



Uhde India Limited

**PART – II
TECHNICAL SPECIFICATIONS
SECTION-2
CONCRETE & FORMWORK**

DOC NO.:
CI-UCH-016-02

Rev. :R0
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2.1 SCOPE

This specification establishes the materials, mixing, placing, curing, etc, of all types of Cast-in-situ concrete to be used in foundation, underground and above ground structures, floors, etc. Any special requirement as shown or noted on the drawings shall govern over the provisions of this specification..

This specification shall also apply to the extent it has been referred to or applicable with the special requirements of structures covered in scope of IS:456.

2.2 LIST OF APPLICABLE IS CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Specification, any other standard practice, as may be specified by the Engineer, shall be followed

- IS:73 - Specification for Paving Bitumen
- IS:216 - Specification for Coal Tar Pitch
- IS:269 - Specification for Ordinary Portland Cement, 33 Grade.
- IS:383 - Specification for Coarse and Fine Aggregates from Natural Sources for Concrete.
- IS:432 - Specification for Mild steel and Medium
(Part I) Tensile Steel Bars for Concrete Reinforcement.
- IS:455 - Specification for Portland Slag Cement
- IS:456 - Code of Practice for Plain and reinforced Concrete.
- IS:457 - Code of Practice for General Construction of Plain and Reinforced Concrete for dams and other Massive Structures.
- IS:516 - Specification for Methods of Test for Strength of Concrete.



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|------------------------|---|
| IS:1199 | - Specification for Methods of Sampling and Analysis of Concrete. |
| IS:1200 | - Specification for Methods of measurement. |
| IS:1322 | - Specification for Bitumen felts for Waterproofing and Damp-Proofing. |
| IS:1489
(Part I/II) | - Specification for Portland pozzolona Cement. |
| IS:1566 | - Specification for Hard drawn steel wire fabric for Concrete Reinforcement. |
| IS:1609 | - Code of Practice for Laying Damp-proof Treatment using Bitumen Felts. |
| IS:1786 | - Specification for High Strength Deformed Steel bars and wires for Concrete Reinforcement. |
| IS:1791 | - Specification for Batch Type Concrete Mixers. |
| IS:2062 | - Steel for general structural purposes. |
| IS:2185 | - Specification for Hollow Cement Concrete Blocks. |
| IS:2210 | - Specification for Design of Reinforced Concrete shell Structures and Folded Plates. |
| IS:2386 | - Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII. |
| IS:2502 | - Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement. |
| IS:2505 | - General Requirements for Concrete Vibrators, Immersion Type. |
| IS:2506 | - General Requirements for Screed Board Concrete Vibrators. |
| IS:2514 | - General Requirements for Concrete Vibrating Tables. |



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|---------|--|
| IS:2722 | - Specification for portable Swing Weight Batchers for Concrete (Single and Double Bucket type). |
| IS:2751 | - Code of Practice for Welding of Mild steel Bars used for Reinforced Concrete Construction. |
| IS:2770 | - Specification for Method of Testing Bond in Reinforced Concrete. |
| IS:3025 | - Specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry. |
| IS:3201 | - Specification for Design and Construction of Precast Concrete Trusses. |
| IS:3370 | - Specification for Code of Practice for Concrete Structures for Storage of Liquids – Parts I to IV |
| IS:3550 | - Specification for Method of Test for Routine Control for Water used in Industry. |
| IS:3558 | - Code of Practice for use of Immersion Vibrators for Consolidating Concrete. |
| IS:3590 | - Specification for Load Bearing Light Weight Concrete Blocks |
| IS:3696 | - Safety Code for Scaffolding and Ladders. |
| IS:3812 | - Specification for Fly Ash for Use as Admixture for Concrete. |
| IS:4031 | - Specification for Method of Tests for hydraulic Cement. |
| IS:4082 | - Specification for Recommendation on Stacking and Storage of Construction Materials at site. |
| IS:4090 | - Specification for Design of Reinforced Concrete Arches. |
| IS:4634 | - Specification for Method of Testing Performance of Batch-type Concrete Mixes. |



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- IS:4656 - Specification for Form Vibrators for Concrete.
- IS:4925 - Specification for Concrete Batching and Mixing Plant.
- IS:4926 - Specification for Ready Mixed Concrete.
- IS:4990 - Specification for Plywood for Concrete Shuttering work.
- IS:4991 - Specification for Blast Resistant Design of Structure for Explosion above ground.
- IS:4995 - Specification for Design of Part-I&II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials.
- IS:4998 - Specification for Design of Reinforced Concrete Chimneys.
- IS:5512 - Specification for Flow Table for use in Tests of hydraulic Cement and Pozzolanic Materials.
- IS:5513 - Specification for Vicat Apparatus.
- IS:5515 - Specification for Compaction Factor Apparatus.
- IS:5751 - Specification for Precast Concrete Coping Blocks.
- IS:5816 - Specification for Method of Test for Splitting Tensile Strength of Concrete Cylinders.
- IS:5891 - Specification for Hand Operated Concrete Mixers.
- IS:6452 - Specification for high Alumina Cement for Structural Use.
- IS:6909 - Specification for Supersulphated cement.
- IS:7251 - Specification for Concrete Finishes.
- IS:7320 - Specification for Concrete Slump Test Apparatus.



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- IS:7861 - Specification for Recommended Part-I & II - Practice for Extreme Weather Concreting.
- IS:7969 - Safety Code for Storage and Handling of Building materials.
- IS:8041 - Specification for Rapid Hardening Portland Cement.
- IS:8112 - Specification for high Strength Ordinary Portland Cement.
- IS:8142 - Specification for Determining Setting time of Concrete by Penetration Resistance.
- IS:8989 - Safety Code for Erection of Concrete Framed Structures.
- IS:9013 - Specification for Method of Making, Curing and Determining Compressive Strength of Accelerated-cured Concrete Test Specimens.
- IS:9077 - Code of Practice for Corrosion Protection of Steel Rails in RB and RCC Construction.
- IS:9103 - Specification for Admixtures for Concrete.
- IS:10262 - Specification for Concrete Mix Design
- IS 12269 - Specification for 53 Grade Ordinary Portland Cement
(Part I & II)
- IS 1311 - Code of Practice for Non-Destructive Testing of Concrete.
(Part I & II)
- IS:13920 - Code of Practice for Ductile detailing of Reinforced Concrete Structures subjected to seismic forces.
- SP 23 - Handbook on Concrete Mixes (based on Indian Standards).

2.3 MATERIALS

2.3.1 CEMENT



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IS:269 - Ordinary Portland cement, 33 Grade

IS:1489 - Portland pozzolona Cement.

IS:455 - Portland Slag Cement.

IS:8041 - Rapid hardening Cement.

IS:8112 - High strength Cement.

IS:12330 - Sulphate resisting portland cement.

IS:8043 – Hydrophobic Cement

IS:12600 – Low Heat Portland Cement

Generally cement shall be obtained from approved suppliers and shall be stored in a waterproof/weatherproof shed in a manner approved by the Engineer. No cement that has been allowed to deteriorate in quality or that has become caked or has perished by dampness or otherwise shall under any circumstances be used on the works. The concrete mix proportions shall be used on the weight of cement bags as delivered at the mixer and not on their theoretical weight. The contractor should allow in his rates for losses in weight of cement bags in transit and handling .

2.3.2 Storage

The Contractor shall follow accepted good practice in handling and storing cement. Cement may be stored on site in moisture proof bulk containers which shall be equipped with venting arrangements.

Cement delivered in bags shall be stored off the ground (at least 15 cms.) in dry, well ventilated, weather-proof/waterproof sheds, arranged in separate consignments as received from the manufacturer so that consumption of cement is insured in the order of receipt, i.e. 'First in First Out' rule. The stacks of cement shall be such that there is easy access for proper inspection and identification. The bags shall be piled not more than 15 bags per pile and placed close together in the pile to reduce circulation of air. Each stack of cement shall be covered with good waterproof tarpaulin or thick polyethylene sheets.

2.3.3 Use

Cement shall be used in the order in which it is received. Cement in bags in storage for more than 3 months shall be retested before use.



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2.3.4 Testing

In addition to verification of manufacturer's test certificates, the Engineer may opt to carry out following tests :

Tests shall be carried out on cement delivered to the site for fineness, initial and final setting time, and compressive strength (IS:4031) and the results should be approved by the Engineer before use of the cement in permanent works. Samples shall be taken immediately on receipt of cement at site. The methods and procedure of sampling shall be in accordance with IS:3535. The Engineer may specify other forms of sampling and tests, if in his opinion the cement is of doubtful quality, the costs of such additional tests, shall be borne by the Contractor, if supplied by him.

The decision of the Engineer will be final and binding on the contractor.

2.3.5 Fine Aggregate (sand) (IS:383)

2.3.5.1 It shall be river or pit sand or, if permitted by the Engineer, crushed stone sand (Produced from crushing stone suitable for concrete aggregates) and all fine aggregates shall be sharp, free from excess fines, loam, earth, vegetable matter, soluble salts and other harmful chemical/organic impurities and shall be clean. If considered by the Engineer as necessary, the same shall be washed. Washing shall be done at least one day before using it in concrete. The aggregate should be stored in such a manner as to avoid contamination.

2.3.5.2 Fine aggregates acceptable for the works shall normally be in a grading which falls within the GRADING LIMITS as specified in IS:383 .
If grading of fine aggregates can be improved by mixing two varieties of sand, the Engineer may at his discretion specify such mixing, and may permit the use of crushed sand as one of the two sands forming the mixture. The provisions of two types of sand and their mixing in the specified proportions shall be done at Contractor's cost.

2.3.6 **Coarse Aggregate**

Coarse aggregate for the works shall be river gravel or crushed stone obtained from sources approved by the Engineer and shall conform to IS:383

Aggregates shall be properly screened and if necessary washed and cleaned before use.

Coarse aggregates containing flat or flaky pieces or mica shall be cleaned of such impurities before use.

2.3.7 The grading shall conform to IS:383 for Grading Limits for Single Sized Coarse Aggregate

Limits for use of single sized coarse Aggregate in various type of structures shall be as follows:

Use	Size
Ordinary plain concrete/ Reinforced concrete foundation.	40mm
Slabs and Walls 200mm or more in thickness.	20mm to 10mm
Columns and Girders with least dimension under 300mm	20mm to 10mm
Very narrow space	10mm
Mass concrete	80mm

2.3.9 Tests of Aggregates

Before commencing the trial mix design, and in course of the work, whenever the apparent quality / source of the aggregates changes, the Engineer may ask for tests on aggregates to be conducted in an approved laboratory and test results to be submitted to Engineer and approved by him. The tests may generally include determination of particle size and shape, organic impurities, surface moisture and 10% fine value.

2.3.10 Water

Before commencing the trial mix design, and in course of the work whenever the source of water changes, or whenever there is in the opinion of the Engineer reason to suspect a change in water quality, the contractor shall get the water to be used for mixing, tested in an approved laboratory. The water in general shall comply with the requirements as specified in IS:456

2.3.11 Mineral Admixtures

The engineer may permit the use of Mineral Admixtures as specified in IS:456. This may be permitted only if

- a. the concrete is manufactured in batching plant **OR**
 - b. Ready mix concrete is used.
- and provided that uniform blending with cement is ensured

2.4 Trial mixes

The contractor shall be entirely responsible for the design of the concrete mixes. The design is however to be approved by the Engineer before commencing any concreting in the works. The contractor shall make trial mixes using samples of coarse aggregates; sand, water and cement, typical of those to be used (discarding the first batch).

2.4.1 Where the mix is not designed following proportions shall be used for the concreting: (by Volume)

M-10 - (1:3:6)

M-15 - (1:2:4)

M-20 - (1:1½:3)

M-25 -

M-30 - } Not recommended by Volume

M-35 - }

M-40 - }

2.4.2 Concrete Mix design

Concrete mixes for various specified design strengths shall be worked out by the contractor, generally as per the requirements of IS:456 / IS:10262.

- a) The mixes designed by the contractor shall be used on works only after obtaining a written approval of the Engineer. It is to be understood that the mix design shall be entirely the responsibility of the contractor and such approval by the Engineer shall not relieve the contractor of his responsibility in respect thereof.
- b) The contractor shall prepare all calculations, tabulation, graphs, etc. pertaining to concrete mix designs and / or test results and supply copies of such calculations, tabulations, graphs etc. as required by the Engineer.
- c) Either Ordinary Portland or Portland Pozzolana Cement or Sulphate resistant Cement will be supplied. No deviation either in rate or schedule of work will be entertained on this account. The mix design should be based on the use of Ordinary Portland Cement/Portland pozzolana Cement/sulphate resistant cement. Due regard should also be taken regarding minimum cement specified as above.
- d) Contractor shall furnish the cement content assumed for various mixes for approval by the Engineer within one (1) week after award of contract. In case

it becomes necessary to use Portland Pozzolana Cement during the course of the work, the contractor shall design fresh mixes and the difference in the consumption of cement due to use of pozzolana cement shall be taken into account for reconciliation purpose also.

In all cases the contractor shall make trial cubes from each consignment of cement and test the same before actually using in the work.

2.4.2 Whenever there is a significant change in the quality of any of the ingredients of concrete, the Engineer may at his discretion order the carrying out of fresh trial mixes. All costs for trial mixes and tests shall be to the Contractor's account and to be included in the contract rates.

2.4.3 Before commencing the works the contractors shall submit to the engineer, for approval full details of all preliminary trial mixes and tests.

2.4.4 When the proportions of the concrete mix have been approved by the Engineer, the Contractor shall not vary the quality or source of the materials or the mix without the written approval of the Engineer.

2.5 **Concrete Batching**

Concrete batching shall be as per IS456

All tests shall be carried out at regular intervals and records of the results shall be kept at site. Copies of records shall be sent to the Engineer for reference.

To ensure that the grading of the aggregate remain the same as the grading to which the mix design is based, sieve analysis shall be carried out regularly and charts showing the results shall be prepared. Copies of these information shall be kept a site and supplied by the contractor as instructed. If a change in grading is unavoidable the mix shall be redesigned and got approved.

Record of theoretical and actual consumption of cement shall be maintained by the contractor for each work separately and regularly.

2.6 **Mixing**

Concrete mixing shall be as per IS456

Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Owner to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS:1791. Should any mixer at any time produce unsatisfactory results, leak mortar or cause waste of materials, its use shall be promptly discontinued until it is repaired. Blades shall be replaced on showing signs of wearing down.

Hand Mixing:

Normally hand mixing shall not be permitted except in special cases (such as far away isolated places, if allowed by the engineer.

When hand mixing is authorised by the Engineer, it shall be done on a water tight platform. The materials shall be turned at least three times after the water is added and until the batch is homogeneous in appearance and colour.

Batching Plant where used shall conform to IS:4925.

Concrete shall be poured and consolidated in its final position within half an hour of mixing. Tampering with concrete which has partially hardened, i.e. remixing with or without additional cement, aggregate or water, shall not be permitted.

2.7 Transportation, placing, compaction

Transportation, placing, compaction of concrete shall be as per IS456

Before depositing the concrete, all debris and dirt shall be removed from the space to be occupied by concrete. Concrete shall not be placed until the formwork, placement of reinforcement, embedments etc. have been checked and approved by Engineer. The formwork shall be sufficiently rigid. During the placing and compaction of concrete, care shall be taken to ensure that there is no loss of water from concrete and no segregation takes place. The method of placing and compaction employed in any particular section of the work shall be to the entire satisfaction of the Engineer.

To ensure bond and water tightness between old concrete surface and the concrete to be placed, the surface should be cleaned and roughened. The bonding old and new concrete should be done by applying the cement slurry after thoroughly watering the old concrete surface and removing all loose particles.



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Unless otherwise approved, concrete shall be placed in single operation to the full thickness of slabs, beams and similar members and shall be placed in horizontal layers not exceeding 1 M. deep in walls, columns and similar members. Concrete shall be placed continuously until completion of the part of the work between construction joints or as directed by Engineer.

Concreting shall not be started unless the Electrical conduits or any other piping wherever required are laid by the concerned agency. The Civil Contractor shall provide all the facilities, and maintain coordination of work with other agencies engaged in electrical and such other works as directed by the Engineer.

Where concrete is placed on soil, it shall be placed only on firm undisturbed ground. Any concrete that is placed on a well compacted fill shall have the prior approval of the Engineer. Concrete shall not be placed in standing water on subgrade or in foundation excavation.

The concrete after being laid shall be compacted by means vibrators of approved type under proper supervision as directed by the Engineer. Vibration shall not be confined only to the top surface, but the whole mass of concrete shall be well vibrated until the dense mass assumes jelly like appearance and consistency. Water just appearing on surface shall be avoided. Care should be taken to avoid segregation and formation of air bubbles. Vibration shall be accomplished by means of "spud" type internal vibrators with flexible shaft of 6000 vibration / min. The vibrator shall not be left in any position for more than 5 sec. The Immersion type vibrators shall be inserted in a vertical position at intervals of about 600 mm and fully worked around reinforcement, embedded fixtures and into corners of formwork without directly coming in contact with reinforcement steel and formwork. Over vibration shall not be permitted.

After concrete has been placed, it shall be spread, if necessary and thoroughly compacted by approved mechanical vibration to maximum subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced persons. In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators the contractor will additionally employ screed



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vibrator as per IS:2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or distorted during placing and consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

The whole process starting from the mixing of concrete to the placing and compaction shall not take more than 20 min. The process shall be completed before the initial setting takes place.

All chutes, pipes and other placing equipment shall be kept clean and free from coatings of hardened concrete by cleaning and thoroughly flushing, with water after each run, and water used from flushing shall be discharged clear of the concrete already in place.

No concrete shall be deposited until the Engineer has inspected the forms, reinforcing steel, inserts, hollow clay tile units, sleeves, etc, and given permission to place. Concrete, shall be deposited only in the presence of representative of the Engineer.

In very hot weather precaution shall be taken to see that temperature of wet concrete does not exceed 38 deg.C while placing. During cold weather, concreting shall not be done when the temperature falls below 4.5 deg.C. During hot weather (atmospheric temperatures above 40 deg.C) or cold weather (atmospheric temperatures below 5 deg.C), the concreting shall be done as per the procedure set out in IS 1761.

Rock at foundation level or construction joint of concrete kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation

cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

2.7.1 Extreme weather and Underwater Concreting

Concreting shall not be deposited under water if it is practicable to de-water the area and place concrete in the regular manner. The concrete shall contain at least 10% more cement than that required for the same mix placed in dry conditions, the quantity of extra cement varying with conditions of placing with prior written permission of the Engineer. Such extra cement will be paid extra. The volume of coarse aggregate shall not be less than 1 1/2 times nor more than twice the fine aggregate and slump not less than 100 mm nor more than 180 mm. Where found necessary to deposit any concrete under water, the method, equipment, materials and mix shall first be got approved by the Engineer. Concrete shall be deposited continuously until it is brought to required height. While depositing, the top surface shall be kept as nearly level as possible and the formation of heaps shall be

avoided. The concrete shall be deposited under water by one of the approved methods such as tremie method, drop buckets, bags, groutings etc. as per details given in IS:456. If it is necessary to raise the water after placing the concrete, the level shall be brought up slowly without creating any waves or commotion tending to wash away cement or to disturb the fresh concrete in any way.

2.8 **Curing shall be done as per IS456**

Heavy loads shall not be placed on or moved across floor slabs until curing is complete. Care shall be taken to prevent floor surface from being marred during curing period. For freshly laid concrete, formwork shall not be jarred. Concrete placed under water shall be protected from falling earth during and after placing. Walking on concrete shall not be permitted for at least twenty four hours after it has been placed in the forms and for such additional length of time as the Engineer may direct.

2.9 **Concrete Cube Tests**

The quality of hardened concrete will be verified by the following procedure:

2.9.1 The Engineer shall select random batches of concrete for examination without warning the contractor and sampling will generally be done at the point of discharge from the mixer.

2.10 Acceptance Criteria

The sampling, testing and "Criteria of Acceptance" for concrete shall be as per IS:456.

2.10.1 If the concrete produced at site does not satisfy the above strength requirements, the Engineer will reserve the right to require the contractor to improve the methods of batching, the quality of the ingredients and redesign the mix with increased cement content if necessary. The contractor shall not be entitled to claim any extra cost for the extra cement used for the modifications stipulated by the Engineer for fulfilling the strength requirements specified.

2.10.2 If from the test results it appears that some portion of the works has not attained the required strength, the Engineer may order the testing of the suspected as well as adjacent portions of the structure. Such testing shall be at the Contractors cost. The Engineer may also reject the work and order its demolition and reconstruction at the contractor's cost.

2.10.3 If the strength of concrete in any portion of the structure is lower than the required strength, but in the opinion of the engineer demolition is not necessary, the Contractor shall be paid a lower rate for such lower strength concrete as determined by the Engineer.

2.11 Quality control

Contractor shall exert proper quality control at the various stages of concrete production and placement.

As frequently as Engineer may require, testing shall be carried out in the field for:

- 1) Moisture content of sand
- 2) Moisture content of aggregates.
- 3) Silt content of sand

4) Grading of sand

The contractor shall provide and maintain all items, (until the works are completed) equipment and staff required for carrying out these tests. The Contractor shall grant the Engineer or his representative full access to this laboratory at all times and shall produce on demand complete records of all tests carried out in site. Alternatively, the Contractor may also avail of the services of the local testing laboratory with prior approval of the engineer.

2.12 Construction Joints

Construction joints shall in general conform to the relevant clauses of IS:456.

When the placing of concrete is interrupted and a construction joint is formed, provision shall be made for interlocking with the succeeding layer by the embedment or saturated wooden blocks or strips, smoothed on four sides to facilitate their removal. Prior to the next pour the wooden pieces shall be loosened and removed in such a manner as to avoid damage to the concrete.

Such construction joints, if the contractor feels are necessary, shall be approved by the Engineer and shall be so located and formed as to least impair the strength and the appearance of the structure.

They shall be made in the positions as specified or as approved. Such joints shall be truly vertical or horizontal as the case may be except that in an inclined or curved member the joints shall be strictly at right angles to the axis of the member.

Construction joints shall be rebated to an approved profile and an approved water stop shall be placed in the joints when specified.

Construction joints shall be made horizontally in the foundations and 75 mm below the lowest beams soffit at the head of columns. Concrete in the ribs and slab of small tee and other beams shall be placed in one operation but for large beams concrete in the rib upto a level 25mm below the slab, soffit shall be placed first. Concrete in haunches or splays on beams

or braces and concrete in the head of adjoining position of the column shall be placed at the same time and at junction of walls and slabs shall be placed at the same time as that in the slab. Construction joints in slab and beams shall be located at one third span and keyed and dowelled as specified.

2.12.1 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:-

- a) If concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.
- b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.
- c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise inspite of extensive vibration, the joint will be left to harden for at least 12 - 24 hrs. It will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface.

2.13 Encasing Rolled Steel Sections

Before concrete work is started, the Engineer shall check that all rolled steel sections to be encased, have been erected truly in position. The sections shall be unpainted and shall be wire brushed to remove the loose rust / scales etc. Where so specified, ungalvanised metal, having mesh or perforations large enough to permit the free passage of 12.5 mm nominal size aggregate through them, shall be wrapped round the section to be encased in concrete and paid for separately.

2.14 Finishing of Concrete

On stripping the formwork, all blowholes and honey combing observed shall be brought to the notice of Engineer. The Engineer may, at his discretion allow such honeycombing or blowholes to be rectified by necessary chipping and packing or grouting with concrete or cement mortar. If mortar is used, it shall be 1:3 mix, or as specified by Engineer. However, if honeycombing or blowholes are of such extent as being undesirable, the Engineer may reject the work totally and his decision shall be final and binding. No extra payment shall be made for rectifying these defects. All humps and uneven faces shall be rubbed smooth with the help of carborundum stone.

The surface of non-shuttered faces shall be smoothed with a wooden float to give a finish equal to that of the rubbed down shuttered faces. Concealed concrete faces shall be left as from the shuttering except that honeycombed surface shall be made as detailed above. The top faces of slabs not intended to be surfaced shall be levelled and floated to a smooth finish as the levels or falls shown in the drawings or elsewhere. The floating shall not be executed to the extent of bringing excess fine materials to the surface.

The top faces or slabs intended to be covered with screed, granolithic or similar finishes, shall be made rough when wet with wire brush. Faces of concrete intended to be plastered shall be roughened by approved means to form a key.

2.15 Protection of Concrete

Care shall be exercised to protect the completed concrete from damage by subsequent construction operation. No equipment shall be run over the complete slabs until they are at least two weeks old, special case shall be taken on concreting in hot weather. The forms must be thoroughly wetted

first before the concrete is placed and the exposed surface of the concrete shall be kept continually damp, by sprinkling for two days.

2.16 Cracks

If cracks, which in the opinion of the Engineer may be detrimental to the strength of the structure, developed in concrete construction, the contractor at his own expense shall test the slab or other construction as specified in Special Conditions. If under such test loads the cracks develop further, the contractor shall dismantle the construction, carry away the debris, replace the construction and carry out all consequential work thereto, at his cost.

If any cracks develop in the concrete construction, which in the opinion of the Engineer have suffered damage either in appearance or stability owing to such cracks. The Engineer's decision as to the extent of the liability of the Contractor in the above matter shall be final and binding.

2.17 Defective concrete

Should any concrete be found honeycombed or in any way defective, such concrete shall on the instruction of the Engineer be cut out by the Contractor and made good at his own expenses.

2.18 Exposed Faces. Holes and Fixtures.

On no account shall concrete surface be patched or covered up or damaged concrete rectified or replaced until The Engineer or his representative has inspected the works and issued written instructions for rectification. Further to observe this procedure will under that portion of the works liable to rejection; in which case it will be treated as rejection which has failed to meet specified strength requirements.

2.19 Approval Before Concreting

Pour card system to be followed. No concreting shall be carried out by the Contractor until the Engineer or his representative has inspected formwork and reinforcement and certified in writing that concreting may proceed. Any concrete poured without such prior written approval shall be cut out and removed by the Contractor at his own cost.

2.20 Concrete for flooring on Grade

Concrete for flooring on grade shall be over well packed stone metalling/pcc levelling course or on earth as specified with or without reinforcement, placed in alternate bays not exceeding more than 6M x 3M or as specified including hacking the joints or adjacent bays. The water cement ratio shall not exceed 0.4 and cement content shall not be less than 320 kg/m³ of finished concrete. The stiff mix shall be thoroughly vibrated and finished to receive the floor finish.

2.21 Precast Concrete

2.21.1 All provisions, not specifically excluded and not in conflict with provisions of Section 2: Concrete and Formwork, Section: 4 Reinforcement and Section 7: Structural Steelwork shall apply to precast concrete.

2.21.2 Casting

All precast units shall be cast on suitable bed or platform with firm foundation and free from wind. Contractor shall be responsible for the accuracy of the level or shape of the bed or platform.

2.21.3 Embedments

Contractor shall not do concreting unless Electrical conduits, pipes, fixtures etc. wherever required, are laid by the concerned agency. Embedded items shall be placed and maintained in correct position while concreting. Embedded items shall be properly anchored to develop required strength.

2.21.4 Striking Forms

Side shutters shall not be struck in less than 16 hours after depositing concrete and no precast unit shall be lifted until the concrete reaches a strength of at least twice the stress to which the concrete may be subjected to at the time of lifting.

2.21.5 Curing

All precast work shall be protected from the direct rays of the sun for at least 7 days after casting and during that period each unit shall be kept constantly watered or preferably completely immersed in water if the size of the unit so permits.

2.22 Expansion and Isolation Joints

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified herein after, if not, otherwise mentioned in the drawings.

In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications.

Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

2.22.1 Bitumen Board/Expanded Polystyrene Board.

Bitumen impregnated fibre board of approved manufacturer as per IS:1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

2.22.2 Metal Sealing Strips / water stops

Metal sealing strips shall be either G.I, Aluminium or Copper and formed

straight, U shaped, Z shaped or any other shape and of thickness as indicated in the drawing and schedule of items and/or as instructed by the Engineer.

The transverse joints will be gas welded using brass rods and approved flux and will be tested by an approved method to establish that it is leakproof, longer lap lengths and different method of brazing which will render it leakproof, will be adopted by the contractor without any additional cost to the Owner. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

a) G.I Strips

G.I strip shall be minimum 1.5mm thick and 150 mm in width unless specified otherwise. The standard of Galvanizing shall be as per relevant India Standards for heavy duty work. At the joints, the overlapping should be for a minimum length of 50mm.

b) Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS:737 of 19000 grade or 31000 grade (Designation as per IS:6051). A minimum lap of 50mm length is required at the joints.

2.22.3 Non-metallic Sealing Strips / water stops

These will be normally in rubber or P.V.C can be of shape having any combination of the following features:-

- a) Plain
- b) Central bulb
- c) Dumb-bell or flattened ends
- d) Ribbed and Corrugated Wings
- e) V shaped

As these types of seals can be easily handled in very large lengths unlike metal strips, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer.

The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match

the central bulbs and the edges accurately.

2.22.3.1 Installation & Jointing Techniques of non metallic sealing strips.

One of the main advantages of PVC water-stops is that they can be installed very easily. The jointing can be carried out by simple heat fusion/welding process. The installation consists of embedding one half of the water-stop across its width in concrete leaving the second half open. After completion of the first half, the concrete would be poured and the second half would also be embedded leaving the centre bulb free for expansion and contraction.

It is important that during pouring of concrete the water-stops should not be deformed due to impact. The concrete should be properly vibrated so that it develops intimate contact with the water-stops. Care should be taken so as not to reduce effective cross section of the water-stops.

It is necessary that PVC water-stops are placed near the centre of the concrete walls. During installation, PVC water-stops are often required to be jointed. there are essentially two types of joints :

- 1) Straight Joints
- 2) Mitred Joints

Straight joints are very simple and can easily be carried out at the site.

Fabrication of PVC water-stops can be carried out by means of simple tools. they are:

1. Hand saw or sharp knife for cutting.
2. Heating source like blow lamp or any other means.
3. A metal strip plate of suitable width and about 500 - 600 mm length with simple holding device like a wooden handle.
4. Metal or wooden templates with suitable marking/grooves for 45 Deg.C and 90 deg.C angle cuttings.

The following jointing method is recommended :

1. Water-stops are cut by means of cutting device. Clean cuts provide the best results.
2. The metal strip is heated to about 200 Deg.C which would be adequate to melt the water-stops material. The strip should not be overheated so as to

prevent charring of PVC material.

3. Two ends of PVC water-stops to be joined are pressed uniformly against the hot metal strip. When sufficient fusing of PVC is attained, the metal strip removed and both the ends are pressed together. It is necessary to ensure that the entire cross section is uniformly heated and fused. It also essential to attain alignments of the complete cross section and particularly of centre bulbs both the ends are well pressed until the joint cools down to ambient temperature.
4. The metal strip should be cleaned by means of wire brush and cotton waste before the next welding is carried out

2.22.4 Rubber Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings or as directed by the Engineer. The rubber shall have a unit weight of 1500 kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, free from moist or dry earth or any other deleterious material.

2.22.5 Grouting under Machinery or Structural Steel Bases.

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone-chips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly.

2.22.6 Non shrink grout

Non-shrink type grout using cementitious base material shall be from approved manufacturer and shall be free flow type. The minimum compressive strength of the grout shall not be less than 650 kg/cm². The grout material shall be expansive to ensure the full contact between the base plate and grout. It should not shrink during setting process. Necessary formwork

shall be used around the portion to be grouted. The water cement ratio shall be as per manufacturer's specification and in no case shall be more than 0.18. To achieve the workability for the minimum horizontal flow of 1000 mm, when the grout is poured from one end, necessary plasticizers may be added as recommended by the manufacturer. These additives / admixtures shall be added by the manufacturer only and shall not be added by the contractor at site in the ready mix grout.

2.22.7 Hydrogen free Non-shrink Grout

Hydrogen free Non-Shrink grout when specified in B.O.q., may be nitrogen generating type with minimum compressive strength as specified (for recommended vendor / brand informations, refer to Data Sheet 'B'). The grout shall have controlled expansion characteristics and shall be capable of being applied in thicker layers. It shall also be impact and vibration resistant. Mixing with water and application procedure shall be all as per manufacturer's instructions.

2.22.8 Non-Shrink Epoxy Grout

Grout shall be a 100% solids system with the ability to be placed in flowable state. Non shrink Epoxy shall have a minimum allowable compressive strength of 800 kg/cm² at 7 days as determined by tests on 50 mm cubes as per ASTM C579, Method B. Epoxy grouts whose resin component has an SPI rating higher than II shall not be used, due to potential local atmospheric contamination making the installation area hazardous.

The grout surfaces shall be made completely dry prior to grouting.

Epoxy grout component ratios shall not be changed from that recommended by the manufacturer. No solvents or thinners shall be added to the mix. The grouts are usually supplied in a 3-pack form consisting of: Resin, Hardener, Aggregate (Filler).

2.23 Waterproofing of Concrete Structure

2.23.1 General

Water proofing of concrete structures shall be done by either suitable extraneous treatments like applying paints, fixing bitumen felts etc. or internally

by suitable design of the concrete mix, addition of suitable admixtures in the concrete or mortar at the time of mixing and/or installing water bars at the joints.

The design, material and workmanship shall conform to the relevant IS Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

If it is found after water / liquid is leaking, the contractor shall carry out rectification work by injection method or any other method as directed by the Engineer at no additional cost to the Owner.

2.23.2 Waterproofing Admixtures

a) In concrete : The admixtures shall be procured from reliable and reputed manufacturers and approved by the Engineer. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to the Owner to supervise the work, if desired by the Engineer.

b) Plaster : The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hrs. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture and laid in appropriate thickness and in layers not exceeding 15 mm layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost to the Owner. On completion, the plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

2.23.3 Bituminous or Tar Coating

The surface shall be sand papered, cleaned and completely coated with hot coal tar pitch of approved manufacture and quality as per IS:216 (not heated above 375 Deg.F) using not less than 1.5 kg. per Sq.M. When the first coat has completely dried up and approved by the Engineer, the second coat shall be applied in the same manner using not less than 1.25 kg. per sq. M. in case of coal tar and 1 kg. per

Sq.M. in case of asphalt. Immediately after application of the second coat and before it is dried up, sand shall be spread on the surface to cover it completely. Sufficient time shall be allowed after spreading of sand before backfilling is done in order to allow the final coat to dry up completely.

2.23.4 Bitumen Felt : Application for Tanking

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The material shall conform to IS:1322, and the workmanship to IS:1609. The bitumen felt shall be hessian base and/or fibre base as specified in Drawing/Schedule of items. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor without charging any extra to the Owner.

The contractor shall execute this work in direct collaboration with one of the well known specialised firm approved by the Engineer.

Cleaning the surface, keeping it dry, providing necessary corner fillets and cement rendering and cutting chases, etc. shall be included in the rate for this item. If any protective brickwork on/against concrete sub-bases or walls are required, these will be paid extra under suitable items in the contract. 10 (Ten) years guarantee for satisfactory performance shall be given by the contractor as well as his specialist sub-contractor jointly and severally, for this item of work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

2.23.5 Polyethylene Films : Application in Walls or base of Structures.

Water proof treatment shall be applied as outlined and as per sequence given hereunder:

- i) The concrete surface shall be made smooth with 12 mm cement plaster 1:6
- ii) Apply hot bitumen 80/100 grade (IS:73-1961) at the rate of 1.0 Kg./Sq.m minimum.

- iii) Lay black polyethylene film 250 micron (IS:2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be heat sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap film another cellophane tape is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

- iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen.
- v) Lay hot bitumen 80/100 grade (IS:73-1961) at 1.0 Kg/Sq.M minimum.
- vi) Lay 250 micron polyethylene film as second layer similar to (iii) above.
- vii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.
- viii) Apply hot bitumen (straight run grade) to IS:73-1961 at 1.0 kg/sq.m dusted with fine sand.
- ix) Protecting with a layer of 75 mm plain cement concrete M-100, or a layer of brick laid in cement mortar 1:6. In case of wall apply a 12mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

2.24 Supply and Specification of Ready Mix Concrete (RMC)

- 2.24.1 Ready Mix concrete (RMC) generally be supplied to the Contractor in grades as required at site by the Owner. In such cases the contractor shall inform the Owner well in advance and inform the Engineer in writing / prescribed form his

requirement time, date and quantity so that the Engineer / Owner can organise such supplies. If the total quantity asked for could not be poured at site, the contractor shall pay for such excess quantity as per mutually agreed rates. It is to be noted that RMC, on arrival at site, shall be immediately pumped to the location of pouring. Pumps and hoses to be supplied by RMC vendor. In case of any delay occurring because of site of pouring being not ready, thus resulting in rejection of RMC because of initial set or otherwise, the entire cost of the rejected batch at mutually agreed rates shall be borne by the Contractor.

2.24.2 In case, RMC is supplied by the Contractor as per contract, the same shall be supplied from M/s. ACC or any other reputed approved supplier. Approval for such supplies shall be given by the Engineer after contractor supplies all information about the supplier as required by the Engineer.

2.24.3 Contractor shall obtain from the manufacturer the test certificates for all materials forming RMC including details of concrete mix design and submit for Engineer's approval.

2.25 FORMWORK

2.25.1 If it is desired by the Engineer, the contractor shall prepare, before commencement of actual work design and drawings for formwork and get them approved by the Engineer.

2.25.2 The arrangement and alignment of formwork, shall be approved by the Engineer prior to concreting. However, this shall not relieve the Contractor from his responsibility of doing accurate work and rectifying the same if required.

2.25.3 Formwork for concrete shall be of plywood, steel, good seasoned timber of other approved materials, properly designed easy to remove and clean and shall give smooth and even surface after removal thereof. It shall be sufficiently tight to prevent loss of cement slurry from the concrete.

As far as practicable, clamps shall be used to hold the forms together. Where use of nails is unavoidable, minimum no. of nails shall be used.

All joints and holes in the formwork shall be caulked with putty, jute cloth or



other approved materials to the satisfaction of the Engineer. The inner face of the shuttering shall be cleaned and thoroughly wetted or greased with approved material. Care shall be taken that such coating is kept free from contact with the reinforcements. All formwork shall be levelled and aligned and all rubbish, particularly, chippings, wood shavings, saw dust and adhering grout shall be removed from the interior of the forms by compressed air or any other approved method before the concrete is placed. Good quality shuttering oil to be used. Burnt black oil will not be permitted.

The contractor shall obtain approval of the Engineer as to the design, fabrication, and erection of the formwork. Form and false work shall be designed to withstand the load pressure determined by the expected rate of deposition of concrete and considering a live load of 145 kg/sq.m. and a wind load of 100 kg/sq.m. where such loads are critical.

Wherever it is specified on the drawings that concrete surface will be left untreated, the pattern of joints in the formwork shall be subject to the approval of the Engineer, and no extra will be paid for special care in shuttering.

Temporary openings shall be provided at columns and wall forms and other places to facilitate inspection and cleaning. Before concrete is placed, all forms shall be carefully inspected to ensure they are properly placed sufficiently rigid and tight and approved by the engineer before the reinforcement bars are placed in position. When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the work shall be stopped until the defects have been corrected.

All corners and angles shall be formed with 45 deg. mouldings to form chambers or fillets on the finished concrete as directed by the Engineer.

Formwork shall be cambered at centre (at free end for cantilevers) as described below, unless otherwise shown or specified. Deflection readings of various elements shall be taken as directed below:-

Type of Member	Compression steel Percentage of tension steel	Camber Coefficient
Simple span	0	0.066
	50%	0.037
Continuous OR restrained span	0	0.032
	50%	0.020
Cantilever span	0	0.086



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Camber (in cms.) = $2.54 K \times L / D$

Where K = Camber coefficient

L = Length of member in meter.

D = Depth of member in Metres

2.26 **TOLERANCES shall be as per IS456**

2.27 The contractor shall submit his design and detailing of formwork before starting the work for the approval of the Engineer. The number of props, their sizes and location shall be such as to be able to safely carry the full dead load and construction loads. However, approval of the Engineer to this effect shall not relieve the contractor of his responsibility for proper work and safety.

2.28 All formwork for beams, slabs and similar members shall be so designed and erected that the sides can be removed without disturbing the soffit and its supports. Vertical props shall be supported on wedges or sole plates or by any other suitable means whereby the props can be gently lowered while commencing the removal of shuttering. Column shuttering shall not be more than 2.5 M in height per piece if not otherwise approved by the Engineer.

2.29 The stripping time for the shuttering and formwork shall in general conform to the provisions in the relevant clauses of IS:456.

2.30 Mode of Measurement

2.30.1 Mode of Measurement for Concrete Work

Payment for all concrete work shall be made on cubic metre basis. The pre-cast members shall be measured on Sq.Metre basis. The measurements shall be as per relevant part of IS:1200. The rates shall be inclusive of taxes, levies, labour, equipments, material, curing, pouring at different heights, working platforms etc. all complete.

Reinforcement and formwork shall be paid separately, if not otherwise mentioned in the Contract.



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2.30.2 Formwork

The payment for formwork items shall be on Sq.m. basis of the actual area in contact with concrete cast. The rate shall be inclusive of all props, struts, bracings, centering and shall be for all heights, with camber, chamfering etc. and keeping formwork for full period as required including all false shuttering and staging and all taxes and levies for high structures.

END