



**SECTION 6**  
**TECHNICAL SPECIFICATION**

**PROPOSED WORKS OF CONSTRUCTION OF ARTIFICIAL  
TURF FOR AIFF NATIONAL CENTER OF EXCELLENCE  
KOLKATA, WEST BENGAL, INDIA**

**FOR**

**ALL INDIA FOOTBALL FEDERATION (AIFF)**

**Football Federation, Football House, Sector 19, Phase 1**

**Dwarka, New Delhi: 110075**

**Telephone: 91-11-25308200/201/202/203/204/205**

**Fax: 91-11- 25308234,25308236**

**[tenders.nce@the-aiff.com](mailto:tenders.nce@the-aiff.com)**

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## CIVIL WORKS

### MATERIAL & WORKMANSHIP

#### I. GENERAL

##### **Materials and Workmanship Specifications**

The specifications listed in this Part of the Employer's Requirements may be modified by the Tenderer at the time of submitting the Tender to suit the requirements of the Tenderer's design. Any such modifications shall be submitted with the Tender.

When considering any changes, it shall be noted that the specifications given in this Part shall represent the minimum required standards for material and workmanship to be followed in the construction of the works.

Where there is any discrepancy between this Part 4 of Employer's Requirements and either Part 2 or Part 3 of the Employer's Requirements, the requirements of Part 2 and Part 3 shall take precedence.

##### **Standard of Works**

The whole of the materials employed in connection with the permanent work of the Contract shall be new and of the best quality and description of their respective kinds and, except where otherwise called for, shall be of the highest grade described in Indian or other relevant Standards for such materials and shall be tested as prescribed therein; similarly, the workmanship in every case shall be of the best character, and the whole shall be subject to the approval of the Engineer.

##### **Standards & Code**

Any Indian, British, American or other International Standard or Code of Practice referred to in the documents relating to the Contract shall be held to be the latest edition published at the time of Tender. Where alternative Standards or Codes of Practice have been published in metric units, these shall take precedence over the publication in imperial units.

##### **Equivalent Standards**

- a) Subject to the approval of the Engineer, materials may be supplied conforming with other recognised Standards which correspond closely with the relevant Specified Standards.
- b) In the event that the Contractor proposes use of an alternative Standard he shall provide to the Engineer a copy of the Standard proposed together with an authoritative translation into English where the original is in a language other than English.

##### **Alternative Materials & Equipment**

- a) In all cases where the name of a particular type or make of equipment or material is referred to on the Drawings or elsewhere in this Specification, this is intended to indicate only the acceptable standard.
- b) The Contractor may offer alternative materials to equipment to that specified and in all such cases the Contractor's offer shall be at least of equal quality. When alternatives are offered the Contractor shall submit to the Engineer for approval, a statement detailing the alternative(s) and shall include full technical descriptions, drawings, specifications, test certificates etc and shall provide such full information as is required to enable the Contractor to demonstrate to the Engineer that the alternative(s) is (are) equivalent to the item specified. Any further information that the Engineer may require shall be produced by the Contractor when called for.

### **Approval of Materials & Items of Equipment**

- a) As soon as possible after the Contract has been awarded, the Contractor shall submit to the Engineer a list of suppliers from whom he proposes to purchase the materials required for the Works. Each supplier must be willing to admit the Engineer, or his representative, to his premises during ordinary working hours for the purpose of obtaining samples or inspection of the works and processes. In addition, if required by the Engineer, the Contractor shall deliver samples to the offices of the Engineer or to nominated testing laboratories or to the site of the Works. The cost of such samples shall be borne by the Contractor.
- b) The Contractor shall provide at least the following information when seeking approval of materials and items of equipment.
  - A Description of the material/item
  - Name of proposed supplier
  - Indian Standard, or other approved Standard applicable
  - Test Certificates as applicable
- c) The Contractor shall use locally produced materials in preference to imported providing they comply with the requirements of the Specification.

### **Supply of Samples**

- a) The whole cost of supplying adequate samples of any materials to be used in the Works for testing either at the Manufacturer's Works or at the site or at an independent Laboratory nominated by the Engineer, shall be deemed to be included in the rates or sums entered in the Price Schedule.
- b) Samples shall be taken at regular intervals and tested in accordance with relevant standards.

### **Material – General**

- a) Sources of supply :
- b) The sources of supply of materials shall not be changed from those approved without the written permission of the Engineer.

- c) Quality of supply :
- d) Materials subsequently supplied shall be at least equal to the approved sample in all respects.
- e) Rejected materials :
- f) Rejected materials are to be removed promptly from the Site.
- g) Copies of orders :
- h) The Contractor shall, at the Engineer's request, forward to the Engineer copies of orders for materials to be incorporated into the Works.
- i) Manufacturers instructions :
- j) All materials, goods etc., shall be used or installed in accordance with the instructions of the Manufacturer or Supplier unless otherwise specified or instructed by the Engineer.

### **Testing of Samples**

- a) At the Manufacturer's Works :
- b) The costs of testing at Manufacturer's Works of any materials to be used in the Works and the supply of "proof" or test certificates by the Manufacturer shall be deemed to be included in the rates or sums entered in the Price Schedule.
- c) At an Independent Laboratory :
- d) In addition to those tests required by the Employer's Requirements and relevant Standards, the Engineer may at any time instruct the Contractor to supply samples of materials to be used in the Works for test by an Independent Laboratory. The costs of transport to the Independent Laboratory and laboratory charges, fees of independent inspectors, etc, shall be paid for under the appropriate item in the Price Schedule, except where a sample is found not to be in accordance with the specified requirements, in which case the costs shall be borne by the Contractor.
- e) Sampling and Testing frequency:  
The sampling and test frequencies shall be as per the relevant IS codes. Where the relevant IS code does not lay down any frequency for sampling and testing, the same shall be as given in the table below or as directed by the Engineer

## **II. TECHNICAL SPECIFICATIONS FOR STRUCTURE, CIVIL & FINISHING WORKS**

### **1. TECHNICAL SPECIFICATION FOR EARTHWORK EXCAVATION**

This specification covers the general requirements of earthwork. The earthwork shall consist of all works involved in site grading, excavation, shoring, filling around foundations, filling in plinths, disposal of spoils as directed by the Engineer, and such

other relevant items. The area to be excavated or filled with the excavated materials shall be clearly demarcated in the field by the Contractor.

The earthwork shall also include, where required, temporary bracing and shoring to maintain excavation etc.

All excavation work shall be inspected and approved by the Engineer before any further works in excavated areas are allowed to commence.

Excavation shall be in all kinds of soils and shall include careful removal of all materials of whatever nature, whether dry or wet, necessary for the construction work, exactly in accordance with lines, levels, grades, curves etc. shown on the drawings. It shall be done to the exact length, width, depth and profile as shown in relevant drawings or as directed by the Engineer. Bottom of excavation shall be levelled both longitudinally and transverse direction and it shall be free of loose unconsolidated material. If excavated to greater length, width or depth, the contractor shall fill such extra excavation with M-10 grade concrete at his own expense and well rammed. If permitted by the Engineer, the extra length and width shall be filled in with good excavated earth or murrum and well rammed as directed. Extra excavation shall not be measured for payment. All bottom of excavation shall be lightly watered and thoroughly rammed before laying the next required material layer.

The contractor shall have full responsibility for the stability of the excavation.

The method of excavation, sheet piling and or other strutting system and methods shall be in every case be subject to the approval of the Engineer. The contractor shall ensure the stability and safety of the excavations and protect the sides of foundation with proper strutting system.

**Any dewatering, shoring, strutting and timbering or cutting of extra width of trenches required for the work and safety of workmen and equipment shall be done by the Contractor at his own cost. Water from the dewatering shall be drained off in such a way that it does not cause any damage to any property or any nuisance to others.**

The Contractor shall erect and maintain during progress of work temporary fences around dangerous excavations.

Excavation material required for filling shall be stacked or dumped where indicated by the Engineer. Excavated material not required for filling, unsuitable material (what is suitable and what is unsuitable is left to the sole discretion of the Engineer) and any surplus material from the stacks or dumps retained for filling, shall be removed and spread on the site where and as directed by the Engineer or carted away from the site

as directed by the Engineer. Dumping of this surplus material shall be in an orderly manner and according to the levels/grades as indicated by Engineer.

Water accumulated within excavated areas from whatever causes shall be bailed or pumped out at Contractor's expense till such time, as backfilling operations are complete.

Contractor shall take necessary measures for protection and maintenance of earthwork. Any damage to the earth work shall be made good at Contractor's cost.

**Backfilling around foundations in pits, trenches, plinth and under floors :**

- a) All clods of earth shall be broken or removed. Material for backfilling shall generally be obtained from the spoil of excavation. But, the Engineer shall have the option, in case of shortage of good selected earth obtained from excavation, to direct the Contractor to get the filling materials from approved borrow pits within the site. The Contractor shall make necessary access roads to borrow area at his own expense and maintain the same, if such access roads do not exist.
- b) After the concrete or masonry in the foundation has fully set, the spaces around the foundation structure in pits and trenches shall be cleared of all debris, brick bats, mortar dropping etc. 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. Back filling shall be done in such a manner as not to cause undue thrust on any part of the structures. The final surface shall be trimmed and levelled to proper profile as directed by the Engineer. Decision of the Engineer concerning proper consolidation shall be final and binding.
- c) The plinth and under floors shall be similarly filled with approved materials as described herein before in layers not exceeding 15 cm watered and consolidated with mechanical machines to the satisfaction of the Engineer. When the filling reaches finished level, the surface shall be flooded with water for atleast 24 hours, allowed to dry and then rammed and consolidated, in order to avoid any settlement at a later stage. The finished level of the filling shall be trimmed to the level specified.

**Site levelling**

Earth for area filling and levelling shall be obtained from the cut areas of work and if necessary the balance with approved good fill material from approved quarry or from any other source outside the boundary including all lifts and leads, laying in layers of 250 mm and below breaking clods, dressing to required lines, grades and levels, watering and compacting with power roller of 10 tonnes.

**Clearing site**

- a) The ground over which the cutting is to be done and the ground over which filling is to be formed shall be cleared of all trees, brushwood, loose stones, vegetation, bushes, stumps and all other objectionable materials. The holes dug up for grubbing roots etc.

shall be filled with suitable excavated material and compacted. Materials obtained from clearing site shall be disposed off by burning or disposal to areas outside the boundary of the project in such a way that there is no chance of their getting mixed with materials for filling.

- b) For removal of vegetation etc. crawler mounted dozer of adequate capacity shall be used. The work will be supplemented by using manual methods wherever required. The dozer shall have ripper attachment for removal of stumps, roots, etc. All trees, stumps etc. falling within excavation and fill area shall be cut to such depth below ground level that in no case these fall within 50 cm of the sub grade bottom.

### **Setting out**

After clearing the site, the area shall be set out as shown on the plans or as directed in writing. The contractor shall provide all labour, tools, tackles, instruments and materials required for setting out and establishing bench marks and grid pillars. The contractor will be responsible for maintaining bench marks, profiles, grid pillars as long as they are required. Levels and sections shall be taken by the contractor in presence of the representative of the Main contractor before the excavation/filling is started.

### **Materials**

The contractor shall utilise all useful and acceptable material obtained from the cutting from anywhere within the site for filling of low areas anywhere within the site. The contractor shall obtain additional good quality material from approved quarries or from any other source. The filling material should be soil, murum or a mixture of soil, sand, murum, gravel, small boulders having laboratory dry density of at least 1.44 gm/cc. Rejected material if brought to site will be ordered to be removed at contractors cost. Any objectionable material found in the filling material shall be hand picked and removed.

The contractor shall be responsible for payment of rents, compensation, fees, royalty etc. and these are deemed to be included in the rates. The Main contractor shall remain indemnified regarding any claims that may be made by private owners.

### **Equipment**

Pickaxes, crowbars, phawras and pans may be used for manual work. Scrapers, dozer, graders, dumpers, shovels, trucks, trolleys etc. may be used for mechanised work. Three wheeled 10 tonne power roller or sheep foot roller may be used for compaction. Mechanically driven tankers may be used for watering.

### **Construction Methods**

Before any material is laid on the ground, the same shall be cleared of all rubbish etc. When the filling is to be laid on slopes, the existing slopes shall be ploughed deeply to give proper hold. The top layer of the ploughed surface shall be scarified and watered and compacted before any filling material is laid.



Whenever fill is to be deposited against the face of a natural slope, or sloping earthworks face including embankments, cuttings, other fills and excavations steeper than 1 vertical on 4 horizontal, such faces shall be benched as mentioned below immediately before placing the subsequent fill.

Continuous horizontal benches, each at least 300 mm wide, shall be cut into the old slope for ensuring adequate bond with the fresh filling material to be added.

However, when the existing slope against which the fresh material is to be placed is flatter than 1 vertical on 4 horizontal, the slope surface may only be ploughed or scarified instead of resorting to benching.

All permanent faces of side slopes of cut and fill formed areas shall, subsequent to any trimming operations, be reworked and sealed to the satisfaction of the Engineer by tracking a tracked vehicle considered suitable by the Engineer, on slope or any other method approved by the Engineer.

The finished side slopes of cut and fill formed areas shall be 2 to 1 (i.e. 2 horizontal to 1 vertical) slope or the slope required by the Engineer.

When the fill level is higher than the adjacent area outside the boundary of the project then the layers shall be laid in a suitable slope upto the ground level at the boundary line.

#### **Laying the filling material**

Filling material shall be placed in successive horizontal layers of 250 mm consolidated thickness or in thickness less than 250 mm if required by the Engineer extending to the complete area of filling. The extra loose stuff at the edges shall be trimmed after completion of earthwork without extra cost. When boulders, broken stones and hand materials are mixed up with the filling materials, care shall be taken to see that they are distributed evenly and uniformly into the earth and no hollows are left near them. No stone or hard material shall project above the top of any layer. Each layer of filling shall be levelled, watered, compacted and tested before the succeeding layer is placed. The surface of the filling at all times shall shed water and prevent ponding.

All clods, lumps, boulders, etc shall be broken to have a maximum size of 75 mm before filling and compaction.

#### **Protection**

The contractor shall take the necessary measures and precautions for the protection of the earthwork. Any damage to the earthwork shall be made good at the contractor's cost.

The contractor will have to make his own arrangements so that water is adequately and effectively drained and this arrangement may left after completion of earthworks if so desired.

### **Rolling**

The layers shall be compacted with Power driven rollers of 8 to 10 Tonnes capacity. The roller shall pass atleast twice over the same area once in forward move and the second time in backward move.

### **Finishing**

The filling shall be finished and dressed smooth and even in conformity with the alignment, levels, cross-sections and dimensions shown on the drawings with due allowance for shrinkage. All damages caused by rain, movement of vehicles or any other reason shall be made good in the finishing operations.

The contractor shall not excavate beyond the specified levels / dimensions on the drawings.

The finished cut and fill formation shall satisfy the permitted surface tolerances of +20 mm or -25 mm.

Where the finished surfaces fall outside the above specified tolerances, the contractor shall be liable to rectify these in the manner described below and to the satisfaction of the Engineer.

Where the surface is high, it shall be trimmed and suitably compacted. Where the same is low, the deficiency shall be corrected by scarifying the lower layer and adding fresh material and recompacting to the required density.

### **Maintenance**

The contractor shall be responsible for maintaining the earth work satisfactorily at his cost till finally accepted including making good any damages.

### **Excess excavation**

Any excess depth excavated below the specified levels shall be made good by dozing, grading and refilling with suitable material of similar characteristics to that removed and watered and compacted to achieve specified density.

### **Compaction**

Only the compaction equipment approved by the Engineer shall be employed to compact the different material types encountered during execution. Smooth wheeled, vibratory, pneumatic tyred, sheep foot or pad foot rollers etc. of suitable size and capacity as approved by the Engineer shall be used for the different types and grades of materials required to be compacted either individually or in suitable combinations.

The compaction shall be done with the help of vibratory roller of 8 to 10 tonne static weight with plain or pad foot drum or heavy pneumatic tyred roller of adequate capacity capable of achieving required compaction.

The contractor shall demonstrate the efficiency of the equipment he intends to use by carrying out compaction trials. The procedure to be adopted for these site trials shall first be submitted to the Engineer for approval.

Rollers of adequate capacity shall be used to achieve the required compaction by artificial watering and rolling. Subsequent layer shall be placed after each finished layer is approved. The level of compaction required is 90% of Standard Proctor Density for all areas except where Roads and Building works are to be provided. At such places the required compaction density of Standard Proctor shall be as given below :

Roads : 95%

**Buildings**

Top Layer : 98%

500 mm below top layer : 95%

Below 500 mm : 90%

The top layer of filling shall be brought to the specified line, levels and grade as shown in the drawings or as directed.

**2. TECHNICAL SPECIFICATION FOR CONCRETE WORKS**

This specification covers the general requirements for plain and reinforced cement concrete of different grades.

The requirements for concrete shall be materials, storage of materials, design of concrete mix, sampling and testing, form and formwork, construction joints, preparation and placement of concrete including batching, mixing, conveying, depositing and curing, finishing, grouting, inspection, clean-up etc. The concrete shall generally comply with the requirements of latest IS : 456.

Unless otherwise specified, the rates for all RCC will be exclusive of reinforcements. Reinforcements will be paid for separately. Unless otherwise specifically mentioned, the rates for all plain and RCC works shall be inclusive of formwork, centering and shuttering.

**MATERIALS :**

**Cement :**

Unless otherwise specified, ordinary Portland cement of 43 grade conforming to latest IS : 8112 shall be used for all concrete works. Test certificates from the manufacturers

to show that the cement brought by the contractor to site for use in the works fully complies with the relevant IS Specification shall be submitted to the Engineer at the Contractor's own cost. In addition, field test shall be conducted for every consignment of cement for the purpose of concrete design mix. Cement shall be stored and neatly packed in piles not exceeding 10 bags high in weather proof sheds with raised wooden plank flooring to prevent deterioration by dampness or intrusion of foreign matter. It shall be stored in such a way as to allow the removal and use of cement in chronological order of receipt, i.e. the first received being first used. Cement deteriorated and/or clotted shall not be used on work but shall be removed at once from the site. Daily record of cement received and consumed shall be maintained by the contractor in an approved form and a copy submitted to the Engineer once a week. Notwithstanding the above, the Engineer, for any reasons whatsoever, may at his discretion order to retest, the cement brought to site in an approved testing laboratory and fresh certificate of its soundness shall be produced at the Contractor's own cost. Cement ordered for retesting shall not be used for any work pending results of re-test.

**Aggregates :**

Fine and coarse aggregates shall conform to IS 383. If required, the aggregates shall be washed and screened. Sampling and testing shall be as per IS : 2386.

Each size of aggregate shall be stored on a separate platform and shall avoid mixing and contamination with foreign material. Segregated aggregates shall be rejected. Cost of stacking, washing, screening and cost of all tests, sampling etc. shall be borne by Contractor.

**Fine Aggregate :**

Sand shall conform to IS: 383. It shall pass through I.S sieve 4.75 mm (3/16 B.S) test seive, leaving a residue not more than 5%. It shall be from a natural source approved by the Engineer. It shall be washed if directed to reduce the percentage of deleterious substances to acceptable limits at Contractors own cost. Sand shall not contain any trace of salt and sand containing any trace of salt shall be rejected.

The fine aggregate for concrete shall be graded within limits as specified in IS : 383 and the fineness modules shall range between 2.60 to 3.20. The fine aggregate shall be stacked carefully on a clean hard dry surface so that it will not get mixed up with deleterious foreign materials. If such a surface is not available a platform of planks or corrugated sheets or brick floor or concrete floor shall be prepared.

IS Sieve Designation	Percentage Passing			
	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone Iv

10 mm	100	100	100	100
4.75	90 - 100	90 - 100	90 - 100	95 - 100
2.36	60 - 95	75 - 100	85 - 100	95 - 100
1.18	30 - 70	55 - 90	75 - 100	90 - 100
600 Micro n	15 - 34	35 - 59	60 - 79	80 - 100
300 Micro n	5 - 20	8 - 30	12 - 40	15 - 50
150 Micro n	0 - 10	0 - 10	0 - 10	0 - 15

**Coarse Aggregate :**

Coarse aggregate shall conform to IS : 383. It shall consist of crushed or broken stone, 95% of which shall be retained on 4.75 mm IS test sieve. It shall be obtained from crushed granite, trap, basalt or similar approved stones from approved quarry. Coarse aggregate shall be chemically inert when mixed with cement & shall be angular in shape and free from soft friable thin porous laminated or flaky pieces. It shall be free from dust and other foreign matter. Gravel/shingle of desired grading may be permitted as a substitute in part or full in plain cement concrete if the Engineer is otherwise satisfied about the quality of aggregate.

IS Sieve Designation	A					B			
	% Passing for single sized aggregate of nominal size					% Passing of graded aggregate of nominal size			
					0 mm				12.5 mm
80 mm					-				-

IS Sieve Designation	A					B			
	% Passing for single sized aggregate of nominal size					% Passing of graded aggregate of nominal size			
					0 mm				12.5 mm
63 mm					-				-
40 mm					-				-
20 mm					-				100
16 mm					-				-
12.5 mm					100				90 - 100
10 mm					85 - 100				40-85
4.75 mm					0-20				0-10
2.36 mm					0-5				-

Unless otherwise specifically stated for all RCC works, the size of coarse aggregate shall be 20 mm and down size.

**Water :**

Water used for mixing concrete and curing shall be potable quality, fresh, clean, free from oil, salts, acids, alkali and shall be in accordance with the clause 4.3 of IS 456. The contractor shall produce test results of water proposed to be used on the job for approval by the Engineer for the mixing before casting any concrete.

**Reinforcement :** Refer separate specification given elsewhere.

**Admixtures :**

The use of admixtures may be allowed only if approved by the Engineer and his decision in this regard shall be final.

**Concrete :**

Concrete shall be specified in various graded designations as M-10, M-15, M-20, M-25, M-30, M-40, M-45, M-50 etc. The letter 'M' refers to the mix and the number to the minimum compressive strength in N/Sq.mm to be established by 28 day of 15 cms works cube tests with the probability of not more than 1 test out of 10 falling below that minimum.

The proportions of ingredients for concrete shall be such that in addition to complying with the strength requirement, the concrete shall have adequate workability and proper consistency to permit it to be worked readily into the forms and around reinforcement,

under the conditions of placement to be employed without excessive segregation or bleeding.

All ingredients shall be proportioned and measured by weight using approved weigh-batching equipment. There shall be full field control of (1) predetermined grading of all aggregates that go into concrete (2) predetermined proportion of coarse aggregate, fine aggregate, cement and water for the required strength.

**Design Mix :**

The Contractor is responsible for the design of the concrete mix. The Contractor shall design the mix and submit for the approval of the Engineer. No concreting works shall be commenced without the approval of the design mix of concrete.

The Contractor shall make trial mixes using coarse aggregates, sand, water and cement actually available at site to be used for making concrete. Before making trial mixes all the ingredients shall be tested in the field laboratory and should conform to the relevant IS Specifications. Suitable proportions of sand and the several sizes of coarse aggregates for each grade of concrete shall be selected to give as nearly as practicable the maximum density, this is to be determined by mathematical means, laboratory tests, field trials or other means.

The minimum cement contents for design mix concrete of various grades shall be as per relevant IS 456:2000

The mix required to produce, place and compact the specified grade of concrete shall be designed by the Contractor. He shall carry out preliminary tests of specimen at his own cost at field laboratory as per IS : 456 and IS : 516 and he shall furnish to the Engineer a statement of proportions proposed to be used for various concrete mixes and grades of concrete for approval.

The minimum strength requirements shall be as follows :

Minimum compressive strength of 15 cm cubes at 7 days and 28 days after mixing, conducted in accordance with IS : 516.

<b>Grade of Concrete</b>	<b>Preliminary Test N/Sqmm</b>		<b>Work Test N/Sqmm</b>	
	<b>At 7 days</b>	<b>At 28 days</b>	<b>At 7 days</b>	<b>At 27 days</b>
	9.0	13.5	7.0	10

M -	17.5	26	13.5	20
10	22.0	32	17.0	25
M -				
20				
M -				
25				

Once a mix including water cement ratio has been determined and specified for use by the Engineer, that W/C ratio shall be maintained.

Details of design mix concrete approved by the Engineer shall be submitted to the Engineer for record along with the results of sieve analysis and such other tests on cement, aggregates and water etc. The approved design mix shall then be followed for subsequent concreting operations at site till a variation in some characteristics of any ingredient is observed or till a variation in the degree of quality control necessitates a change in the mix.

#### **Batching and Mixing of Concrete :**

All materials for controlled concrete shall be batched as per approved design mix in suitable weigh batcher of adequate capacity and of approved design. Mixers for concrete may be stationary mixers of either the tilting or non-tilting type, or truck mixers of approved design. Thorough mixing of the concrete is essential and mixers shall be capable of combining the materials into a uniform mixture, uniform colour and of discharging this mixture without segregation. The mixers should always be operated at the speed and time recommended by the makers. The mixers shall be maintained in satisfactory operating condition, and mixer drums shall be kept free of hardened concrete. The consistency of the concrete produced from the mixers should have sufficient workability to enable it to be well consolidated, to be worked into the corners of the shuttering and around the reinforcements.

The slump for concrete as determined by slump tests as per Indian Standard 1199 latest edition, shall not exceed the maximum slumps indicated below for each type of construction using high frequency vibration unless otherwise approved or directed by the Engineer.

The contractor shall not place concrete having a slump outside the limits specified without the approval of the Engineer.

Atleast one slump test shall be made for every compressive strength test carried out. More frequent tests shall be made if there is a distinct change in job conditions, or if required by the Engineer.

#### **Transporting :**



shall be conveyed from the place of mixing to the place of final deposit as rapidly as practicable by methods which will prevent segregation or loss of any of the ingredients. If segregation does occur during transport, the concrete shall be remixed before being placed. Normally not more than 30 minutes shall lapse between mixing and consolidation in position. All means of conveyance shall be adopted to deliver concrete of the required consistency and plasticity without segregation or loss of slump.

### **Concrete should be transported only by transit mixers**

#### **Placing :**

Method of placing shall be such as to preclude segregation and as far as practicable the placing shall be continuous. Special care shall be taken in accordance with latest IS : 456 while laying concrete under extreme weather.

Concrete shall be transported by transit mixers and placed in position without segregation. It is important that the concrete be placed in its final position before the cement reaches its initial set. The concrete should normally be compacted in its final position within 30 min. of leaving the mixer, and once compacted, it should not be disturbed. Before the concrete is actually placed in position, the insides of the forms should be inspected to see that they have been cleaned and oiled, care being taken to see that the reinforcements do not get contaminated. Temporary openings should be provided to facilitate inspection, especially at the bottom of columns, to permit the removal of all sawdust, wood shavings etc. Openings should be placed so that the water used to flush the forms will drain away. No water should be left in the forms. The concrete should be spread evenly in the form to avoid segregation and should completely fill all corners of the form work and the space between the reinforcement. Vibrator should not be used for spreading the concrete. Concreting should be carried on without interruption between predetermined construction joints.

#### **Compacting :**

The object of compacting concreting is to achieve maximum density. The concrete should therefore, be placed a little in excess of its specified depth so that after proper compaction its final desired depth is obtained. Manually rodding and tapping the concrete and tapping the form work on its external face shall be continuously carried out at the actual pouring head, while compacting the concrete with mechanical vibrators shall be done sufficient distance away from the pouring head, so that the vibrator is utilised only to compact the concrete and not to spread it. The Engineer may, however, at his absolute discretion, permit concreting by increasing the slump and correspondingly increasing the cement contents at contractor's cost. Except for shallow or inaccessible concrete the vibrator shall be penetrated vertically and at regular distance intervals, not at an angle and not at haphazard intervals. At corners, obstructions, embedded fixtures and congested reinforcement areas, the vibrators shall be manipulated with the utmost care and handled only by the most experienced workmen.

The number and type of vibrator to be used shall be subject to the approval of the Engineer and in general immersion type vibrators shall be used. Consolidation by using immersion vibrator will be in accordance with IS Code : 3558. Sufficient number of reserve vibrators in good working condition shall be kept on hand at all times, so as to ensure that there is no slacking of interruption in compacting.

**Protection of Concrete :**

All freshly placed concrete surfaces shall be protected from damages by workmen equipment or any other cause. The surface shall be protected from dry wind and direct sun rays. The Contractor shall provide and use, where directed by the Engineer enough tarpaulins or other suitable materials to cover completely or enclose all freshly finished concrete.

**Curing :**

As soon as the concrete is hardened sufficiently, it shall be cured by maintaining the concrete in a damp condition by application of wet sacking or other approved moisture retaining covering for a period of 28 days after placing the concrete. In floors curing should be carried out by ponding and covering with polythene sheets to reduce evaporation losses. Extreme care should be taken to ensure that all surfaces are kept in a moist condition and no local area shall be allowed to dry out intermittently. Curing shall be done with potable water free from sediments of any kind.

**Construction Joints :**

Construction joints in exposed concrete work shall be made only where shown on the drawings or directed by the Engineer and shall be in accordance with the details shown or approved by the Engineer. The procedure given in clause 20.1.4.2 of IS : 456 shall be followed for general guidance. All foreign matters shall be removed from the concrete before it is allowed to fully harden. The removal shall be effected by scrubbing the concrete surface with wire and with bristle brushes and washing down to expose clearly the aggregate. However care shall be taken to avoid dislodgment of particles of aggregate. If concrete has been allowed to harden excessively the surface shall be chipped over its whole surface and thereafter thoroughly washed. Before fresh concrete is added on the construction joints, the surface of the old concrete shall be thoroughly wetted and covered with a thin layer of cement mortar 1:1.

Construction joints in concrete floors and walls of basement, water tanks or any other structures in contact with water or earth, shall be provided with PVC water stops of approved make coated on either side with hot asphalt. The longitudinal joints, in water stops, shall preferably be not welded or overlapped atleast 200 mm.

**Sampling and strength test of concrete :**

Sampling and testing of concrete shall be conducted in accordance with the latest issue of Indian Standard 1199, 516 and 456.

During the progress of construction compression tests shall be made to determine whether the concrete being produced complies with the strength requirements specified. The test will be made in accordance with Indian Standard 516 latest edition.

The minimum frequency of sampling of concrete of each grade shall be in accordance with the following :

<b>Quantity of concrete in the work, Cum</b>	<b>Number of Samples</b>
1 - 5	1
6 - 15	2
16 - 30	3
31 - 50	4
51 and above	4 Plus one additional sample for each additional 50 Cum or part thereof

**NOTE :**

At least one sample shall be taken from each shift

A set of six specimens from random mixer batches, shall constitute a test, three being tested for 7 days and three being tested for 28 days strength.

The strength test result shall be the average strength of the three companion test specimens, tested at 28 days, except that, if one specimen in a test shows manifest evidence of improper sampling, moulding or testing the result shall be discarded and the remaining two strengths averaged. Separate procedures shall be established when cements other than Portland cement are used.

Normally, 7 day and 28 day tests shall be made on specimens. For any mix, a correlation between 7 day and 28 day strengths may be made in the laboratory. Soon after a job starts, a similar correlation will evolve for samples of concrete taken from the mixer. After that correlation has been established, the results of the 7 day tests may be used as an indicator of the compressive strengths which should be expected at 28 days, provided such results are consistent. If 7 day tests show compressive strengths that are too low, measures shall be taken at once, at the Engineer's direction, without waiting for the results of the 28 day tests.

A. The concrete shall be deemed to comply with the strength requirements if:

- a) every sample has a test strength not less than the characteristic value ; or
- b) the strength of one or more samples though less than the characteristic value, is in each case not less than the greater of ;
  - i) the characteristic strength minus 1.35 times the standard deviation; and
  - ii) 0.80 times the characteristic strength and the average strength of all the samples is not less than the characteristic strength plus

$$\left| \begin{array}{c} \bar{\phantom{x}} \\ | \\ 1.65 - \frac{\phantom{x}}{\text{number of samples}} \\ | \\ \underline{\phantom{x}} \end{array} \right| \begin{array}{l} \phantom{x} \\ \text{times the standard} \\ \text{deviation} \end{array}$$

B. The concrete shall be deemed not to comply with the strength requirements if :

- a) The strength of any samples is less than the greater of:
  - i. the characteristic strength minus 1.35 times the standard deviation and;
  - ii. 0.80 times the characteristic strength; or
- b) the average strength of all the samples is less than the characteristic strength plus

$$\left| \begin{array}{c} \bar{\phantom{x}} \\ | \\ 1.65 - \frac{\phantom{x}}{\text{number of samples}} \\ | \\ \underline{\phantom{x}} \end{array} \right| \begin{array}{l} \phantom{x} \\ \text{times the standard} \\ \text{deviation} \end{array}$$

C. Concrete which does not meet the strength requirements as specified in para (A) but has a strength greater than that required by para (B) may be accepted as being structurally adequate without further testing by the Engineer in consultation with designer.

In the event that concrete tested in accordance with the requirements of the above clause, fails to meet the specification, the Engineer shall have the right to require any one or all the following :

- a) Changes in the concrete mix proportions for the remainder of the work
- b) Coring and testing of the concrete represented by the tests which failed as per IS : 456.
- c) Load tests on part of structures as per IS : 456.
- d) Removal and replacement of any such portions of the structure.
- e) Extended curing of the concrete represented by the specimen.

The Contractor shall carryout all such measures as directed at his own expense, if the concrete cannot be accepted due to reasons attributable to the Contractor.

The unit rate of concrete shall be inclusive of all tests and remedial measures.

**FORM WORK :**

The formwork shall conform to the shapes, lines and dimensions for all the elements as shown on the drawing. The formwork shall be designed and constructed so that the concrete can be properly placed and thoroughly compacted to obtain the required shape, position and level subject to specified tolerances. The designed formwork arrangement shall be got approved by the Engineer. Approval of the proposed formwork by the Engineer will not diminish the Contractor's responsibility for the satisfactory performance of the formwork, nor for the safety and co-ordination of all operations.

Formwork for architectural shapes for columns, ring, beams, circular or spherical walls, shell roofs or bottoms in the case of water reservoirs or any other structure shall be made from approved wrought and put up timber or steel plates and frames.

The form work to be used shall be of an approved system type

Wooden props are strictly prohibited. Note that all RCC works are form finished. Any rectification's at Contractors Cost.

**Erection of Formwork :**

The following shall apply to all formwork.

1. The contractor shall obtain the approval of the Engineer for the design of forms and the type of material used before fabricating the forms.
2. All shutter planks and plates shall be adequately backed to the satisfaction of the Engineer by a sufficient number and size of walers or framework to ensure rigidity during concreting. All shutters shall be adequately strutted, braced and propped to the satisfaction of the Engineer to prevent deflection under deadweight of concrete and superimposed live load of workmen, materials and plant, and to withstand vibration and wind. No joints in props shall be allowed.
3. Vertical props shall be supported on wedges or other measures shall be taken where the props can be gently lowered vertically during removal of the formwork. Props for an upper storey shall be placed directly over those in the storey immediately below and the lowest props shall bear on a sufficiently strong area.
4. Care shall be taken that all formwork is set plumb and true to line and level or camber or batter where required and as specified by the Engineer.

5. If formwork is held together by bolts or wires, these shall be so fixed that no iron will be exposed on surface against which concrete is to be laid. In any case wires shall not be used with exposed concrete formwork. The Engineer may at his discretion allow the Contractor to use tie-bolts running through the concrete and the Contractor shall decide the location and size of such tie-bolts in consultation with the Engineer. Holes left in the concrete by these tie-bolts shall be filled as specified by the Engineer at no extra cost. No through tie will be permitted in all cases where water is likely to be retained and gas tightness of the structure is to be ensured.

6. Provision shall be made in the shuttering for beams, columns and walls for a port hole of convenient size so that all extraneous materials that may be collected could be removed just prior to concreting.

7. Formwork shall be arranged as to permit removal of forms without jarring the concrete. Wedges, clamps and bolts shall be used wherever practicable instead of nails.

8. An approved mould oil or other material shall be applied to faces of formwork in contact with the wet concrete to prevent adherence of concrete. The use of oil which darkens the surface of the concrete shall not be allowed. Oiling shall be done before reinforcement has been placed and care shall be taken that no oil comes in contact with the reinforcement while it is being placed in position. The formwork shall be kept thoroughly wet during concreting and the whole time that it is left in place.

9. Formwork for beams and slabs shall be so erected that the shuttering on the side of the beams and soffits of slabs can be removed without disturbing the beam bottoms.

Immediately before concreting is commenced, the formwork shall be carefully examined to ensure the following :

- a) Removal of all dirt, shavings, sawdust and other refuse by brushing and washing.
- b) The tightness of joints between panels of sheathing and between these and any hardened core.
- c) The correct location of tie bars, bracing and spacers, and especially connections of bracing.
- c) That all wedges are secured and firm in position.
- d) That provision is made for traffic on formwork not to bear directly on reinforcing steel.

The Contractor shall obtain the Engineer's approval for dimensional accuracies of the work and for the general arrangement of propping and bracing. It is imperative that for scaffolding heights of 3.6 M and above, timber posts or steel scaffolding be used with

adequate bracings in horizontal and vertical planes. The Contractor shall be entirely responsible for the adequacy of propping and for keeping the wedges and other locking arrangements undisturbed through the decentering period.

Formwork shall be continuously watched during the process of concreting. If during concreting any weakness develops and formwork shows any distress the work shall be stopped and remedial action taken.

**Exposed Concrete Work :**

Exposed concrete surfaces shall be smooth and even, originally as stripped without any finishing or rendering. Where directed by the Engineer, the surface shall be rubbed with carborundum stone immediately on striking the forms. The Contractor shall exercise special care and supervision of formwork and concreting to ensure that the cast members are made true to their sizes, shapes and positions and to produce the surface patterns desired. No honeycombing shall be allowed. Honeycombed parts of the concrete shall be removed by the Contractor as directed by the Engineer and fresh concrete placed without extra cost, as instructed by the Engineer.

All materials, sizes and layouts of formwork including the locations for their joints shall have the prior approval of the Engineer.

**Camber :**

Forms and falsework shall be generally cambered as indicated in the drawings or as instructed by the Engineer. However, for beams upto 5 M span and slabs upto 4 M span camber is not normally required to be provided.

**Age of Concrete at removal of formwork :**

Unless otherwise permitted in writing by the Engineer, the minimum period of keeping formwork in position after concreting the members in normal circumstances and where ordinary portland is used shall conform to the Indian Standard

Specifications and shall be as follows :

- |    |   |   |
|----|---|---|
| a) | Walls, columns and vertical faces of all structural members | 24 to 48 hours as may be decided by the Engineer. |
| b) | Slabs (props left under)                                    | 3 days  |
| c) | Beam soffits (props left under)                             | 7 days  |
| d) | Removal of props under slabs :                              |   |
|    | i. Spanning up to 4.5 m                                     | 7 days  |
|    | ii. Spanning over 4.5 m                                     | 14 days   |
| e) | Removal of props under beams                                |   |

and arches

- |     |                    |         |
|-----|--------------------|---------|
| i.  | Spanning up to 6 m | 14 days |
| ii. | Spanning over 6 m  | 21 days |

For other cements, the stripping time recommended for ordinary Portland cement may be suitably modified.

The Engineer may vary the above period if he considers it necessary. Immediately after the forms are removed, they shall be cleaned with a jet of water and a soft brush.

**Stripping of Formwork :**

Formwork shall be removed carefully without jarring the concrete, and shall be eased off carefully in order to allow the structure to take up its load gradually and curing of the concrete shall be commenced immediately. Immediately after the shuttering is removed, all the defective areas such as honeycombed surfaces, rough patches, holes left by form bolts etc. shall be brought to the notice of Engineer who may permit patching of the defective areas or reject the concrete work. Rejected concrete shall be removed then replaced by Contractor at his own cost. After removing loose materials, the surface shall be prepared and saturated with water for 24 hours before patching is done with 1:1.5 CM. The use of epoxy for bonding fresh concrete shall be carried out as directed by Engineer. Concrete surfaces to be exposed shall, where required by the Engineer, be rubbed down with carborundum stone to obtain a smooth and even finish. Where the concrete requires plastering or other finish later the concrete surface shall be immediately hacked lightly all over as directed by the Engineer. No extra charge will be allowed to the Contractor for such work on concrete surfaces after removal of forms.

In the case of folded plates and shell roofs the contractors should take approval for the pattern of centering and shuttering along with programme for deshuttering.

**Repropping :**

For multistoried buildings the floors may need repropping to support the loads of the upper floors under construction. The extent of such repropping shall be as directed by the Engineer. Such repropping shall not be paid for separately and the cost of such repropping shall be deemed to have been included in the Contractor's rates.

**Reuse of Forms :**

The Engineer may in his absolute discretion order rejection of any forms he considers unfit for use for a particular item, and order removal from the site of any forms he considers unfit for use in the works.

**Hacking-out :**



1. Immediately after removal of forms, the concrete surfaces to be plastered shall be roughened with a brush-hammer or with chisel and hammer as directed by the Engineer to make the surfaces sufficiently coarse and rough to provide a key for plaster.

This shall not be paid for separately and shall be deemed to have been included in the Contractor's rates.

2. No payment shall be made for temporary formwork used in concreting, nor for formwork required for joints or bulkheads, in floors, or elsewhere, whether such joints are to be covered later with concrete or mastic or other material.

**Inspection :**

All materials, workmanship and finished construction shall be subject to the continuous inspection and approval of Engineer. Materials rejected shall be replaced by Contractor immediately at his own cost.

**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.

**PRECAST CONCRETE :**

All precast concrete shall be cast over vibrating tables or by using form vibrators. Exposed surfaces of precast members shall be finished as called for on the drawings. All jointing surfaces shall be wire brushed and hosed down until the aggregate is free from cement slurry. Castellations shall be provided wherever called for. Leave grouting holes, grooves, inserts, projections, reinforcements, lifting hooks, etc., to conform to the erection procedure. All edges and delicate projections likely to be damaged during handling and erection shall be protected by means of wooden cover fillets, until placed in position.

**MATERIALS :**

The materials used for the construction shall conform to IS- 456 latest.

**MOULD :**

The mould used for manufacturing precast components normally consist of two parts, (a) bottom mould, and (b) side moulds. The bottom mould can be made out of timber, masonry, concrete, steel, FRP, plastic or any other material acceptable to the Engineer. The side moulds similarly can be of timber, steel, FRP, or plastic. When using masonry or concrete moulds, the top surface shall be finished to the required accuracy and made smooth.

In case of masonry moulds, the use of chicken mesh or fibre reinforcements in the top surface will help in making the mould last longer for higher efficiency.

In the case of cored units the voids can be created either by an extrusion process, by inflated tubes, Mild steel tubes, timber, cardboard / hard paper or any other materials.

The castellations / depressions / roughening of required depth shall be provided in the sides of the precast units. Suitable provisions in the side shutters of the mould may create better keying between in situ concrete and precast concrete units at the joints.

#### **REINFORCEMENT COVER :**

Minimum cover for the reinforcement for precast units shall be as follows ;

- a) For reinforcement in the flange, 12 mm clear in all directions. This shall be increased to 15 mm when surfaces of precast members are exposed to corrosive atmosphere and
- b) For main reinforcement in the rib, 20 mm or diameter of bar whichever is greater. In case of corrosive atmosphere, this shall be increased to 25 mm, or diameter of bar, whichever is greater.

It shall be ensured that the reinforcement cages are not in any way distorted during storage, handling, placement and casting. In the case of mass production in large precasting factories, the use of reinforcement ladders and mesh made by using a resistant welding machine will be advantageous for improving production.

#### **CONCRETE :**

The concrete mix used shall be minimum of M-15 grade in accordance with IS: 456 latest but M 25 and above grade of concrete is preferred for reinforced concrete units. The concrete mix as specified in the drawings shall be used for respective units in accordance with IS: 456 latest.

#### **CASTING & CURING OF UNITS :**

Mechanical vibration either through mould/table vibrators or screed vibrators is essential to ensure good compaction. Needle vibrators can be used for compacting concrete in the ribs and screed vibrators for compacting concrete in the flange. For larger factories, concrete placing machine, which level, vibrate and finish the concrete units can be advantageously utilized for this purpose.

Curing shall be done as per IS 456 latest. If necessary, low pressure steam curing may be provided to get early stripping / release strength.

#### **SAMPLING AND TESTING OF UNITS**

##### **Sampling :**

Sampling shall be done in accordance with latest load test : Load tests shall be carried out in accordance with IS 456 latest. All the units passing the load test can be used in the constructions.

## **TRANSPORTATION AND ERECTION OF PRECAST ELEMENTS :**

### **Lifting Hooks**

Wherever lifting hooks / holes are used these shall be provided at structurally advantageous points (for example, 1/5 of the length from the end of the element) to facilitate demoulding and erection of the precast unit. The lifting hooks can be formed out of normal Mild steel reinforcing bars with adequate carrying capacity to carry the self weight during demoulding, handling and erection. After erection, the hooks can either be cut or bent down inside the screed or joint concrete that will be laid subsequently.

Lifting and removal of precast units shall be undertaken without causing shock, vibration or undue bending stress to or in the units. Lifting and handling positions should conform to the Engineers directions.

### **Stacking of Units**

After removal from moulds the precast units shall be stacked over supports placed at about 1/6 of span from ends. Care shall be taken to see that no support is placed at the centre of span. Care also shall be taken to see that the main reinforcement is always at the bottom of stacked units.

### **TRANSPORTATION :**

The units shall be transported always with the main reinforcement at the bottom. For transporting and erecting the units, rope slings shall be tied near the ends at 1/5 of the length from either end of the unit. In case the units are transported in trolleys, the over-hang of the units from the trolley shall not be more than 1/5 of the length. The unit shall be lifted manually or with the help of chain pulley blocks or mechanically with a hoist or a crane.

### **PLACING AND ALIGNING :**

The units shall be placed and aligned side by side across the span to be covered. While placing the units, care shall be taken to see that they have the specified bearing on supporting wall / beam. Placing of units shall be started from one end of the building.

### **BEARING :**

The precast units shall have a minimum bearing of 75 mm on the beams and 100 mm on the conventional masonry wall.

### **CURING OF IN SITU CONCRETE IN JOINTS :**

The in situ concrete in the joint shall be cured for at least 7 days in accordance with IS 456 latest. The concrete shall then be allowed to dry for at least a week. A coat of cement slurry may be applied to the joints to fill the hairline cracks that might have developed. Joints shall be finished as specified in the drawings.

**FIXTURES :**

Designers shall indicate provisions for fixtures like fan hooks / inserts / electric conduits, etc., to be incorporated within the precast units or the in situ joints / screed concrete.

In case of concealed wiring, conduits may be placed within the joints along the length or within the screed before concreting. If adequate thickness is available this may be concealed within the floor / roof finish.

Holes, openings and fixtures required to be provided within the precast units shall be fixed accurately with adequate embedment at the precasting stage. Drilling of holes / cutting of edges shall not be made unless permitted by the Engineer.

**DEFECTS IN CONCRETE :**

Immediately on removal of form work, the surface of the concrete shall be examined by the contractor and any honeycombs or other imperfections shall be brought to the notice of the Engineer. The acceptability or otherwise of such defective concrete shall be at the sole discretion of the Engineer who may direct the contractor to repair the defective work or ask for demolition and replacement of such defective work at the risk and cost of the contractor.

**PROTECTION OF CONCRETE :**

All concrete shall be protected from damage by workmen, equipment, overload or any other cause. All edges, corners and projections of concrete members likely to be damaged shall be protected by means of cover fillets or as directed by the Engineer.

**EQUIPMENT FOUNDATION :**

The contractor shall provide concrete foundations for the various equipments in accordance with the drawings. All concrete for equipment foundations shall be of specified grade as per drawing. Bolts, inserts and other anchoring features shall be left in their correctly assigned position to templates prepared for this purpose at the time of casting. Where it is not possible to leave bolts, etc., in position, pockets of suitable sizes shall be left in the concrete foundations to receive the bolts. Pockets shall be formed by suitable form work as directed by the Engineer. Bolts shall be grouted by expanding cement mortar, non-shrink grouting compound and finished neat.

It is essential that the Engineer who is in-charge of the construction of all concrete work, whether plain or reinforced shall be well experienced in this class of work and shall superintend personally the whole construction and pay special attention to:-

- a) Quality Control in respect of selection of materials, proportioning and mixing, etc.

- b) Placing and consolidation of concrete.
- c) Accuracy in cutting, bending, placing and binding of reinforcement.
- d) Accuracy in fabrication, assembly and erection of form work.
- e) Casting, handling, transportation and erection of precast members.

### 3. TECHNICAL SPECIFICATION FOR STEEL REINFORCEMENT

This specification covers the general requirements of steel reinforcement.

Steel reinforcement shall be either mild steel of tested quality high yield strength deformed bars of grade Fe-500D conforming to IS:1786 or as called for on the drawings. Fabric reinforcement where called for shall be of hard drawn mild steel wire mesh conforming to IS:1566. Bars shall be free from deleterious materials, mill scale, loose rust, oil or paint.

The contractor shall submit bar bending schedules for approval of the Engineer prior to commencement of fabrication. These shall indicate the accurate dimensions and bending of bars as called for on the structural drawings. Fabrication shall be accurately done to the dimensions, spacing and ensuring minimum cover as called for on structural drawings.

All reinforcing steel within the limit of a day's pour shall be in place and firmly wired at least one day prior to the date of pour to permit inspection. The contractor shall also ensure that all conduits, embedments and inserts are in position before placing concrete.

#### **Bending :**

All reinforcement bars shall be made straight before bending. Bars shall be bent cold gradually by machine or other approved means without the use of heat. Bars having cracks or splits on the bends shall be rejected. Bars incorrectly bent once shall not be used without the approval of the Engineer.

The Contractor shall prepare bar bending schedules as per details given in IS 2502 and get them approved before proceeding with cutting and bending of bars.

All bars shall be carefully and accurately bent by the Contractor in accordance with the drawings and special care shall be taken such that :

- a) the depth of the crank is correct as per the drawing or the Bar Cutting and Bending Schedule.

- b) the rods are placed in exact positions. The bars should not be bent or straightened in any manner that will injure the material
- c) hooks where indicated shall be either a complete semi-circular turn with a radius of not less than four and not more than six bars diameters, plus an extension of atleast four bar diameters at the free end, or a 90 degree bend having a radius of not less than 4 bar diameters plus an extension of 12 bar diameters, as shown or implied on the drawings.

No reinforcement shall be bent when in position in the works without approval whether or not it is partially embedded in hardened concrete.

**Lapping :**

As far as possible bars of maximum length available shall be used.

Unless otherwise specified or shown on the drawings, all laps shall be 50 times the diameter of bar. Not more than 33% (Thirty Three Percent) of the bars shall have lapped joints at the same location.

**Welding :**

Only where specifically shown on the drawings, reinforcement shall have welded joints.

All welding shall be carried in accordance with IS : 2751. Only qualified welders shall be permitted to carry out such welding.

The welding procedure shall be approved by the Engineer and tests shall be made to prove the soundness of the welded connection.

Rate quoted for steel reinforcement work shall be deemed to include the cost of such weldings wherever specified.

**Cleaning, Placing and Fastening :**

All reinforcement shall be cleaned to remove loose mill scale, loose rust, oil and grease or any other harmful matter immediately before placing the concrete. Dowel bars will be provided where shown on drawing or where required.

All steel reinforcement shall be accurately placed in position shown on the drawing tied with 18 gauge GI annealed steelwire and firmly held during the placing and setting of concrete.

The vertical distance required between successive layers of bars shall be maintained by providing space bars, inserted at such intervals that main bars do not perceptibly sag between adjacent space bars.

### **COVER FOR REINFORCEMENT :**

Reinforcement shall have cover as shown on the structural drawings and where not specified the thickness of cover shall be as follows.

- a) At each end of reinforcing bar not less than 25 mm. nor 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 20 cm. or under whose reinforcing bars do not exceed 13 mm., the cover 25 mm shall 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 13 mm., nor less than the diameter of such reinforcement.
- e) For any other reinforcement not less than 13 mm., nor less than diameter of such reinforcement. For giving the necessary covers, concrete cover blocks of same strength of concrete proposed for the structure shall be used. All cover blocks shall be secured firmly so that they are not disturbed during compaction.

## **4. TECHNICAL SPECIFICATION FOR WATER PROOFING WORK**

### **SCOPE**

This specification covers the general requirements for water proofing to the underground structure, machinery foundation, pits, trenches, lift pits, roof slab, toilet sunken slab etc.

### **GENERAL REQUIREMENTS**

Waterproofing treatment shall be done with waterproofing materials of approved reputed manufacturers and applied by specialist firms with long experience in the particular trade and proven track record.

The Contractor shall furnish all skilled and unskilled labour, plant, tools, tackle, equipment, men, materials required for complete execution of the work in accordance with the drawings and as described herein and/or as directed by the Engineer.

The Contractor shall strictly follow, at all stages of work, the stipulations contained in the Indian Standard Safety Code and the provisions of the Safety Rules as specified in the General Conditions of the Contract for ensuring safety of men and materials.

Any approval, instructions, permission, checking, review etc. whatsoever by the Engineer shall not relieve the Contractor of his responsibility and obligation regarding adequacy, correctness, completeness, safety, strength, workmanship etc.

The treatment shall include both external and internal type at different stages of execution involving various operations of preparation, application and induction of chemicals as water proof barrier in order of sequence.

The treatment shall be done as per the specifications and instructions of manufacturers including cost of all materials all leads and lifts, cleaning, scaffolding, curing, conducting, leakage test etc.

**All spaces underneath the tiered seating completely watertight and designed as habitable spaces**

### **CODES AND STANDARDS**

The applicable Indian Standard and Code is given below :

IS : 2645 : Integral cement water proofing compounds.  
IS : 9103 : Admixtures for Concrete

### **MATERIALS**

Cement : Ordinary Portland cement of 43 Grade conforming to IS : 8112 shall be used.  
Coarse Aggregate : Coarse aggregate shall conform to IS:383  
Sand : Sand shall conform to IS : 383, IS :1542 and IS :2116  
Water : Water shall conform to IS : 456.  
Water Proofing : Waterproofing compound shall conform to IS:2645 Compound

### **SURFACE PREPARATION**

The surface to receive the waterproofing shall be cleaned of all dust, dirt, loose material, debris, mortar droppings, laitance, oil, grease or any other form of foreign matter which might affect adhesion and left in a saturated, surface dried condition and approval of Engineer taken before starting the work. The surface to be treated in underground structures shall be kept dry by continuous pumping of water.

The surface preparation shall be done as per specification and instructions of the manufacturer.

### **DIFFERENT STAGES OF TREATMENT TO UNDERGROUND STRUCTURES**

**Treatment on PCC levelling course :**

Treatment on the top surface of PCC levelling course before casting of base slab :



After laying of PCC to proper level and line, the surface shall be cured for the required period.

The PCC surface shall be prepared as described above and kept dry by continuous pumping of water.

12 mm thick plaster with cement sand mortar (1:3) admixed with approved normal setting integral cement water proofing compound like **CICO No.1 – (Normal Setting Integral Waterproofing Compound) Conforming to IS : 2645** @ 2% by weight of cement, or approved equivalent at the rate specified by the manufacturer shall be laid on top of the PCC surface as per specifications and instructions of the manufacturer. The plaster shall be finished smooth with a steel trowel and cured for 1 day.

The plastered surface shall then be coated with two (2) coats of **TAPECRETE – Acrylic Polymer modified cementitious coating**, or approved equivalent as per manufacturer's specification and instructions. The coating shall be cured with water for 1 day.

The surface shall then be covered with another 12 mm thick plaster as described under clause (c) above. The treated surface shall be cured for 5 days.

Base slab concrete admixed with **CICO No.1 (Normal Setting Integral Waterproofing Compound) Conforming to IS : 2645** or **CICO SUPAPLAST Super Plasticiser-cum-High Range Water Reducing Admixture-Cum-Waterproofer conforming to IS : 9103 as Plasticiser and IS : 2645 as Integral Waterproofer** as per recommended dosage or approved equivalent shall be laid over this treated surface.

**Note :**

Applicable to PCC levelling course below base slab of under ground sump, under ground structure, lift pit, machinery foundations, trenches etc.

**Chemical injection treatment to base slab :**

**Chemical injection treatment in the form of pressure grouting to the concrete mass of base slab :**

The treatment shall be as per manufacturers specification adopting following general operation details :

After casting of base slab and side wall, the surface shall be cured as per the standard practice.

18 mm dia. holes shall be drilled on top of base slab to required depth using pneumatic hammer drill in grid pattern at a spacing not exceeding 1 M centre to centre. Particular care should be taken to drill holes and fix nozzles along the construction joint line wherever it occurs and on other vulnerable areas.

The depth of nozzles shall be adequate to push the grout at all depth. GI nozzles shall be fixed in the holes drilled using single component rapid setting mortar like CICO No.3, or approved equivalent.

Cement slurry mixed with grout admixture like **CICO Non-Shrink Polymer Waterproof Grouting Compound** at 2% by weight of cement or approved equivalent as per specification and instruction of the manufacturer shall be prepared to the required consistency.

The prepared slurry shall be injected through the prefixed nozzles under pressure using grout pump to fill all possible pores and gaps left within the concrete mass. When the flow of the grout stops the grout mains shall be disconnected.

The GI nozzles shall be sealed off with single component rapid setting mortar like **CICO NO. 3**, or approved equivalent after the injection operation is over.

The grout holes shall then be finished after cutting the projected nozzles.

**Note :**

Applicable to base slab of underground sump, underground structure, pile and pipe cap, lift pit, trenches etc.

**Treatment to side wall**

**Treatment to side wall from exterior surface**

Casting of RCC walls shall be done with specified grade of concrete admixed with **CICO No.1 (Normal Setting Integral Waterproofing Compound) Conforming to IS : 2645** or **CICO SUPAPLAST Super Plasticiser-cum-High Range Water Reducing Admixture-Cum-Waterproof conforming to IS : 9103 as Plasticiser and IS : 2645 as Integral Waterproofing** as per recommended dosage or approved equivalent, shall be laid over this treated surface.

After casting of side wall to the required height, the surface shall be cured as per the standard practice.

Chemical injection treatment in the form of pressure grouting shall be done as given below :

18 mm dia. holes shall be drilled on exterior surface of wall to required depth using pneumatic hammer drill in grid pattern at a spacing not exceeding 1 M centre to centre. Particular care should be taken to drill holes and fix nozzles along the construction joint line wherever it occurs and on other vulnerable areas.

The depth of nozzles shall be adequate to push the grout at all depth. GI nozzles shall be fixed in the holes drilled using single component rapid setting mortar like CICO No.3, or approved equivalent.

Cement slurry mixed with grout admixture like **CICO Non-Shrink Polymer Waterproof Grouting Compound** at 2% by weight of cement or approved equivalent as per specification and instruction of the manufacturer shall be prepared to the required consistency.

The prepared slurry shall be injected through the prefixed nozzles under pressure using grout pump to fill all possible pores and gaps left within the concrete mass. When the flow of the grout stops the grout mains shall be disconnected.

The GI nozzles shall be sealed off with single component rapid setting mortar like **CICO NO. 3**, or approved equivalent after the injection operation is over.

The grout holes shall then be finished after cutting the projected nozzles.

The outside surface of wall shall be prepared as described under head "Surface Preparation" after the chemical injection treatment is over.

The prepared exterior surface shall be coated (2 coats) with **TAPECRETE – Acrylic Polymer modified cementitious coating**, or approved equivalent as per Manufacturer's Specification and instructions. The surface shall be cured with water for 1 day.

On top of the coating a 12 mm thick plaster with cement sand mortar (1:3) admixed with **CICO NO. 1 – Normal Setting Integral Waterproofing Compound conforming to IS : 2645**, or approved equivalent at the rate specified by the manufacturer shall be applied as per specifications and instructions of the manufacturer. The plaster shall be finished smooth with a steel trowel and cured for 5 days.

In case of nil accessibility owing to constructional hazards, etc. the interior surface of wall may be treated as mentioned above to produce same effect.

**Note :**

Applicable to side walls of underground sump, underground structure, trenches and retaining wall. In the case of underground sump interior surface of walls shall be treated.

**GUARANTEE**

Guarantee for watertight performance of the structure for a minimum period of 10 years from the date of completion shall be given in the prescribed form given below. This guarantee shall be in legal paper in an acceptable form. The guarantee shall be enforceable by the Owner. If, during the guarantee period, water leaks are noticed in the structure from the portions treated by the Contractor, the same shall be rectified when called upon immediately, all at no extra cost to the entire satisfaction of the Owner.

### **III FOOTBALL GROUND (ARTIFICIAL TURF)**

#### **FOOTBALL TURF**

Football Turf with UV resistant from America, Europe and Australian region only conforming to FIFA Quality Standard as per their latest Technical Specification FIFA 15 , including SBR Rubber granules as per manufacture's recommended quantities , unloading and staging of rolls, sewing and levelling equipment, brushing of fibres with all Polly hydraulic controlled equipment , painting of any lines with approved Synthetic turf paint.

#### IV APPROVED MAKES OF MATERIAL

##### APPROVED MAKES OF MATERIAL

Acceptable makes of materials to be used in the work are enclosed. In case of non- availability of these makes, after the approval of the Authority, the Contractor can use the alternative makes only BIS marked materials. Non BIS marked materials may be permitted by the Authority only when BIS marked materials are not manufactured

<b>SR. NO.</b>	<b>NAME OF ITEM</b>	<b>MAKE APPROVED</b>
1)	ORDINARY PORTLAND CEMENT GRADE 43/53	BIRLA, JK, ACC, ULTRATECH, JAYPEE, AMBUJA,
2)	WHITE CEMENT	JK, BIRLA, ACC, JAYPEE, AMBUJA
3)	REINFORCEMENT STEEL	TATA , SAIL, RINL, JINDAL, JSW STEEL, SHYAM STEEL
4)	PAINT/POLISH/ PRIMER/ WATER PROOFING PAINT	BERGER, ASIAN, DULUX, BRITISH PAINT
5)	SILICON / POLYURETHANE SEALANT	FOSROC / G.E. SILICONES / DOW-CORNING,/ WACHER SILICON, /HOLEX,/ DECOT, SIKA / CHOKSEY CHEMICALS
6)	PVC PIPE FOR WEEP HOLES	PRINCE, SUPREME, FINOLEX
7)	CONCRETE ADMIXTURES, OTHER CONSTRUCTION CHEMICALS	M.C.BAUCHEMIE,FOSROC,P IDILITE,CICO,SIKA,BASF,AS IAN LABORATORIES,ULTRACON
8)	STRUCTURAL STEEL/MS	TATA , SAIL, RINL, JINDAL, JSW STEEL, SRMB
9)	WATERPROOFING CHEMICALS/SYSTEM	BASF,SIKA,FOSROC,PIDLIE, CARLISLE,FIRE STONE
10)	RHS/SHS CLOSED STRUCTURAL	SAIL/TISCO / RINL /JSW

11)	SHUTTERING PLY	ARCHID,CENTURY,MERINO ,KITPLY
12)	BRICKS	CLAY BRICKS,FLY ASH BRICKS
13)	COVER BLOCKS	FACTORY MADE CONCRETE COVER BLOCKS (ASTRA MAKE).
14)	READY MIX CONCRETE (RMC)	THE RMC SHALL BE PROCURED FROM THE SOURCE AS APPROVED BY ENGINEER – IN CHARGE.
15)	FOOTBALL TURF	DOMO/PLAYRITE/EQUIVAL ENT