



V2-S2&S3&S4-4
ATTACHMENT-4 CONCRETE AND
ALLIED WORKS



1. SCOPE

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

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

2. APPLICABLE CODES AND SPECIFICATIONS

The pertinent clauses of the following Indian Codes, Standards and Specification shall apply to the material and workmanship covered by this specification. In the event of the conflict of certain requirements between this specification and the codes referred herein, this specification shall govern.

The codes and standards mentioned herein shall be latest as on the day of award of contract of the works unless otherwise specified. Bidder shall be responsible to inform to the Consultant/ Owner in case of any revisions/re-affirm/amendment in the relevant codes and standards after the date of award of contract within 30 days of the issue of such revision/re-affirm/amendment of the code/ standard. Consultant/ Owner may approve use of the earlier code/ standard if the revisions do not materially affect the statutory requirements of the project or does not impact safety practices.

It is not the intent to specify herein all the codes and standards required for the satisfactory completion of work. The list of codes and standards indicates certain primary codes and standards and not all the codes required for the work under the contract. It is understood that all the pertinent codes and standards shall form the part of this specification whether explicitly indicated or not. Indian Standards shall be

supplemented by International Standards for clarity and coverage wherever felt so.

2.1 MATERIALS

IS 455	Specification for Portland Slag Cement.
IS 1489: PART 1:	Portland pozzolana cement - specification part 1 fly ash based
IS 1489: PART 2:	Portland pozzolana cement - specification part 2 calcined clay based (fourth revision)
IS 269	Ordinary Portland Cement- Specification
IS 12330	Specification for Sulphate Resisting Portland Cement
IS 383	Coarse and fine aggregate for concrete - specification (third revision)
IS 432	Specification for Mild Steel and Medium Tensile Steel Bars and Hand Drawn Steel Wire for Concrete Reinforcement – Part 1 and 2
IS 1786	High strength deformed steel bars and wires for concrete reinforcement - specification
IS 1566	Specification for hard-drawn steel wire fabric for concrete reinforcement
IS 9103	Concrete admixtures - specification
IS 2645	Integral waterproofing compounds for cement mortar and concrete - specification
IS 4990	Plywood for concrete shuttering work - specification
IS 4926	Ready-mixed concrete - code of practice
IS 8041	Specification for rapid hardening cement.
IS 12600	–Specification for Low Heat Portland Cement
IS 6909	Specification for super-sulphated cement
IS 12089	Specification for granulated slag for manufacture of portland slag cement

2.2 MATERIAL TESTING

IS 4031 (Part 1 to 15)	Methods of physical tests for hydraulic cement
IS 4032	Method of chemical analysis of hydraulic cement.
IS 650	Specification for standard sand for testing of cement.
IS 2430	Methods for sampling of aggregates for concrete.
DIN EN 12620	Aggregates for concrete (Refer Note).
IS 2386	Methods of test for aggregates for concrete (Parts 1 to 8)
IS 3025 (Part 1 to 51)	Methods of sampling and test (physical and chemical) for water and wastewater
Is 6925	METHODS OF TEST FOR DETERMINATION OF WATER-SOLUBLE CHLORIDES IN CONCRETE ADMIXTURES

NOTE: These tests are optional and shall be carried out by the Bidder at his cost, if directed by ENGINEER.

2.3 MATERIAL STORAGE

IS 4082	Recommendations on stacking and storage of construction materials and components at site.
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2.4 CONCRETE MIX DESIGN

IS 10262	Concrete mix proportioning-guidelines
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2.5 CONCRETE TESTING

IS 1199	Method of sampling and analysis of concrete.
IS 516	Method of test for strength of concrete.
IS 9013	Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.
IS 8142	Method of test for determining setting time of concrete by penetration resistance.
IS 9284	Method of test for abrasion resistance of concrete.
IS 2770 (Part 1	Methods of testing bond in reinforced concrete: Part 1 Pull-out test

2.6 EQUIPMENT

IS 4925	Specification for concrete batching and mixing plant.
IS 7251	Specification for concrete finishers.

IS 2750	Specifications for steel scaffoldings.
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2.7 CODES OF PRACTICE

IS: 456	Plain and reinforced concrete - code of practice.
IS: 457	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
IS 3370 (Part 1	Concrete structures for storage of liquids - code of practice - part 1 : general requirements
IS 3370 (Part 2	Concrete structures for storage of liquids - code of practice - part 2 : reinforced concrete structures
IS 3370 (Part 3	Code of practice for concrete structures for the storage of liquids: part 3 prestressed concrete structures
IS 3370 (Part 4	Code of practice for concrete structures for the storage of liquids: part 4 design tables
IS 3935	Code of practice for composite construction.
IS 2204	Code of practice for construction of reinforced concrete shell roof.
IS 2210	Criteria for the design of reinforced concrete shell structures and folded plates.
IS 2502	Code of practice for bending and fixing of bars for concrete reinforcement.
IS 5525	Recommendation for detailing of reinforcement in reinforced concrete works.
IS 2751	Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.
IS 9417	Welding of high strength steel bars for reinforced concrete construction-recommendations
IS 3558	Code of practice for use of immersion vibrators for consolidating concrete.
IS 3414	Code of practice for design and installation of joints in buildings.
IS 4326	Earthquake resistant design and construction of buildings - code of practice
IS 4014 (Part 1	Code of practice for steel tubular scaffolding Part 1 Definitions and materials

IS 4014 (Part 2	Code of practice for steel tubular scaffolding: Part 2 Safety regulations for scaffolding (first revision)
IS 2571	Code of practice for laying in situ cement concrete flooring
IS 7861 (Part 1	Code of practice for extreme weather concreting: Part 1 Recommended practice for hot weather concreting
IS 7861 (Part 2	Code of practice for extreme weather concreting: Part 2 Recommended practice for cold weather concreting
IS 3812 (Part 1	Pulverized fuel ash – Part 1 – For use as pozzolana in cement, cement mortar and concrete
IS 15388	Specification for Silica Fume

2.8 CONSTRUCTION SAFETY

IS 3696 (Part 1	Safety code of scaffolds and ladders: Part 1 Scaffolds (first revision)
IS 3696 (Part 2	Safety code of scaffolds and ladders: Part 2 Ladders (first revision)
IS 7969	Safety code for handling and storage of building materials.
IS 8989	Safety code for erection of concrete framed structures.

2.9 MEASUREMENT

IS 1200 (Part 2	Method of measurement of building and Engineering works (Part 2 and 5) Methods of measurement of building and civil engineering works: Part 2 Concrete works (third revision)
IS 1200 (Part 5	Methods of measurement of building and civil engineering works: part 5 Form work (fourth revision)

3. GENERAL

ENGINEER shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged, and ENGINEER's approval obtained, prior to starting of concrete work. This shall, however, not relieve BIDDER of any of his responsibilities of quality work.



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

4. MATERIALS

4.1 CEMENT

Unless otherwise specified or called for by ENGINEER/ OWNER, cement shall be Ordinary Portland Cement Grade 53 conforming to IS: 269.

The Portland Pozzolana Cement shall conform to IS: 1489/ Portland Slag Cement conforming to IS: 455 and it shall be used as directed by ENGINEER. Sulphate Resisting Portland Cement conforming to IS: 12330 may be used as needed for concrete construction.

Only one type of cement shall be used in any one mix unless specifically approved by ENGINEER. The source of supply, type or brand of cement within the same structure or portion thereof shall not be changed without prior approval from ENGINEER.

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

4.2 AGGREGATES

Aggregates shall conform to IS: 383. IS 383 permits use of manufactured and recycled aggregates. However, aggregates such as slag, crushed over burnt bricks, bloated clay ash, sintered fly ash and tiles shall not be used.

Aggregates shall be washed and screened before use where necessary or if directed by the ENGINEER.

Aggregates containing reactive materials shall be used only after tests conclusively prove that there will be no adverse effect on strength, durability and finish, including long term effects, on the concrete.

The fineness modulus of sand shall neither be less than 2.2 nor more than 3.2. If use of sand having fineness modulus more than 3.2 is unavoidable then it shall be suitable blended with crusher stone dust.

WATER

Water used for both mixing and curing shall conform to IS: 456. Potable water is generally satisfactory. Water containing any excess of acid, alkali, sugar or salt shall not be used.

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

Seawater shall not be used for concrete mixing and curing.

4.3 REINFORCEMENT

Reinforcement bars shall conform to IS: 432 and/ or IS: 1786 and welded wire fabric to IS: 1566 as shown on the drawing.

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

Special precaution like coating of reinforcement may be provided with the prior approval of ENGINEER.

At-least one Sample from each lot received at site shall be tested in the laboratory approved by the ENGINEER and the cost of testing shall be borne by the BIDDER. It shall be ensured that all the test results conform to IS: 432 or IS: 1786 as applicable.

4.4 ADMIXTURES AND ADDITIVES

Admixtures from approved manufacturer's shall be used in concrete mix along-with aggregates, cement and water with the written instruction or approval of the ENGINEER in each case. If more than one admixture is proposed for use in the same concrete mix, their interaction shall be checked by trial mixes to ensure their compatibility.

The Bidder shall submit manufacturer's test certificates and technical literature of the admixture proposed to be used. If directed by the ENGINEER, the admixture shall be got tested at an approved laboratory at no extra cost.

The ENGINEER will, wherever appropriate, call for trial batches of concrete to be prepared to demonstrate the effect of the proposed admixtures both on the fresh concrete and on the hardened concrete before giving his approval. He may also lay down additional requirements for the control of the use of such admixtures.

Notwithstanding any previously given approval, the ENGINEER may withdraw such approval at any time with respect to any mix containing admixtures if, in his opinion, the performance of the particular admixture under actual Site conditions is not completely satisfactory.

1. Supply and Storage of Admixtures

Accelerating, retarding, water-reducing, super plasticising and air entraining admixtures shall conform to IS: 9103, integral cement water proofing admixture to IS: 2645, any other admixture to BS: 5075, if it is applicable, unless otherwise specified or agreed. Admixtures shall be stored strictly in accordance with manufacturers' recommendations and precautions shall be taken during delivery and storage to prevent damage to or adulteration of admixtures.

2. Use of Admixtures

Any admixture used in concrete for any reason, shall only be used at the rate of dosage or in the proportions previously approved by the ENGINEER, method of mixing, etc. all in accordance with the manufacturer's instructions and within the manufacturer's recommended ambient temperature range.

Any batch of concrete, which has received an incorrect dose of an admixture or which shall show deterioration after placing as a result of incorrect use of admixtures, shall be broken out or otherwise replaced at no additional cost to the OWNER.

Where admixtures are to be used in bulk form, these shall be weigh-batched as is provided in this Specification for the batching of cement.

Powder admixtures to be used in dose form shall only be allowed if premixed and used as solutions and then only if the premixing procedure has been previously approved by the ENGINEER.

Under no circumstances shall calcium chloride or chloride-based admixtures be used in any concrete mix, grout or mortar. The chloride content of admixtures shall be independently tested in an approved laboratory for each batch of admixture before acceptance.

4.5 SAMPLES AND TESTS

All materials used for the works shall be tested before use. The frequency of such confirmatory tests shall be decided by ENGINEER.

Manufacturer's test certificate shall be furnished for each batch of cement/reinforcing steel and when directed by ENGINEER samples shall also be got tested by the BIDDER in a laboratory approved by ENGINEER at no extra cost to OWNER. However, where material is supplied by OWNER, all testing charges shall be borne by OWNER, but transportation and



preparation of material samples for the laboratory shall be done by BIDDER at no extra cost.

Sampling and testing of aggregates shall be as per IS: 2386 under the supervision of ENGINEER. The cost of all tests, sampling, etc. shall be borne by BIDDER.

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

4.6 STORING OF MATERIALS

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

BIDDER shall make his own arrangements for the storage of adequate quantity of cement even if cement is supplied by OWNER. If such cement is not stored properly and has deteriorated, the material shall be rejected. Cost of such rejected cement, where cement is supplied by OWNER, shall be recovered at issue rate or open market rate whichever is higher. Cement bags shall be stored in dry weatherproof shed with a raised floor, well away from the outer walls and insulated from the floor to avoid moisture from ground. Storage arrangement shall be approved by ENGINEER. Storage under tarpaulins shall not be permitted. Each consignment of cement shall be stored separately and consumed in its order of receipt. BIDDER shall maintain record of receipt and consumption of cement.

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

5. CONCRETE

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

5.1 MIX DESIGN AND TESTING (DESIGN MIX)

For Design Mix Concrete, the mix shall be designed as per IS 10262 to provide the grade of concrete having the required workability and characteristic strength not less than appropriate values given in IS: 456. The design mix shall in addition be such that it is cohesive and does not segregate during placement and should result in a dense and durable

concrete capable of giving the specified finish. For liquid retaining structures, the mix shall also result in watertight concrete. The BIDDER shall exercise great care while designing the concrete mix and executing the works to achieve the desired result.

The minimum cement content for Design Mix Concrete shall be as given IS 456.

Cement content not including fly-ash and GGBS in excess of 450 kg/m³ should not be used unless special consideration has been given in design to the increased risk of cracking due to shrinkage in thin sections, or to early thermal cracking and to the increased risk of damage due to alkali silica reactions.

It shall be BIDDER's sole responsibility to carry out the mix designs at his own cost. He shall furnish to ENGINEER for approval at least 30 days before concreting operations, a statement of proportions proposed to be used for the various concrete mixes and the strength results obtained. The strength requirements of the concrete mixes ascertained on 150 mm cubes as per IS: 516 shall comply with the requirements given in Table 2 of IS: 456.

The sampling, minimum frequency of sampling and acceptance of concrete of each grade shall be in accordance with the clause 15 of IS 456.

In the 'very low' category of workability where strict control is necessary, for example pavement quality concrete, measurement of workability by determination of compacting factor will be more appropriate than slump (refer to IS: 1199) and a value of compacting factor of 0.75 to 0.80 is suggested.

In the 'very high' category of workability, measurement of workability by determination of flow will be appropriate (refer to IS: 9103).

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

1. Batching and mixing of concrete

Proportions of aggregates and cement, as per approved concrete mix design, shall be by weight. These proportions shall be maintained during subsequent concrete batching by means of weigh batchers capable of controlling the weights within $\pm 2\%$ for cement and $\pm 3\%$ for aggregate.

The batching equipment shall be calibrated at the frequency decided by ENGINEER.

Amount of water added shall be such as to produce dense concrete of required consistency, specified strength and satisfactory workability and shall be so adjusted to account for moisture content in the aggregates. Water- cement ratio specified for use by ENGINEER shall be maintained. Each time the work stops, the mixer shall be cleaned out, and while recommencing, the first batch shall have 10% additional sand and cement to allow for sticking in the drum.

Arrangement should be made by BIDDER to have the cubes tested at his own expense in an approved laboratory or in field with prior consent of ENGINEER. Sampling and testing of strength and workability of concrete shall be as per IS: 1199, IS: 516 and IS: 456. It is preferable to cast additional cubes (minimum 3 specimens) for testing at 7 days and 14 days.

5.2 MIX DESIGN AND TESTING (NOMINAL MIX)

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

1. Batching and mixing of concrete

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

6. READY MIXED CONCRETE

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

The BIDDER shall identify at least two sources of Ready Mixed Concrete supplier and get it approved by ENGINEER prior to start of the Works. Any change in the source of the RMC, shall be got approved by the ENGINEER.

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



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

7. FORMWORK

Formwork shall meet the requirements given in IS 456.

The Design and Engineering of the formwork as well as its construction shall be the responsibility of BIDDER. However, if so directed by ENGINEER, the drawings and calculations for the design of the formwork shall be submitted to ENGINEER for approval.

Formwork shall be designed to fulfil the following requirements:

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

Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits as given in clause 11.1 of IS 456.

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

Forms intended for reuse shall be approved by the ENGINEER. BIDDER shall equip himself with enough quantity of shuttering to allow for wastage so as to complete the job in time.

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

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

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

ENGINEER, than that required as per drawing to compensate for irregularities in excavation.

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

The striking time for formwork shall be as per IS 456.

Under normal circumstances (generally where temperatures are above 200 Celsius) forms may be struck after expiry of the period given in IS: 456 unless directed otherwise by ENGINEER. For Portland Pozzolona/ Slag Cement the stripping time shall be suitably modified as directed by the ENGINEER. It is the BIDDER's responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not undergo excessive deformation and resists surface damage and any stresses arising during the construction period.

7.1 SETTLEMENT OF FORMWORK AND CAMBER

Due to various reasons such as closure of form joints, shrinkage of timber, dead load deflections, elastic shortening of form members or formwork, deflections, settlement may occur. The BIDDER shall take precautions, including using adequately rigid formwork, in order to prevent excessive settlement/ deflection; the usual acceptable limit being 1/500 of the spans of the formwork.

8. REINFORCEMENT FABRICATION AND PLACEMENT

Reinforcing bars shall be bent and fixed in accordance with the procedure specified in IS 2502.

All bars shall be bent using bar bending machines.

Re-bending or straightening incorrectly bent bars shall not be done without approval of ENGINEER.

Reinforcement shall be accurately fixed and maintained firmly in the correct position by the use of blocks, spacers, chairs, binding wire, etc. to prevent displacement during placing and compaction of concrete in accordance with clause 12.3 to 12.6 of IS 456. The tied in-place reinforcement shall be approved by ENGINEER prior to concrete placement. PVC or concrete spacers of appropriate size shall be used with the approval of ENGINEER.

Binding wire shall be GI/16 gauge soft annealed wires. Ends of the binding wire shall be bent away from the concrete surface and in no case encroach into the concrete cover.

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

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

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

9. **TOLERANCES**

Tolerance for formed and concrete dimensions shall be as per IS: 456 unless specified otherwise.

Tolerance is a specified permissible variation from lines, grade or dimensions given in drawings. No tolerance specified for horizontal or vertical building lines or footings shall be construed to permit encroachment beyond the legal boundaries. Unless otherwise specified, the following tolerances will be permitted.

9.1 **TOLERANCES FOR RC BUILDINGS**

1. **Variation from the Plumb**

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

2. **Variation from the level or from the grades indicated on the drawings**

v	In slab soffits, ceilings, beam soffits and in arises	
vi	In 2.5 m	- 5 mm
vii	In any bay or 5 m maximum	- 10 mm
viii	In 10 m or more	- 15 mm
ix	For exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines	
x	In any bay or 5 m maximum	- 5 mm
xi	In 10 m or more	- 15 mm

3. Variation of the linear building lines from established position in plan and related position of columns, wall and partitions

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

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

5. Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls

Minus	-	5 mm
Plus	-	10 mm

6. Footings

i	Variation in dimension in plan		
ii	Minus	-	5 mm
iii	Plus	-	50 mm
iv	Misplacement or eccentricity		
v	2% of footing width in the direction of misplacement but not more than 50 mm		
vi	Reduction in thickness		
vii	Minus	-	5% of specified thickness subject to a maximum of 50 mm

7. Variation in steps

i	In a flight of stairs		
ii	Rise	-	3 mm
iii	Tread	-	5 mm
iv	In consecutive steps		
v	Rise	-	1.5 mm
vi	Tread	-	3 mm

9.2 TOLERANCES IN OTHER STRUCTURES

1. All structures

i	Variation of the construction linear outline from established position in plan.		
ii	In 5 m	-	10 mm
iii	In 10 m or more	-	15 mm
iv	Variation of dimensions to individual structure features from established positions.		
v	In 20 m or more	-	25 mm
vi	In buried construction	-	50 mm

vii	Variations from plumb, from specified batter or from curved surfaces of all structures.		
viii	In 2.5 m	-	10 mm
ix	In 5 m	-	15 mm
x	In 10 m or more	-	25 mm
xi	In buried construction	-	Twice the above values
xii	Variations from level or grade indicated on drawings in slabs, beams, soffits, horizontal grooves and visible areas.		
xiii	In 2.5 m	-	5 mm
xiv	In 7.5 m or more	-	10 mm
xv	In buried construction	-	Twice the above values
xvi	Variation in cross-sectional dimensions of columns, beams, buttresses, piers and similar members.		
xvii	Minus	-	5 mm
xviii	Plus	-	10 mm
xix	Variation in the thickness of slabs, walls, arch sections and similar members.		
xx	Minus	-	5 mm
xxi	Plus	-	50 mm

2. Footing for Columns, Piers, Walls, Buttresses and Similar Members

i	Variation of dimension in Plan		
ii	Minus	-	10 mm
iii	Plus	-	50 mm
iv	Misplacement or eccentricity		
v	2% footing width in the direction of misplacement but not more than 50 mm		
vi	Reduction in thickness		
vii	5% of specified thickness subject to a maximum of 50 mm		

3. Tolerance in fixing Anchor Bolts shall be as follows:

i	Anchor bolts without sleeves	:	1.5 mm in plan
ii	Anchor bolts with sleeves	:	5.0 mm in elevation
iii	for bolts up to and including 28 mm dia.	:	5 mm in all directions
iv	for bolts up to 32 mm dia.	:	3 mm in all directions
v	Embedded parts	:	5 mm in all directions



9.3 TOLERANCES IN FORMWORK

The formwork shall be designed and constructed to the shapes, lines and dimensions shown on the drawings within the tolerances given in clause 11.1 of IS 456.

Tolerance for top of concrete of equipment and structural steel foundations shall be as under unless more stringent requirements are specified by equipment manufacturer:

- a) Where grout thickness is less than or equal to 25 mm: ± 5 mm.
- b) Where grout thickness is more than 25 mm: ± 5 mm.

10. PREPARATION PRIOR TO CONCRETE PLACEMENT

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

All arrangements - formwork, equipment and proposed procedure, shall be approved by ENGINEER. BIDDER shall maintain separate Pour Card for each pour as per the format enclosed.

11. TRANSPORTING, PLACING AND COMPACTING CONCRETE

Transportation, placement and compaction of concrete shall be as per IS 456.

In all cases concrete shall be deposited as nearly as practicable directly in its final position. For locations where direct placement is not possible and in narrow forms, BIDDER shall provide suitable drops and “Elephant Trunks”. Concrete shall not be dropped from a height of more than 1.5 m.

Under water concrete shall be placed in position by tremie or by pipeline from the mixer and shall never be allowed to fall freely through the water.

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

- a) Continuously between construction joints and predetermined abutments.
- b) Without disturbance to embedment;
- c) Without disturbing the unsupported sides of excavations; prevent contamination of concrete with earth. Provide sheeting, if



necessary. In supported excavations, withdraw the linings progressively as concrete is placed.

- d) If placed directly onto hard-core or any other porous material, dampen the surface to reduce loss of water from the concrete.
- e) Ensure that there is no damage or displacement to sheet membranes.
- f) Record the time and location of placing structural concrete.
- g) When concrete is brought from batching plant to site in millers, the time of mixing and the time of pour shall be checked to ensure that setting has not started.
- h) Concrete shall normally be compacted in its final position within Initial setting time of leaving the mixer.
- i) When concrete is to be pumped, the concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.

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

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

Pumping of concrete shall be done only after conducting pumpability trials to ascertain the performance of fresh concrete on pumping in presence of the ENGINEER as per approved procedure. A steady supply of pumpable concrete is necessary for satisfactory pumping. Pumpable concrete requires properly graded aggregates, material uniformity, consistent batching and thorough mixing.

Placement of normal concrete by pumping will be permitted as specified or authorised by the ENGINEER. The decision, whether or not to pump any particular mix shall rest entirely with the ENGINEER and no extra claims for payment on this account will be entertained.



12. TESTING FOR PUMPABILITY

No mix shall be accepted for pumping until an actual test under field condition has been satisfactorily completed. Before commencing a new concreting job, the BIDDER shall carry out pumpability tests in consultation with the ENGINEER. Concrete used in such tests shall not be used in the actual construction, unless specifically permitted by the ENGINEER.

Following parameters shall be established by pumpability trials:

- a) In-situ compressive and split tensile strength of concrete.
- b) Curing the sample at Site by sprinkling water.
- c) Curing the sample at Laboratory in curing tanks.
- d) Wet sieve analysis of concrete to ensure that proportions of ingredients before and after pumping are same.

13. MASS CONCRETE WORKS

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

14. PLACING TEMPERATURE OF CONCRETE

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

Mixing water shall be kept cool by storing it under cover. Chilled water or crushed ice as part of the mixing water to achieve the specified placing temperature shall be used. The full quantity of crushed ice shall be stored in cold storage 24 hours in advance of the start of concreting. The temperature in cold storage shall not be more than -20 C. The BIDDER should study the placing temperature condition and work out plant capacity commensurate with the construction schedule requirements and submit his scheme along with the tender. Ice when used as replacement for a portion or all the mixing water shall be produced from water, which meets the requirements.

15. CURING

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

- a) Premature drying out, particularly by solar radiation and wind;



- b) Leaching out by rain and flowing water;
- c) Rapid cooling during the first few days after placing;
- d) High internal thermal gradients;
- e) Low temperature or frost;
- f) Vibration and impact, which may disrupt the concrete and interfere with its bond to the reinforcement.

All concrete, unless directed otherwise by ENGINEER, shall be cured as specified in IS 456.

Extra precautions shall be exercised in curing concrete during cold and hot weather as per IS: 7861 (Part II) and IS: 7861 (Part I) respectively.

Curing arrangement shall be subjected to ENGINEER's approval.

16. CONSTRUCTION JOINTS AND KEYS

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

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

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

17. CONSTRUCTION JOINT TREATMENT (OPTIONAL)

Methodology stated here must be followed by BIDDER wherever instructed by the ENGINEER at no additional cost to the OWNER.

The entire construction joint shall be treated by green cutting using air/water jet at suitable pressure to remove the laitance from the green concrete surface to receive subsequent pour over it. Suitable, approved brand of surface retarder shall be used to retard the setting time of green concrete to a depth of 5 to 8 mm. Green cutting shall be done only after the final setting of concrete, so that the additional water available from the

air water jet used for green cutting on the surface does not harm the quality of the concrete.

18. APPLICATION OF SURFACE RETARDER AND GREEN CUTTING AT CONSTRUCTION JOINT OF CONCRETE

18.1 MATERIAL QUALIFICATION

The surface retarder shall be qualified for use based on number of site trials/ mock-ups for achieving the desired surface after green cutting during different ambient conditions.

18.2 APPLICATION

Surface retarder shall be applied uniformly with the help of agricultural spray machine at the rate of 5 to 6 sqm/litre

- a) Form panel at construction joint: Wherever the side of a particular pour is to receive concrete at a later date, a bulk head of such sides will be coated with surface retarder at least one hour before the receipt of concrete.
- b) For horizontal construction joints: Wherever the concrete is to be placed above a particular pour, surface retarder shall be applied on the finished top surface of the said pour within half an hour of finishing.

18.3 GREEN CUTTING

Green cutting shall be started after final setting time of concrete to expose the aggregate, for proper bonding with fresh concrete of successive pours. The surface of concrete shall be green cut using air-water jet. Bunds shall be made using cement mortar at convenient locations and cut out shall be made in the side shutter to drain off excess water. All the laitance and green cut material shall be removed from the green cut surface simultaneously.

The time of green cutting shall be displayed on Tags, which will be placed at appropriate locations so that said activity can be controlled in the proper way.

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

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

19. FOUNDATION BEDDING

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

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

20. BASE CONCRETE

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

Before placing the blinding concrete of 1:4:8 mix, 50/ 75/100 mm thick as per the item of work, the sub-base of rubble packing shall be properly wetted and rammed. Concrete for the base shall then be deposited between the forms, thoroughly tamped and the surface finished level with the top edges of the forms. Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surface of the base concrete shall be left rough to provide adequate bond for the floor finish to be provided later.

21. FINISHES

21.1 GENERAL

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

21.2 SURFACE FINISH TYPE F1

The main requirement is that of dense, well compacted concrete. No treatment is required except repair of defective areas, filling all form tie holes and cleaning up of loose or adhering debris. For surfaces below

grade which will receive waterproofing treatment, the concrete shall be free of surface irregularities which would interfere with proper and effective application of waterproofing material specified for use. This finish is formed for surfaces at construction joints. The surface produced shall be free from voids, honeycombing or other large blemishes, steps, sharp protrusions or local hollows.

21.3 SURFACE FINISH TYPE F2

The appearance shall be that of a smooth dense, well compacted concrete showing the slight marks of well fitted shuttering joints. The Bidder shall make good any blemishes.

This finish is for surfaces that are permanently exposed to view. The surface produced by the formwork shall have smooth finish, free from board marks, voids, honeycombing or other large blemishes. Any small blemishes shall be carefully filled immediately after the removal of the formwork and other marked imperfections such as fins or steps or joint marks shall be smoothed off and made good.

21.4 SURFACE FINISH TYPE F3

This finish shall give an appearance of smooth, dense, well-compacted concrete with no shutter marks, stain free and with no discolouration, blemishes, air holes, etc. Only lined or coated plywood with very tight joints shall be used to achieve this finish. The panel size shall be uniform and as large as practicable. Any minor blemishes that might occur shall be made good by the Bidder.

21.5 SURFACE FINISH TYPE F4

Surfaces of precast elements, which are later to be in contact with in-situ concrete, shall be roughened by air-water jetting, between the period of initial and final set, to remove all laitance, cement slurry and fine aggregate. Coarse aggregate is to be left exposed but undisturbed.

21.6 INTEGRAL CEMENT FINISH ON CONCRETE FLOOR

In all cases where integral cement finish on a concrete floor has been specified, the top layer of concrete shall be screeded off to proper level and tamped with tamper having conical projections so that the aggregate shall be forced below the surface. The surface shall be finished with a wooden float and a trowel with pressure. The finish shall be continued till the concrete reaches its initial set. No cement or cement mortar finish shall be provided on the surface. Where specified, a floor hardener of appropriate thickness as approved by the ENGINEER shall be supplied and used as recommended by the manufacturer.

22. REPAIR AND REPLACEMENT OF UNSATISFACTORY CONCRETE

Immediately after the shuttering is removed, all the defective areas such as honeycombed surfaces, rough patches, etc. shall be brought to the notice of ENGINEER who may permit patching of the defective areas or

reject the concrete work. ENGINEER's decision on rejection of concrete work shall be final.

All through holes for shuttering shall be filled with cement mortar for full depth and neatly plugged flush with surface. Rejected concrete shall be removed and replaced by BIDDER at no additional cost to OWNER.

For patching of defective areas all loose materials shall be removed and the surface shall be prepared by cleaning by compressed air or water jetting.

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

23. VACUUM DEWATERING OF SLABS/RCC ROADS

Where specified floor slabs, either on grade or suspended/RCC Roads, shall be finished by vacuum dewatering including all operations such as poker vibration, surface vibration, vacuum processing, floating and trowelling as per equipment manufacturer's recommendation. The equipment to be used shall be subject to ENGINEER'S approval.

24. HOT WEATHER REQUIREMENT

Concreting during hot weather shall be carried out as per IS: 7861 (Part I).

Adequate provisions shall be made to lower concrete temperatures, which shall not exceed 40°C at the time of placement of fresh concrete.

Where directed by ENGINEER, BIDDER shall spray non-wax based curing compound on unformed concrete surface at no extra costs.

25. COLD WEATHER REQUIREMENTS

Concreting during cold weather shall be carried out as per IS: 7861 (Part 2).

The ambient temperature during placement and up to final set shall not fall below 5°C. Approved anti-freeze/ accelerating additive shall be used where directed.



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

26. LIQUID RETAINING STRUCTURES

The BIDDER shall take special care for concrete of liquid retaining structures, underground structures and those other specifically called for to guarantee the finish and water tightness.

The minimum level of surface finish for liquid retaining structures shall be of smooth type. All such structures shall be hydro-tested.

The BIDDER shall include in his price hydro-testing of structure, all arrangements for testing such as temporary bulk heads, pressure gauges, pumps, pipe lines, etc.

Any temporary arrangements that may have to be made to ensure stability of the structures shall also be considered to have been taken into account while quoting the rates.

Any leakage/ sweating that may occur during the hydro-test or subsequently during the defects liability period or the period for which the structure is guaranteed shall be effectively stopped either by cement/ epoxy pressure grouting, guniting or such other method as may be approved by the ENGINEER. All such rectification shall be done by the BIDDER to the entire satisfaction of the OWNER/ ENGINEER at no extra cost to the OWNER.

27. HYDRO TESTING CONCRETE STRUCTURES

Hydrostatic test for water tightness shall be done (On bare concrete surface as well as after attending leakages/seepages if any identified at this stage. Any waterproofing treatment/coating shall be carried out only after arresting leakages/seepages by pressure grouting – Epoxy/Cement/PU as mentioned above in clause no 26) observed during bare concrete hydro test.) at full storage level or soffit of cover slab, as may be directed by ENGINEER, as described in IS 3370 (Part-1).

28. OPTIONAL TESTS

If ENGINEER feels that the materials i.e. cement, sand, coarse aggregates, reinforcement and water are not in accordance with the specifications or if specified concrete strengths are not obtained, he may order tests to be carried out on these materials in laboratory, to be approved by the ENGINEER, as per relevant IS Codes. OWNER shall pay only for the testing of material supplied by the OWNER; otherwise

BIDDER shall have to pay for the tests. Transporting of all material to the laboratory shall however be done by the BIDDER at no extra cost to OWNER.

In the event of any work being suspected of faulty material or workmanship requiring its removal or if the works cubes do not give the stipulated strength, ENGINEER reserves the right to order the BIDDER to take out cores and conduct tests on them or do ultrasonic testing/tomography or load testing of structure, as per relevant IS specifications. All these tests shall be carried out by BIDDER at no extra cost to the OWNER. Alternately ENGINEER also reserves the right to ask the BIDDER to dismantle and re-do such unacceptable work at the cost of BIDDER.

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

29. QUALITY CONTROL

BIDDER shall adopt the Quality Control format provided by the ENGINEER. A copy of formats shall be furnished to BIDDER by ENGINEER/ OWNER after the contract is awarded.

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

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

30. INSPECTION

All materials, workmanship and finished construction shall be subject to continuous inspection and approval of ENGINEER. Materials rejected by ENGINEER shall be expressly removed from site within 3 working days and shall be replaced by BIDDER immediately at no extra cost to OWNER.

31. 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.

32. ACCEPTANCE CRITERIA

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



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

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

For work not accepted, ENGINEER may review and decide whether remedial measures are feasible so as to render the work acceptable. ENGINEER shall in that case direct the BIDDER to undertake the remedial measures. These shall be expeditiously and effectively implemented by BIDDER. Nothing extra shall become payable to BIDDER by OWNER for executing remedial measures.

END