TECHNICAL SPECIFICATION
**SECTION-4**

**CONCRETE**

**Indian Standards**

The following IS with latest revision apply to this section:

<table>
<thead>
<tr>
<th>I.S. No</th>
<th>Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>10262 -1982</td>
<td>Recommended Guide Lines for Concrete Mix Design</td>
</tr>
<tr>
<td>383-1970</td>
<td>Specification for coarse and fine aggregates from natural sources for concrete (Second revision)</td>
</tr>
<tr>
<td>516-1959</td>
<td>Method of test for strength of concrete.</td>
</tr>
<tr>
<td>1199-1959</td>
<td>Method of sampling and analysis of concrete.</td>
</tr>
<tr>
<td>2185 (part-I)-1979</td>
<td>Specification for load bearing, hollow concrete blocks (second revision)</td>
</tr>
<tr>
<td>2185 (Part-II)-1983</td>
<td>Specification for concrete masonry units Hollow and solid light weight concrete blocks (first revision)</td>
</tr>
<tr>
<td>2185 (Part-III)-1984</td>
<td>Specification for concrete masonry units Auto cleaved cellular (aerated) concrete blocks (first revision)</td>
</tr>
<tr>
<td>2645-1975</td>
<td>Specification for integral cement water proofing compounds (first revision)</td>
</tr>
<tr>
<td>4926 - 2003</td>
<td>Ready Mixed Concrete – Code of practice</td>
</tr>
<tr>
<td>7861 (part-I)-1971</td>
<td>Code of practice for extreme weather concreting Part 1-Recommended Practice for hot weather concreting</td>
</tr>
<tr>
<td>8112-1989</td>
<td>Specification for 43 Grade Ordinary Portland Cement</td>
</tr>
<tr>
<td>12269 - 1987</td>
<td>Specification for 53 Grade Ordinary Portland Cement</td>
</tr>
</tbody>
</table>

**MATERIALS :**

**Cement :**

Unless otherwise indicated, cement used shall be Ordinary Portland Cement 43 grade confirming to IS 8112 of approved make. Use of any other grade of cement in case of extreme emergency shall be with the specific approval from the consultant and Engineer – in – Charge. Cement older than 3 months from the date of manufacturing shall not be used for the work.

**Storage:**

Cement in bags shall be stored in dry waterproof sheds to protect the cement from dampness and to minimize warehouse deteriorations. Where cement has been stored for over 3 month or for any reason the stored cement shows signs of deterioration or contamination, it may be tested before use for its strength, setting time, etc., cement which has fully or partially set shall not be used.

Storage of cement at the site of work shall be at the contractor's expense and risk. In the event of any damage occurring to cement due to faulty storage in contractor's sheds or on account of negligence on his part, such damage shall be the liability of the contractor. The storage shall be planned considering optimum utilization as per planned progress and shall not allow storage of cement for longer period than...
Precautions in storage:

Cement bags shall not be piled against the wall. A space of 60 cm all round shall be left between the walls and the piles, bags shall be piled off the floor on wooden planks. Bags shall be kept close together in the pile to reduce circulation of air as much as possible and shall not be piled more than 10 bags high to avoid lumping under pressure. The width of pile shall not be more than about 3m. For extra safety during the monsoon, or when it is expected to store the cement for an unusually long period, the pile shall be completely enclosed by a waterproof membrane such as polythene, tarpaulin etc. Each consignment of cement shall be stacked separately to permit easy access for inspection and facilitate removal. Cement shall be used in the order in which it is received.

Aggregates from Natural Sources:

Quality of Aggregates:

Aggregates from natural sources shall consist of (crushed or uncrushed) stones, gravel and sand or combination thereof conforming to IS 383. Specification for coarse and the fine aggregates from natural sources used for concrete. They shall be hard, strong, dense, durable, clean and free from veins and adherent coatings and free from injurious amounts of disintegrated pieces, alkali, vegetable matter and other deleterious substances. As far as possible, flaky and elongated pieces shall be avoided. Aggregated shall be obtained from approved sources as indicated.

Coarse aggregates shall be obtained from crushed granite, trap, basalt or similar stones from approved quarry. Sampling and testing shall be as per IS : 2386.

Deleterious Materials:

Aggregates shall not contain any harmful material, such as pyrites, coal, lignite, mica, shale or similar laminated material, clay, alkali, organic impurities, soft fragments, sea shells, etc., in such quantities as to affect the strength or durability of the concrete. Aggregates to be used for reinforced concrete shall not contain any material liable to attack the steel reinforcement. Aggregates, which are chemically reactive to alkalis in cement, shall not be used in cement concrete.

Limits of Deleterious Materials:

The maximum quantities of deleterious materials in the aggregates shall not exceed the limits laid down in IS 383.

4.3.3.1 If the quantities of deleterious materials in the aggregates exceed the limits mentioned above the aggregates shall be washed in fresh and clean water to the satisfaction of E.I.C before use.

4.3.3.2 Use of sea-sand shall not be allowed for any description of mortar and concrete works, in any location.

4.3.4 Aggregate Crushing Value:

The aggregate crushing value shall not exceed 45 percent for aggregate used for concrete other than for wearing surfaces and 30 percent for concrete for wearing surfaces such as runways roads and pavements.

4.3.5 Aggregate Impact Value:

As an alternative to aggregate crushing value, the aggregate impact value shall not exceed 45 percent by weight for aggregates used for concrete other than for wearing surfaces and 30 percent by weight for concrete for wearing surfaces, such as runways roads and pavements.

4.3.6 Aggregate Abrasion Value:

The abrasion value of aggregate, using Los Angels machine shall not exceed the following value: For aggregates to be used in concrete for wearing surfaces-30 percent

a) For aggregates to be used in other concrete-50 percent

4.3.7 Size and Grading of Aggregates:
(1) Graded Coarse Aggregate: Grading shall be within the limits given in the following table:

### GRADING OF COARSE AGGREGATE:

<table>
<thead>
<tr>
<th>IS Sieve Designation</th>
<th>Percentage Aggregate</th>
<th>Passing for graded of nominal size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40 mm</td>
<td>20 mm</td>
</tr>
<tr>
<td>80 mm</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>63 mm</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>40 mm</td>
<td>95-100</td>
<td>100</td>
</tr>
<tr>
<td>20 mm</td>
<td>30-70</td>
<td>95-100</td>
</tr>
<tr>
<td>12.5 mm</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10 mm</td>
<td>10-35</td>
<td>25-55</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>0-5</td>
<td>0-10</td>
</tr>
</tbody>
</table>

(2) Fine Aggregate (Sand): The grading of fine aggregates shall be within the limits given in the following table and shall be described as fine aggregates Grading zone I, II, III & IV. Where the grading falls outside the limits of any particular grading zone of sieves other than 600 micron I.S. Sieve, by a total amount not exceeding 5 percent, it shall be regarded as falling within that Grading Zone. This tolerance shall not be applied to percentage passing the 600 micron I.S. Sieve or to percentage passing any other size on the coarser limit of grading Zone I or the finer limit of Grading Zone IV.

<table>
<thead>
<tr>
<th>IS Sieve Designation</th>
<th>Percentage passing for</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grading</td>
</tr>
<tr>
<td></td>
<td>Zone I</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>10 mm</td>
<td>100</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>90-100</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>60-95</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>30-70</td>
</tr>
<tr>
<td>600 micron</td>
<td>15-34</td>
</tr>
<tr>
<td>300-micron</td>
<td>5-20</td>
</tr>
<tr>
<td>50 micron</td>
<td>0-+10</td>
</tr>
</tbody>
</table>

NOTE 1: For crushed stone sands the permissible limit on 150 micron I.S. Sieve shall be increased to 20 percent. This does not affect the 5 percent allowance, as already permitted, applicable to other sieve sizes.

NOTE 2: Fine aggregate conforming to Grading Zone IV shall not be used in reinforced concrete, unless tests (which shall be recorded) have been made to ascertain the suitability of proposed mix proportions and prior written approval of EIC for use of such fine aggregate is obtained.

(3) All-in Aggregate: Grading of all in aggregate shall be within the limits given in the following table:

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SIGN

ATU

RE OF TENDERER WITH SEAL

EMPLOYER

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<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>80 mm</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>40 mm</td>
<td>95-100</td>
<td>100</td>
</tr>
<tr>
<td>20 mm</td>
<td>45-75</td>
<td>95-100</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>25-45</td>
<td>35-50</td>
</tr>
<tr>
<td>600 micron</td>
<td>8-30</td>
<td>10-35</td>
</tr>
<tr>
<td>150 micron</td>
<td>0-6</td>
<td>0-6</td>
</tr>
</tbody>
</table>

NOTE: For carrying out tests on all-in-aggregates, the fractions passing through 4.75 mm IS sieve and the fractions retained on 4.75 mm IS sieve shall be first separated and there shall comply with the requirements (except grading) specified for fine aggregates and coarse aggregate respectively.

4.4 Water Proofing Compound:

Integral cement waterproofing compound where indicated shall be used and the same shall confirm to the requirements of IS 2645-1975. Specifications for integral cement water proofing compound or as specified in the BOQ.

4.5 Water:

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. The pH value of water shall generally be not less than 6. Potable water is generally considered satisfactory for mixing concrete.

Water found satisfactory for mixing is also suitable for curing concrete. However, water used for curing should not produce any objectionable stain or unsightly deposit on the concrete surface. The presence of tannic acid or iron compounds is objectionable.

WORKMANSHIP

4.6 Plain and Reinforced Cement Concrete:

4.6.1 Cement Concrete:

Cement concrete shall be of the specified Grade or volumetric mix as indicated. Cement concrete and reinforced cement concrete shall be provided in accordance with IS 456-2000, code of practice for plain and reinforced concrete, except as otherwise stated.

4.6.2 Concrete Mix Proportioning:

Where concrete is specified by its Grade i.e., characteristic compressive strength, determination of proportions of cement, aggregates and water to attain the required strength shall be made by designing the concrete. Mix (Design mix concrete).

Design Mix Concrete:

The mix shall be designed to produce the grade of concrete having the required workability and the characteristic strength not less than that specified. The contractor shall conduct all necessary tests and analysis of the materials and provide necessary test/analysis data required for design of the concrete mix. The contractor shall also make trial mixes of concrete and conduct necessary tests to arrive at the approved mix proportioning and strength at his cost. As long as the quality of materials does not change a mix design done earlier may be considered adequate for later work. The mix design shall be done/tested from the Government Laboratories preferably located at NASIK.

4.6.2.1 MINIMUM CEMENT CONTENTS:

The minimum cement contents for design mix concrete of various grades shall be as indicated.

Volumetric Mix Concrete:

Where indicated concrete will be of the specified volumetric mix. For volumetric mix concrete, the proportions of cement and aggregates are defined by bulk. Volumetric mix shall be designated as 1:4:8.
1:3:6 etc., the figures denote the relative proportions of cement, fine aggregate in dry condition and graded coarse aggregate respectively. If fine aggregate is moist, necessary allowance shall be made for bulking. To determine bulk, 50 kg of cement shall be taken as equal to 0.035 cum. Quantities of fine and coarse aggregates shall be determined by Volume separately and accurately in proper gauge boxes. The gauge boxes shall be of such dimensions that 50 kg of cement forms a unit. The equivalent size of a box for 50 kg cement bag will measure 40x35x25 cm internally. Consolidation of aggregates in the gauge boxes by ramming or shaking shall not be allowed.

4.6.3 Batching:

In proportioning design mix concrete, the quantity of both cement and aggregates shall be determined by weight. Water shall be either measured by volume in calibrated tanks or weighed. All measuring equipment shall be maintained in a clean serviceable condition and their accuracy periodically checked. All materials for controlled concrete shall be batched as per approved design in suitable weigh batcher of adequate capacity and of approved design.

4.6.3.1 The material shall be stockpiled for several hours, preferably a day before use. The grading of coarse and fine aggregates shall be checked as frequently as possible, the frequency for a given job being determined by the EIC to ensure that the specified grading is maintained.

4.6.3.2 Where the aggregates supplied are not graded, different sizes shall be blended in right proportions; the different sizes being stacked in separate stock piles.

4.6.3.3 Water cement ratio shall be maintained at its correct value.

4.6.3.4 No substitutions in the materials used on the work or alterations in the established proportions shall be made without additional test to show that the quality and strength of concrete are satisfactory.

4.6.4 Workability of concrete:

The concrete shall be of adequate workability for the placing condition of the concrete and proper compactions with the means available. Suggested ranges of values of workability of concrete for some placing conditions, measured in accordance with IS 1199-1959, are given below:

<table>
<thead>
<tr>
<th>Placing conditions</th>
<th>Degree of workability</th>
<th>Values of Workability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concreting of shallow sections with vibration</td>
<td>Very low</td>
<td>20-10 seconds vee-bee time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR 0.75-0.80 compacting factor</td>
</tr>
<tr>
<td>Concreting of lightly Low reinforced sections with</td>
<td>Low</td>
<td>10-5 seconds vee-bee time</td>
</tr>
<tr>
<td>vibration</td>
<td></td>
<td>OR 0.80-0.85 compacting factor</td>
</tr>
<tr>
<td>Concreting of lightly reinforced sections without</td>
<td>Medium</td>
<td>5-2 seconds vee-bee time</td>
</tr>
<tr>
<td>vibration, or heavily reinforced section with</td>
<td></td>
<td>OR 0.85-0.92 compacting factor</td>
</tr>
<tr>
<td>vibration</td>
<td></td>
<td>6-25mm slump for 12.5 mm aggregate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR 25-75mm slump for 20 mm aggregate</td>
</tr>
<tr>
<td>Concreting of heavily reinforced section without</td>
<td>High</td>
<td>Above 0.92 compacting factor</td>
</tr>
<tr>
<td>vibration</td>
<td></td>
<td>OR 75,125mm slump for 20 mm aggregate</td>
</tr>
</tbody>
</table>

4.6.5 Mixing:

Concrete shall be mixed in a mechanical mixer. The mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in color and consistency. If there is segregation after
unloading from the mixer, the concrete shall be re-mixed. The mixing time may be taken as 1-1/2 to 2
minutes.

4.6.6 Form Work:

4.6.6.1 General:

The formwork shall be designed and constructed to the shapes, lines and dimensions shown on the
drawings. All forms shall be sufficiently watertight to prevent leakage of mortar. Forms shall be constructed
so as to remove in sections. Formwork shall be provided finished fair and even as specified in section 7-
Woodwork. The form work shall be properly designed so that it is rigid enough to remain free from bulging,
sagging or displacement while placing the concrete and consolidation.

4.6.6.2 Cleaning and Treatment of Forms:

All rubbish particularly chippings; shavings and sawdust shall be removed from the interior of the forms
before the concrete is placed. The formwork in contact with the concrete shall be cleaned and thoroughly
wetted or treated with an approved composition to prevent adhesion between formwork and concrete. Care
shall be taken that such approved composition is kept out of contact with the reinforcement.

4.6.6.3 Stripping Time:

Forms shall not be struck until the concrete has attained strength at least twice the stress to which the
concrete may be subjected at the time of removal of formwork. The strength referred to shall be that of
concrete using the same cement and aggregates, with the same proportions and cured under conditions of
temperature and moisture similar to those existing of the work. Where so required formwork shall be left
longer. In normal circumstances and where ordinary Portland cement is used, forms may generally be
removed after the expiry of the following periods: For other cement stripping time shall be indicated:

| (a) | Walls, columns and vertical faces of all structural members | 2 days |
| (b) | Slabs (props left under) | 3 days |
| (c) | Beam Soffits (props left under) | 7 days |
| (d) | Removal of props under slabs |
| (1) | Spanning up to 4.5 m | 7 days |
| (2) | Spanning over 4.5 m | 14 days |
| (e) | Removal of props under beams and arches |
| (1) | Spanning up to 6 m | 14 days |
| (2) | Spanning over 6 m | 21 days |

In case of bad weather these periods may be increased at the direction of EIC

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

4.6.6.4 Removal of Form work:

Formwork shall be removed in such a manner as would not cause any shock or vibration that would
damage the concrete. Before removal of soffits and props concrete surface shall be exposed to ascertain
that the concrete has sufficiently hardened.

4.6.6.5 Where the shape of the element is such that formwork has re-entrant angles, the formwork shall be
removed as soon as possible after the concrete has set, to avoid shrinkage cracking occurring due to the
restraint imposed.

REINFORCEMENT:

4.6.7 Assembly of Reinforcement:

Reinforcement shall be bent and fixed as specified in section 10 Steel and Iron work. All reinforcement shall
be placed and maintained in the position shown in the drawings during concreting. Crossing bars shall not
be tack welded for assembly of reinforcement, unless otherwise indicated. All Reinforcement shall be of
tested Quality and specified Diameter as per the design. Test reports shall be submitted to Engineer – in – Charge / Consultant for approval.

4.6.7.1 Tolerance on Placing of Reinforcement:

Unless otherwise directed, reinforcement shall be placed within the following tolerance:

(a) For effective depth 200 mm or less + 10 mm
(b) For effective depth more than 200 mm + 15 mm

4.6.7.2 Welded joints or mechanical connectors:

Welded joints in reinforcement may be used where indicated / directed but in all cases of important connections, tests shall be made to prove that the joints are of the full strength of the bars connected.

4.6.8 Cover to Reinforcement:

4.6.8.1 Reinforcement shall have concrete cover and the thickness of such cover (exclusive of plaster or other decorative finish) shall be as follows, unless otherwise indicated:

a) At each end of reinforcing bar, not less than 25 mm or less than twice the diameter of such bar;

b) For a longitudinal reinforcing bar in a column not less than 40 mm nor less than the diameter of such bar.
   In the case of columns of minimum dimension of 200 mm or under whose reinforcing bars do not exceed 12 mm, a cover of 25 mm may be used;

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

d) For tensile, compressive, shear, or other reinforcement in a slab, not less than 15 mm nor less than the diameter of such bar; and

e) For any other reinforcement, not less than 15 mm nor less than the diameter of such bar.

4.6.8.2 Increased cover thickness may be provided when surfaces of concrete members are exposed to the action of harmful chemicals, acid vapour, saline atmosphere, sulphurous smoke, etc., and such increase of cover may be between 15 mm and 50 mm beyond that specified in 4.6.8.1, as indicated.

4.6.8.3 In all cases the cover shall not exceed 75 mm.

4.6.9 Transporting:

Concrete shall be transported from the mixer to the formwork as rapidly as possible by methods, which will prevent the segregation or loss of any of the ingredients and maintaining the required workability. During hot or cold weather, concrete shall be transported in deep containers.

Other suitable methods like transporting by transit mixers may be adopted. Special care should be taken to reduce loss of water by evaporation in hot weather and heat loss in cold weather during transportation. Sufficient numbers of transit mixtures shall be employed for maintaining continuity of concreting process.

Concrete line-pumps of suitable capacity and sufficient numbers shall be engaged for pouring concrete in pavements.

4.6.10 Placing:

The concrete shall be deposited as nearly as practicable in its final position to avoid rehandling. The concrete shall be placed and compacted before setting commences and should not be subsequently disturbed. Methods of placing should be such as to preclude segregation. Care shall be taken to avoid displacement of reinforcement or movement of formwork. The concrete, which is deposited or otherwise disturbed after initial setting commences shall be immediately removed from the site.
4.6.10.1 Before placing the concrete in trenches or on sub-grade or sub-base, the sub-grade / sub-base shall be cleaned of all injurious or foreign matter, watered and well consolidated, if necessary.

4.6.10.2 The final layer of concrete shall be laid to such levels and falls as may be directed.

4.6.10.3 When concrete has to be lowered to any depth below 15m, it shall be conveyed in suitable receptacles or by chute. The delivery end of the chute shall be as close as possible to the point of deposit. The chutes shall be thoroughly flushed with water before and after each working period, the water for this purpose shall be -discharged outside the formwork.

4.6.11 Compaction:

Concrete shall be thoroughly compacted and, fully worked around the reinforcement, around embedded fixtures and into the corners of the formwork. Mechanical vibrators shall be employed for compacting concrete. Over vibration or vibration of very wet mixes is harmful and shall be avoided; under vibration is also to be avoided. Sufficient numbers of reserve / vibrators in good working condition shall be kept at all times so as to ensure that there is no slacking / interruption in compacting. Vibrators of specified sizes shall be used depending upon the quantum of concreteing.

4.6.11.1 Where vibration is to be applied externally, the design of formwork and the disposition of vibrators shall be such as to ensure efficient compaction and to avoid surface blemished.

4.6.12 Construction Joints:

Concreting shall be carried out continuously up to construction joints the position and arrangement of which shall be as indicated or directed by the consultant and Engineer – in – charge.

4.6.12.1 When the work has to be resumed on a surface which has hardened, such surface shall be roughened. It shall then be swept clean and thoroughly wetted. For vertical joints neat cement slurry at the rate of 2.50 kg of cement per sqm shall be applied on the surface before it is dry. For horizontal joints surface shall be covered with a layer of mortar about 10 to 15 mm thick composed of cement and sand ratio as the cement and sand in the concrete mix. The layer of cement slurry or mortar shall be freshly mixed and applied immediately before placing of concrete.

4.6.12.2 Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes. Care being taken to avoid dislodgement of particles of aggregate. The surface shall be thoroughly wetted and all free water removed. The surfaces shall then be coated with neat cement slurry. On this surface, a layer of concrete not exceeding 150mm in thickness shall first be placed and shall be well rammed against old work; particular attention being paid to corners and close spots; work thereafter shall proceed in the normal way.

4.6.12 Curing:

Exposed surfaces of concrete shall be kept continuously in. a damp or wet condition by covering with a layer of sacking, canvas, Hessian or similar materials or a layer of sand or by ponding for at least seven days from the date of placing of concrete. Approved curing compounds may be used in lieu of moist curing with the permission of EIC. Such compounds shall be applied to all exposed surface of the concrete as soon as possible after the concrete has set.

4.6.13 Protection:

The concrete shall be carefully protected after it is laid against the action of frost and shielded from exposure to sun to avoid rapid drying. Care shall be taken to protect the concrete from all shaking and other disturbances during construction. No traffic shall be allowed on the finished concrete surface for at least 7 days. This period may be increased or decreased at the discretion of EIC.

4.6.14 Inspection:

Immediately after stripping the formwork, all concrete shall be carefully inspected for any defective work
and defects either removed or made good before the concrete has thoroughly hardened.

4.6.15 Exposed Surfaces:

4.6.15.1 The contractor shall use proper formwork so that the concrete in contact with removal of formwork present an even surface. Concrete while being poured against formwork shall be adequately tamped, or vibrated where directed, so that fines are drawn towards the surface and honey combing is avoided.

4.6.15.2 Exposed surfaces of concrete shall be "Finished fair and Even in Forms".

Exposed surfaces after striking off formwork shall be such as to present a fair and even surface and shall not be plastered unless otherwise specified. The surface shall be presentable without any further treatment. Any irregularities and protruding formwork marks shall be removed and minor honeycombing made good with cement and sand mortar 1:3. Lines along the formwork joints may however show.

4.6.15.3 Exposed surfaces of concrete which are indicated/required to be plastered shall be roughened with wire brushes and hacked out closely immediately after removal of formwork.

4.6.15.4 Openings and Inserts:

Openings and Positions of Inserts shall be made as per the drawing or as directed by the Consultant and EIC. This shall be done with utmost accuracy/precision and any deviation from the Drawing or instruction by the Consultant or EIC, the same shall be rectified by the Contractor at his own cost. No Extra payment shall be admissible for making openings/inserts etc.

4.6.16 Sampling and testing of concrete:

Samples from fresh concrete shall be taken as per IS 1199-1959. Method of sampling of concrete and cubes shall be made, cured and tested at 28 days in accordance with IS 516-1959, Method of test for strength of concrete.

4.6.16.1 Where indicated, tests on beams for modulus of rupture at 72 ± 2hrs or at 7 days, or compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength alone shall be the criterion for acceptance or rejection of the concrete.

4.6.16.2 Test Specimen:

Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for such purpose as to determine the strength of concrete at 7 days or to check the testing errors.

4.6.16.3 Test Strength of samples:

The test strength of the sample shall be the average of the strength of three specimen. The individual variation shall not be more than +/- 15 percent of the average.

4.6.16.4 Acceptance Criteria:

The concrete shall be deemed to comply with the strength requirement when both the following conditions are met:-

a) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in Column No. 2 Table –11 of IS 456 -2000

b) Any individual test results complies with the appropriate limits in column No.3 of Table -11 of IS 456-2000.

If the concrete is deemed not to comply pursuant to acceptance criteria, it shall be dismantled and redone at the contractor’s expenses.

Concrete of each grade shall be rejected if it is porous or honey-combed: its lacing has been interrupted without providing a proper construction joint; the reinforcement has been displaced beyond the tolerances specified or construction tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer-in-charge.

4.6.16.5 Standard Deviation:

Standard deviation of concrete of each grade shall be determined separately as stated below. When result
of sufficient number of tests (at least 30) are not available, than depending on the degree of quality control expected to be exercised at the site, the value of standard deviation given in the following table may be adopted for guidance. Grade of Concrete Suggested Values of S.D

<table>
<thead>
<tr>
<th>Grade of Concrete</th>
<th>S.D. for different degree of control in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very Good</td>
</tr>
<tr>
<td>M 10</td>
<td>2</td>
</tr>
<tr>
<td>M 15</td>
<td>2.5</td>
</tr>
<tr>
<td>M 20</td>
<td>3.6</td>
</tr>
<tr>
<td>M 25</td>
<td>4.3</td>
</tr>
<tr>
<td>M 30</td>
<td>5</td>
</tr>
<tr>
<td>M 35</td>
<td>5.3</td>
</tr>
<tr>
<td>M 40</td>
<td>5.6</td>
</tr>
</tbody>
</table>

Control expected for this work is "Very Good" and the contractor shall deploy weigh batcher as required to attain the required control

### 47 Waterproof Concrete:

Where indicated, cement concrete shall be waterproofed by adding integral waterproofing compound conforming to IS 2645-1975, Specification for integral cement waterproofing compounds at the time of making concrete as per the manufacturer's instructions. The quality of waterproofing compound shall be as indicated but in no case shall be less than the quality recommended by the manufacturers and not exceeding 3 percent by weight of cement.

### 48 Work in Extreme Weather Concreting:

Concreting during hot and cold weather shall be done as per the procedures set out in IS: 7861 (part-I) Code of practice for extreme weather concreting; part I Recommended practice for hot weather concreting, or IS7861 (part-II)-1981 Code of practice for extreme weather concreting; Part II Recommended practice for cold weather concreting.

### 4.9 Reinforced Concrete Work in water Retaining Structure:

4.9.1 Special care shall be taken to get the most suitable grading of aggregate so as to produce the densest possible concrete. Mix proportion shall be indicated. Water cement ratio shall be controlled consistent with the requirements of workability to produce impervious concrete.

4.9.2 The concrete between the reinforcement and the formwork on the water face shall be well compacted and the board joints tight, so as to produce a face free from honey-combing or pores. External vibrators viz. shutter vibrators at the rate of one vibrator per 2.5 m² of shutter area shall be used to produce a compact concrete with a dense skin which shall not, however, contain an excess of cement, wherever it is not possible to use shutter vibrator, pin vibrator shall be used after the approval of EIC.

4.9.3 Construction, Contraction & Expansion Joints.

4.9.3.1 All vertical, horizontal construction and expansion joints in water retaining structures shall be located and executed as shown in the drawings and no deviation shall be permitted without the specific permission of EIC. Where days' work joints are formed whether horizontally or vertically, they shall be rebated as called out on drawings. Care shall be taken to remove from the earlier lift over all loose pieces of gravel, stone chips, wooden chips, country nails or any other foreign materials. All laitance shall also be thoroughly removed. If necessary, the face of the old concrete shall be well hacked to expose the aggregate and after washing the surface, a thin coat of mortar or grout (1 cement: 1 sand) shall be applied immediately before resuming concreting.

4.9.3.2 Water bar installation along the joints shall be done by embedding one half of the water bar in each side of the joint by suitable jigs / supporting arrangements between the adjacent sections of the concrete as per the manufacturer's specifications and directions of the EIC. Water bars shall be properly aligned and placed in position during embedding. To achieve the continuity of the water bar all along the joint at crossing and at change of alignment, the water stops shall be welded (in T, X or L shapes as the case may be) as per manufacturer's specifications and directions of EIC. Suitable jigs manufactured out of reinforcing
bars may be used for fixing the water bars.

4.9.3.3 Fittings:

Pipes and outer fittings passing through the walls and bottom shall be well embedded in the concrete and shall be provided with normal puddle flanges. Opening in the walls, and floor slabs if any shall be provided as per the relevant drawings.

4.9.4 Curing:
Concrete in water retaining portion shall be cured minimum for 21 days.

4.9.5 Hydraulic Testing:
Structures shall be tested strictly in accordance with IS: 3370 (Part I) for water tightness. For underground tank, the total maximum drop in water surface level over seven days shall not exceed 40 mm.

4.10 Pre-cast Reinforced Concrete—Generally

4.10.1 Pre-cast reinforced concrete articles such as manhole cover and frame, columns, fencing posts, door and window frames, lintels, chajjas, coping, sills, shelves, slabs, louvers etc. shall be of the grade or mix as indicated and cast in forms or moulds. The forms shall be of timber or of steel for better finish. Provisions shall be made in the forms and moulds to accommodate fixing devices such as nibs, clips, hooks, bolts and forming of notches and holes. The contractor may precast the units on cement or steel platform that shall be adequately oiled provided the surface finish is of the same standard as obtained in the forms. Each unit shall be cast in one operation.

4.10.2 Concrete shall be proportioned, mixed, placed and thoroughly compacted by vibration or tamping to give a dense concrete free from voids and honeycombing.

4.10.3 Precast articles shall have a dense surface finish showing no coarse aggregate and shall have no cracks or crevices likely to assist in disintegration of concrete or rusting of steel or other defects that would interfere with the proper placing of the units or to impair the strength or the performance of construction. All angles of the precast units with the exception of the angles resulting from the splayed or the chamfered faces shall be true right angles. The rises shall be clean and sharp except those specified to be rounded. The wearing surface shall be true and out of winding. On being fractured, the interior of the units shall present a clean, homogeneous appearance.

4.10.4 The longitudinal reinforcement shall have a minimum cover of 12 mm or twice the diameter of the main bar, whichever is more, unless otherwise directed.

4.10.5 Curing:

After placing, the concrete shall be adequately protected during setting and in first stages of hardening from shocks and from the harmful effects of sunshine, drying winds and cold. The concrete shall be cured for at least 7 days.

4.10.6 Maturing:

From the date of casting, the precast articles shall be matured for 28 days before erection or being built up.

4.10.7 Concrete shall have sufficient strength to prevent damage to units when first handled.

Flyash:

Addition of flyash may be considered to the extent of 10% only and not more for footings, pedestals, columns, slabs and beams. Flyash shall not be used for Pavements and floors.

Nevertheless of what is specified herein above or not, IS – 456,516,10262 and 1199 shall be followed related to all the matters of concrete specified therein.
4.10.8 Marking:
Precast articles shall be clearly marked to indicate the top of member and its location and orientation in the structure. While the concrete is still green, each unit shall be marked with the date of casting. Precast units shall be stored, transported and placed in position in such a manner that they will not be over stressed or damaged.

4.11 Epoxy resin concrete bonding agent

Scope of work.

For bonding new cementitious materials to existing cementitious surfaces. For use on horizontal surfaces and on vertical surfaces where mortar or concrete can be supported by formwork. Where extension to existing structure or similar work is ordered. The following strengths should be achieved as per table below:

<table>
<thead>
<tr>
<th>Strength</th>
<th>BS 6319 Pt</th>
<th>Duration</th>
<th>Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressive Strength</td>
<td>2</td>
<td>@ 7 days</td>
<td>50 N/mm²</td>
</tr>
<tr>
<td>Flexural strength</td>
<td>3</td>
<td>@ 7 days</td>
<td>35 N/mm²</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>7</td>
<td>@ 7 days</td>
<td>20 N/mm²</td>
</tr>
<tr>
<td>Shear strength</td>
<td>4</td>
<td>@ 7 days</td>
<td>10 N/mm²</td>
</tr>
</tbody>
</table>

Adhesive strength to concrete: In general the bond strength will always exceed the tensile strength of M30 concrete.

The Tests shall be carried out at manufacturers laboratory and results shall be submitted to the consultant / EIC for approval.

Specification clauses

The bonding agent shall be an epoxy based two component resin system pre packed in distinct colours to give visual evidence for proper mixing. The bonding agent should remain in tacky state after application for a minimum period of 6 hours at 30°C. There shall not be bond failure of the specimen when tested by slant shear method according to BS 6319 pt 4.

Application instructions

Preparation

All surfaces to be treated must be firm, dust free and clean. All laintence should be removed by etching with Reebaklens and wire-brushing. Where ever necessary, the existing concrete must be chipped to a sound substrate. Where surfaces are contaminated with oil or grease, this should be removed by using a strong industrial detergent or organic degreaser. Surface should be washed thoroughly with water and dried before the application.

Mixing

The entire contents of the hardener shall be poured into the resin container and the two materials thoroughly mixed until a uniform colour is obtained. To facilitate application at temperatures below 10 °C the separate components should be warmed in hot water to a maximum of 25 °C before mixing.

Coating

Mixed Epoxy resin bonding agent should be brush applied to the prepared surface. The new concrete should be placed within 6 hours at 30°C to the coated substrate, when it is in a tacky state.

Rate
The rate shall include the cost of all labour and materials involved in all the above operations and testing (including surface preparation) described above. No Extra Payment shall be made for Testing.

4.12 High strength, non-shrink, cementitious grout

Description of work: It is used for grouting of base plates of columns, stanchions, and similar applications etc.

Description of material: This material is supplied as a ready to use dry powder. The addition of a controlled amount of clean water produces a free flowing, non-shrink grout for gap thicknesses up to 100mm.

This material is a blend of Portland cement, graded fillers and chemical additives which impart controlled expansion in the plastic state whilst minimizing water demand. The low water demand ensures high early strength. The graded fillers are designed to assist uniform mixing and produce a consistent grout.

The Tests shall be carried out at at approved Govt. laboratory and results shall be submitted to the consultant / EIC for approval.

Specification Clauses

Performance specification

All grouting shown on the drawing must be carried out with a pre packed cement based product which is chloride free. It shall be mixed with clean water to the required consistency. The grout must not bleed or segregate. A positive volumetric expansion shall occur while the grout is plastic by means of gaseous system. The compressive strength of the grout must exceed 50 N/mm² at 7 days and 60 N/mm² at 28 days as per Code (BS 1881 - Part 116: 1983). The flexural strength of grout must exceed 9N/mm² @ 28 days as per Code (BS 4551, 1998). The fresh wet density of the mixed grout must exceed 2150 kg/m³.

The storage, handling and placement of the grout must be in strict accordance with the manufacturer's instructions.

Application instructions

Preparation Foundation surface

The substrate surface must be free from oil, grease or any loosely adherent material. If the concrete surface is defective or has laitence, it must be cut back to a sound base. Bolt holes and fixing pockets must be blown clean of any dirt or debris.

Pre-soaking

Several hours prior to placing, the concrete substrates should be saturated with fresh water. Immediately before grouting takes place any free water should be removed with particular care being taken to blow out all bolt holes and pockets.

Base plate

It is essential that this is clean and free from oil, grease or scale. Air pressure relief holes should be provided to allow venting of any isolated high spots. Leveling shims if these are to be removed after the grout has hardened, they should be treated with a thin layer of grease.

Formwork

The formwork should be constructed to be leak proof. This can be achieved by using foam rubber strip or mastic sealant beneath the constructed formwork and between joints. In some cases it is practical to use sacrificial semi-dry sand and cement formwork. The formwork should include outlets for pre-soaking.

Unrestrained surface area.
This must be kept to a minimum. Generally the gap width between the perimeter formwork and the plate edge should not exceed 150mm on the pouring side and 50mm on the opposite side. It is advisable, where practical, to have no gap at the flank sides.

**Mixing and placing**

Mixing

For best results a mechanically powered grout mixer should be used. When quantities up to 50kg are used, a heavy duty slow speed drill (400-500 rpm) fitted with a paddle is suitable larger quantities will require a heavy duty mixer.

To enable the grouting operation to be carried out continuously, it is essential that sufficient mixing capacity and labour are available. The use of a grout holding tank with provision to gently agitate the grout may be required.

**Consistency of grout mix**

The quantity of clean water required to be added to a 25kg bag to achieve the desired consistency as given in table below:

<table>
<thead>
<tr>
<th>Consistency</th>
<th>Water Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pourable</td>
<td>4.125 litres</td>
</tr>
<tr>
<td>Flowable</td>
<td>4.500 litres</td>
</tr>
</tbody>
</table>

**Placing**

At 30°C place the grout within 20 minutes of mixing to gain full benefit of the expansion process. Grouting material can be placed in thicknesses up to 100mm in a single pour when used as an under plate grout.

For thicker sections it is necessary to fill out grouting material with well graded silt free aggregate to minimize heat buildup. Typically a 10mm aggregate is suitable. 50 - 100% aggregate weight of grouting material can be added.

**Rate**

The rate shall include the cost of all labour and materials involved in all the above operations and testing as described above. No Extra Payment shall be made for Testing.

**BATCH MIXING PLANT**

Central Mixed Concrete Batching Plant specified capacity in General Conditions of Contract (Volume I) shall be set up by the contractor.

**4.13 READY MIX CONCRETE**

*(IF SPECIFICALLY PERMITTED BY ENGINEER IN CHARGE ON EMERGENCY)*

**SPECIFICATIONS for RMC:**

Contractor shall make ready mixed concrete with who is expert in the field, would supply designed mix. The RMC producer accepts the responsibility for the design of the mixture for the desired performance. The contractor shall specifies aggregate size, slump, air content, cement content, or weight of cement per cubic meter of concrete, maximum water content and admixtures required. The contractor shall accept the responsibility for concrete strength and its performance.

**PROPORTIONING of RMC:**

The proportioning of an RMC aims at obtaining the properties, such as workability, strength, durability and appearance. The following basics of a good concrete mix should be considered while proportioning RMC. Concrete aggregates should be clean, strong and durable. Fly ash or other supplementary cementitious materials added as directed if necessary by EIC to RMC to enhance concrete properties.
Admixtures are commonly used to improve the rate of setting and strength of development of concrete as directed by EIC.

**CENTRAL- MIXED CONCRETE:**
Concrete batch plants include a stationary, plant mounted mixer that mixes the concrete before it is discharged into a truck mixer. While traveling to the job site the drum is turned at agitating speed (slow speed). After arriving at the job site, the concrete is completely mixed. The drum is then turned for 70 to 100 revolutions, or about 5 minutes, at mixing speed. Concrete mixed in the yard or central batching plant: The drum is turned at high speed or 12-15 rpm for 50 revolutions. This allows quick check of batch. The concrete is then agitated slowly while driving to the job site. Concrete mixed in transit: The drum is turned at medium speed or about 8 rpm for 70 revolutions while driving to the job site.

**DELIVERY OF RMC:**

Ready mix concrete can be delivered to the construction site in truck-mounted, rotating drum mixers. Truck mixers have a revolving drum with the axis inclined to horizontal. To load or charge the raw materials from a transit mixed plant or central mixed plant into the truck, the drum must be turned very fast in the changing direction. After the concrete is loaded and mixed, it is normally hauled to the job site with the drum turning at the speed of less than 2 rpm. The truck mixer shall have discharge units to convey through the pump to desired location in the site.

**INSPECTION AND TESTING:**

Specific control tests and evaluations are required during the manufacturing process to produce predictable high quality concrete. The concrete shall undergo all the specified test for concrete as per IS codes.

**4.14 Plasticizer**

**Scope of work**
To produce high workability concrete without loss of strength and to promote high early and ultimate strengths by taking advantage of water reduction whilst maintaining workability. To produce high quality concrete of improved durability and impermeability. At higher dosages, advantages can be taken of the retardation of initial setting time of concrete especially in large pours.

**Standards compliance**

Plasticizer should conform to IS: 9103-1999 and carries license from Bureau of Indian Standards. It should comply with IS 2645: 1975 and BS 5075 Part 3 and ASTM C494 Type F and **chloride content should be nil as per IS 456.**

**Description of material**

Plasticizer is based on a blend of specially selected organic polymers and disperses the cement particles effectively in the concrete mix and hence exposes a larger surface area to the hydration process. This effect is used either to increase the strength or to produce high workability concrete or reduce cement content of concrete or to retard the setting time of concrete.

**Application instructions**

Application process as per manufacturer’s specifications and contractor should submit the technical literature & get approval from the EIC and the material should be used within the shelf time.