free of undulations or other visible defects.

#### **Preparation of Surfaces**

Prepare surfaces to receive paint, thoroughly clean off grease, dirt, chalk, dust, loose materials and other substances that may interfere with proper adhesion of paint. Paint dry surface only. Fill dents, cracks, hollow places, open joints and other irregularities with an approved filler suitable for the purpose. After setting, sand to a smooth, hard finish.

Prime surfaces not more than 8 hours after cleaning.

#### **Surface Preparation of Steel Works**

Clean bare metal surfaces thoroughly of foreign matter such as mortar, plaster, grease, rust, scale and dirt before priming coat is applied.

#### **Cutting**

1. Steel shall be cut by the most suitable and accurate method.
2. Steel of thicknesses greater than 13mm shall not be cut by shearing.
3. All slag, burrs and unnecessary sharp edges shall be removed from cut edges.
4. Unless otherwise specified, gas cut surfaces shall comply with the following:

Depth of notches < 2mm

Maximum Roughness (R<sub>max</sub>)  $\pm$  200 microns over 25mm

Repair of edges cracked, notched or otherwise damaged shall be strictly subject to approval by engineering in charge.

Methods of cutting and repair shall be submitted to for approval before cutting and repair works are carried out.

**Holes**

Holes shall be flame cut, drilled or punched, without notches, tears or ragged edges or other methods approved by engineer incharge. Holes for Bolts, rivets, pins, etc. shall be formed by drilling at a right angle to the surface of metal or, for steel thicknesses less than 13mm only, by punching. Holes for Bolts, rivets, pins, etc. shall not be enlarged by gas cutting methods.

**Bending**

Hot bending shall be carried out in red heated condition, not in the blue heated brittle range (200-400 °C), with due care not to affect the quality of the steel. The inner radius for cold bending shall be at least twice the material thickness.

**Welding**

1. Welding operations, including preparation, tack welding, inspection and testing, shall be carried out in accordance with approved welding standards.
2. Weld locations, type and dimensions shall be as shown on approved drawings. Welds shall be properly prepared for and made in accordance with applicable codes and standards.
3. Welding shall be carried out by Welders approved as per Indian standards.
4. Welding operations shall be properly protected against adverse climatic and other conditions. Welding shall not be permitted in wind exceeding 2m/s in velocity or when the presence of moisture may compromise weld quality or the safety of personnel.
5. Particular care shall be taken in starting and terminating welds to ensure consistent weld penetration and cross section and the prevention of lag inclusions, cratering, loss of base metals, cracking and other defects.

**CLEANING**

From commencement through completion of the work, promptly remove all paint where spilled splashed or spattered. During the progress of work, keep the premises free from any unnecessary

**13.6 Approval of Welding Procedures and Welders**

1. The CONTRACTOR shall prepare, and submit, detailed welding procedures for all welding operations. Approval testing of welding procedures shall be carried out in accordance with Indian standard codes.
2. The CONTRACTOR shall carry out approval testing of welders as appropriate, and provide certification that each welder is so qualified

Should the work of any welder subsequently produce reasonable doubt as to his skill, that welder shall be either replaced or re-tested and re-certified at the CONTRACTOR's expense.

3. Approved welding procedures shall include test and inspection procedures and take project health and safety requirements into due account.

4. Any welding not carried out in strict accordance with approved procedures, and by approved welders, shall be rejected.

### **Welding**

1. Visual inspection of all welded parts shall be performed after welding and include, but not be limited to, confirmation of the following:

- a) Shapes and sizes of welds.
- b) Effective weld length.
- c) Adequate penetration.
- d) Good fusion.
- e) Continuity of beads.
- f) Absence of overlap.
- g) Absence of excessive undercut.
- h) Filling of craters.
- i) Reinforcement of weld.
- j) Absence of pits, cracks, trapped slag, or blowholes.
- k) Proper grinding of weld spatter.

## **13.7 Erection**

### **General**

- 1. The CONTRACTOR shall submit for approval prior to the work commencing, a description of the erection methods, erection sequence, temporary works and equipment to be used for erection work.
- 2. All steel erection works shall be carried out strictly in accordance with approved project procedures, especially the Work Permit Procedure.
- 3. Erection methods shall maximize the amount of work that is performed at ground level, using proper jigs and supports to maintain dimensional accuracy, prior to steelwork being hoisted into position.
- 4. Approved temporary braces, bolts, etc. shall be used to stabilize steelwork components during lifting operations, prevent deformation and damage and to ensure safety of personnel and equipment.

2. The sequence of erection shall be in accordance with the requirements of related works. In particular, the installation of grating, handrails etc.

### **13.8 Anchor Bolts And Embedded Items**

1. The CONTRACTOR shall check that all anchor bolts and embedded items required for steel erection work have been installed to correct level and position as soon as possible. If any such items are found to be missing, or set out of allowable tolerance, the CONTRACTOR shall engineer in charge and take corrective action in accordance with his instructions.
2. Anchor bolts shall not be adjusted by mechanical means without the prior approval. No heat treatment shall be permitted.
3. The CONTRACTOR shall clean all anchor bolt and embedded items of loose rust, mortar, dirt and other foreign matter, by wire brushing or other approved methods, prior to commencing erection of steelwork.

### **13.9 Leveling and Base Support**

1. The CONTRACTOR shall set out and level steel erection works by optical survey methods to the approval of Engineer in charge.
2. Steel plate and cement mortar leveling pads shall be provided on foundations to support steelwork at required elevations.
3. The number of steel plates used in a leveling pad shall be minimized. No more than 1 base sheet and 2 tapered liner plates shall be used, if possible.
4. Top surfaces of foundations shall be cleaned and, where cement mortar or grout is required, properly roughened to ensure good adhesion.
5. Voids under base plates shall be fully grouted after final levelling, alignment and properly contained by formwork during casting, as required and tapered away from the base plate to prevent collection of water or other substances.
6. Unless specified or approved otherwise, final tightening of anchor bolts shall not be carried out until grout has achieved the required compressive strength.

### **13.10 Erection Inspection**

The position, level and alignment of erected steelwork shall be confirmed to be in accordance with applicable drawings and specifications, within specified tolerances, by approved optical survey methods.

### **13.11 Tolerance for Erected Steelwork**

The tolerance for the erected steelwork shall be as follows:

(a) Position

Permissible deviation of the erected column from its + 5mm

Specified position.

(b) Linear Dimensions

Permissible deviation from specified length or width  $\pm 5\text{mm}$  per 10m of length,

Maximum deviation in 30m or over + 15mm

(c) Plumb

Permissible deviation from verticals per 15m of height  $\pm 5\text{mm}$

Maximum deviation in 45m or over + 15mm

(d) Levels

Unless otherwise specified the level of a beam should be taken on the top of the upper flange. Permissible deviation between the specified level and that of the erected member  $\pm 3\text{mm}$

### 13.12 Painting Of Steelwork

All steelwork shall be painted in accordance with the requirements of Specification "Painting of Steelworks & Concrete Structure".

### 13.13 Reporting

1. The CONTRACTOR shall prepare test and inspection reports, recording all results and observations, including, but not limited to, the following:

- a) Dimensional and Visual Inspections.
- b) Welding Tests and Inspections (including approval testing).
- c) High Strength Bolt Checks.
- d) Painting Inspections.

2. Reports shall be submitted to, and approved by engineer in charge within 2 weeks of completion of the related test or inspection and before fabricated steelwork is delivered to site.

**13.14 Storage and Handling**

Materials and equipment shall be stored in a designated storage space on the site. The storage space shall be kept neat, clean and accessible at all times and the floors are to be protected from paint spillage. Storage temperature shall not exceed 30°C. During handling and storage, the paint materials shall be protected from contamination of foreign elements that might upset the integrity of the materials. All materials shall be stored in secure, dry housing, on timber bearers or properly constructed racks, as recommended by manufacturers and/or as otherwise appropriate. Materials shall be kept free from dirt, grease, paint spray and other contamination and shall be protected from corrosion. All materials shall be sorted by type. Different grades of materials shall be clearly marked and separated to prevent accidental use of incorrect material.

Due care shall be taken in the handling and transportation of steel and fabricated subassemblies to avoid damage. Particular care shall be taken in the selection of slings and lifting arrangements, and to steel which has been galvanized, painted, painted or otherwise coated.

Structural steelwork shall be fabricated in controlled shop conditions in strict accordance with approved for construction and shop drawings, this specification and applicable codes and standards.

The fabrication shop shall have sufficient technical and production capability and quality control systems necessary to ensure that all requirements herein are met. The fabrication work shall be carried out carefully and accurately and by using mechanically guided tools whenever possible. Work shall not be performed when inclement weather or other conditions may adversely affect quality or restrict inspection

**13.15 Shop Drawings**

Shop drawings shall be based on the approved for construction drawings and give all information necessary for the fabrication of the component parts of the structure. Information provided by shop drawing shall include, but not be limited to, the following:

1. Unique identification of each member and fabricated subassembly.
2. Position and dimensions of each member in the structure.
3. Details of fittings, e.g. gusset plates, base plates etc.



4. Joint and connection details with clear differentiation between shop and field Connections, welds and bolts.
5. Weld details including location, type and size.
6. Location, type and size of bolts and holes and referenced bolt list.
7. Layout and details of required ladders, stairs, walkways etc.
8. Material specifications.
9. Shop coatings specifications.
10. Details of handling and transportation provisions including packing, lifting, and support and lashing points and lifting spread requirements.

### **13.16 Assembly Drawings**

Assembly drawings shall include, but not be limited to, the following information required for erection work on site. All information contained on the shop drawings as may be required for erection, testing and inspection purposes. Framing elevation at each reference line and where intermediate framing is provided. Framing plan at each elevation, required erection order and methods (including handling). Site coatings specifications.

### **13.17 Inspection And Testing**

Engineer in charge shall have free access at all times to the material testing equipment and to all parts of the steel structure which is being fabricated. CONTRACTOR shall notify in charge on the commencement date of shop work so that testing or inspection may be properly scheduled. Copies of Certified Mill Test Reports, properly correlated to the materials shall be made available by the CONTRACTOR to Engineer in charge upon request.

### **13.18 Protection**

The CONTRACTOR shall take every precaution to avoid damage by fire and shall place paint or solvent soaked rags, waste or other materials, which might constitute a fire hazards in metal containers which shall be removed and stored at the storage area at the close of each day's work.

CONTRACTOR shall provide suitable coverings to protect the work and adjacent surfaces and objects.

CONTRACTOR shall remove or protect items such as hardware, hardware accessories, plates, lighting fixtures and similar items placed prior to painting.

Reposition or removal of the protection shall be carried out upon completion of each space. CONTRACTOR shall disconnect equipment adjacent to walls by Workmen skilled in these trades to permit painting of wall surfaces, replace and reconnect after completion of painting.

Surfaces not requiring painting shall be protected. The CONTRACTOR shall maintain wrappings or other factory applied protection furnished with finishing hardware or other items provided by other trades and install in areas where painting is required, and if displaced or removed, replace for the duration of painting work.

### **13.19 Scaffolding, Staging, Accessibility**

Fixed scaffolding or staging shall be used as required for surface preparation and painting and will be subject to approval by EMPLOYER'S. Easy and sufficient access shall be provided for correct painting and inspection of all surfaces. It shall be such that operators will be able to stand up with body and arms free of scaffolding or staging and the structure being worked on. CONTRACTOR shall supply and maintain rigging and scaffolding equipment capable of enabling completion of the Work in accordance with Specification.

### **13.20 Performance of The Work**

CONTRACTOR shall propose the details of the systems to be applied in Accordance with Painting specification. The proposal shall include the manufacturer recommendations relating to paint composition and application to achieve maximum life to the coating. After acceptance of the system CONTRACTOR shall submit detailed procedures for implementing this Specification with particular relation to type, make and description of paint and materials to be used, manufacturer's specifications, application, drying and over coating times, at least one month before start of any coating. The proposed sequence and timing of blasting, application and touch up activities shall be clearly shown in relation to the overall schedule for the Works.

**14 APPROVED MAKES LIST CIVIL / STRUCTURAL WORKS:**

<b>Sr. No.</b>	<b>Category</b>	<b>Sub Category</b>	<b>Brand Name</b>
1	Cement	OPC 43/53 Grade(ISI marked)	Ambuja Cement, L & T, ACC, Birla,VIKRAM,J.K.,Ultratech,Ambuja, Grasim, JK, Binani, India cement
2	Cement	PSC (ISI marked)	Commando Cement Ltd.
3	Cement	White Cement	Ultra tech, ACC, Birla ,J.K,
4	Cement	Chemical Admixtures	Kerakoll, MC Bauchemie, BASF, MYK Schomburg, Pidilite, Sunanda Chemicals, Sika, FOSROC, Choksey Chemicals
5	Cement	Expansion joint board	Supreme Industries or equivalent
6	Steel	Structural Steel	Vizag,TISCON, SAIL, Metro structure, RINL,AGRASEN ISPAT,JSW, CORUS
7	Steel	TMT Bars	TMT Bars Fe-415 /Fe-500 conforming to IS-1786:1985 (reaffirmed 2004)
8	Steel	M.S. Pipe, Tubes, Bar, Flats,Angle, Tee Sections	SAIL ,TISCO
14	Ready Mix Concrete	Ready Mix Concrete	ACC, RMC, Ultra tech
15	Miscellaneous	Structural Sealant	Wacker, Dow Corning, GE
16	Miscellaneous	Polysulphide sealant	Pidilite, Chemetall-Rai
17	Miscellaneous	Bitumen Impregnated Board	Shalitex
18	Miscellaneous	Polyethylene back up rod	Supreme Ind. Ltd.
19	Miscellaneous	Epoxy	Fosroc/ STP/ CICO/ Ardex
20	Miscellaneous	Welding rod	ADVANI
21	Miscellaneous	Shear Stud/Connector	KOCO
22	Miscellaneous	Clamp,Rebar,Chemcial fastner	Hilti,Fischer,Wurth

<b>Sr. No.</b>	<b>Category</b>	<b>Sub Category</b>	<b>Brand Name</b>
23	Miscellaneous	Anchor Fasteners / bolts	Hilti, Fischer, Halfen
24	Miscellaneous	Masking Tapes	3M, Sun Control/ Wonder Polymer
26	Miscellaneous	Dash Fasteners	SS grade, Hilti/
27	Miscellaneous	Stainless Steel Bolts, Washers and Nuts	Kundan/ Puja/ Atul
28	Miscellaneous	Stainless Steel Pressure Plate Screws	Kundan/ Puja/ Atul
29	Miscellaneous	Stainless Steel Friction Stay	Hetish, Haffle, Securistyle
30	Miscellaneous	Weather Silicon make and grade	Dow Corning/ Mumentive (GE)
31	Miscellaneous	Structural Silicon	Dow Corning/ Mumentive (GE)
32	Miscellaneous	Tensile fabric System	Ferrari, Mehler, MakMax, Akruti
33	Miscellaneous	Stainless Steel	Jindal/ SAIL/ Golden
34	Miscellaneous	Polycarbonate Sheet	Danpalon, Alcox, Polygal, V. A. Corporation, Joy Fab, Yadav Engineering
35	Miscellaneous	Adhesives & Grouts	Bal, Laticrete, KeraKoll, Pidilite

**15 LIST OF DRWAINGS**

<b>Sr. No.</b>	<b>Drawing title</b>
1	Demolition and Tree Protection Plan
2	Overall Site Plan, Notes and Legends
3	Hardscape Finishes Layout
4	Material Plan and specification
5	mock-up drawings and sections
6	Grading Plan
7	Standard General Notes for RCC and Steel Structures
8	RCC Retaining wall
a.	<i>General Arrangement Drawing (Plan, Section, Elevation)</i>
b.	<i>Reinforcement Detail Drawing (Plan, Section, Elevation)</i>
9	Railing drawings
a.	General Notes
b.	Detailed Drawing with Description
10	All Pathway drawings
a.	General Notes
b.	Detailed Drawing for Finishes
c.	Detailed Drawing Steps in brick masonry
d.	Detailed Drawing Steps in Rubble masonry
11	Walkway steel Bridge
a.	RCC Foundation and Supporting Beam column frame detail drawing
b.	<i>General Arrangement Drawing for RCC Foundation, Supporting Beam column frame(Plan, Section, Elevation)</i>
c.	<i>Steel Assembly drawing (Plan, Section, Elevation)</i>
d.	Fabrication Drawing for all Bridge Elements like Cross Girder, Bracings, Decking etc.
12	Compound / Boundary wall drawing with sectional details(Brick masonry wall ,coping & Chain link fencing )
13	As Built drawings for all above items